Tata Creek Environmental Water Management Plan

mallee
catchment management authority

DOCUMENT CONTROL

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Executive Summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) covers 216 identified waterways which have been grouped into planning units according to hydrological interconnectedness and commonality of threats impacting on the waterways values; resulting in 23 Waterway Management Units. This Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of Tata Creek. It is an important part of the Victorian Environmental Water Planning Framework and provides the long-term management intentions, based on scientific information and stakeholder consultation that can be used by the respective agencies; Mallee Catchment Management Authority (CMA), Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH); for both short and longer-term environmental water planning.

Tata Creek is located in the Robinvale Plains bioregion within the Mallee Catchment Management Authority (Mallee CMA) region immediately downstream of the township of Boundary Bend and covers 2,131 ha. This plan focuses on a target area predominantly within the eastern section of Tata Creek, covering 272.6 ha that is able to be inundated through environmental watering. The target area includes:

Tata North:

- a deeply incised creek line, known as Tata Creek;
- Tata Wetland (wetland # 7528 933564);
- Racecourse Wetland (wetland # 7528 938566);

Tata South:

- Black Box/Lignum wetland (wetland # 7528 925551); and
- a connected flood runner (wetland # 7528 917550).

The main features of Tata Creek are an eastern section which is predominantly public land consisting of an anabranch, deep wetlands and shallow high level wetlands, and a western section which is private land and has been highly modified for irrigation and grazing. A major feature within the Tata Creek target area is the Murray Valley Highway which runs east-west through the site.

At Tata North, north of the Murray Valley Highway the target area consists of a forested floodplain area with a deeply incised creek, two deeper wetlands known as Tata Wetland and Racecourse Wetland and a series of effluents. South of the Murray Valley Highway the target area of Tata South consists of shallow wetland areas higher on the floodplain. These areas provide habitat for a large range of fauna, including 16 species of waterbirds and nine listed species of native fauna, including the eastern Regent Parrot (*Polytelis anthopeplus monarchoides*) and Inland Carpet Python (*Morelia spilota metcalfei*).

In addition several emergent and semi-emergent aquatic macrophytes have been recorded at Tata Creek, which are particularly important habitat and food sources for aquatic fauna such as frogs, fish and turtle species. Other significant flora in the target area includes the iconic River Red Gum (*Eucalyptus Camaldulensis)*, and also Black Box (*Eucalyptus largiflorens)* and Lignum (*Muehlenbeckia florulenta)* communities, which provide habitat to a variety of native fauna.

The long term management goal of the Tata Creek EWMP is to provide a flow regime that more closely reflects natural events, thus improving the capacity of the target area to provide a productive ecosystem for native flora and fauna.

To achieve this, ecological and hydrological objectives, were designed with the consideration of separate inundation zones. These have been developed to sustain the various ecological components of the creek and four targeted wetlands, and have been incorporated in an optimal watering regime. The ecological objectives are outlined below:

Tata North

- Maintain vegetation health and structure in the Red Gum communities (EVCs 106, 295, 809, 811, 813, 818, 823)
- Maintain vegetation health and structure in the Black Box communities (EVCs 103, 813, 818)
- Promote aquatic macrophyte diversity and area in the wetland habitats (EVCs 200, 810, 811, 819, 821)

Tata South

- Maintain vegetation health and structure in the Black Box communities (EVCs 103, 813, 823)
- Maintain vegetation health and structure in the Lignum communities (EVCs 104, 813, 823)

All Areas

Increase dissolved organic matter, particulate matter and macro-invertebrate productivity

This EWMP outlines two stages of inundation. Stage 1 involves the inundation of approximately 68 ha including part of Tata Creek itself, Tata Wetland and Racecourse Wetland, requiring approximately 780 ML of environmental water. Stage 2 will inundate Tata North and also the Black Box/Lignum wetland, the flood runner and part of the floodplain, encompassing an area of approximately 204.6 ha in Tata South. Approximately 2242 ML of environmental water will be required.

The optimal watering regime for Tata Creek is outlined below:

	Inundation area, duration and frequency
Tata Creek North	Inundate Tata Wetland, Racecourse Wetland and Tata Creek through to the regulator structure three years in ten with a maximum interval of seven years between events. Maintain water in the wetlands for at least six months to promote aquatic macrophytes before allowing natural recession through Tata Creek to improve health of fringing River Red Gum. It is expected water will be retained in Tata Wetland and/or Racecourse Wetland for a number of years, resulting in inundation of this area for every year to encourage aquatic macrophyte diversity.

	Inundation area, duration and frequency
Tata Creek South	Inundate the Black Box/Lignum wetland three times in ten years with a maximum interval of eight years between events. Maintain water within the wetland for three months to maintain the health of Black Box and Lignum communities, allowing wider floodplain inundation once in ten years for up to two months to maintain elevated Black Box and Lignum communities.

The delivery of environmental water necessary for these water regimes will require the installation of infrastructure, outlined in this plan. The proposed infrastructure requires further investigation and design.

Acknowledgements

This EWMP was produced by The Mallee Catchment Management Authority, with funding from the Victorian Government. The valuable contributions of Parks Victoria, Jane Roberts, Terry Hillman, other agencies and community members are also acknowledged.

1 Introduction

This Environmental Water Management Plan (EWMP) has been prepared to establish the long-term management goals at Tata Creek. The key purposes of the EWMP are to:

- identify the long-term objectives and water requirements for Tata Creek, Tata Wetland and Racecourse Wetland, identified as a medium priorities in the *Mallee Waterway Strategy 2014 – 2022* (MWS);
- identify the long-term objectives and water requirements for two other floodplain wetlands within the Tata Creek area (Black Box/Lignum Wetland and #7528 17550);
- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetland;
- inform the development of seasonal watering proposals and seasonal watering plans; and
- inform Long-term Watering Plans that will be developed under Basin Plan requirements.

2 Site overview

2.1 Site Location

The Mallee CMA region is located in the north-west of Victoria and is the largest catchment in the state. Its area of responsibility covers approximately 39,000 km² with an estimated regional population of 65,000. The catchment runs along the Murray River from Nyah to the South Australian border, and as far south as Birchip and Rainbow (MCMA 2014). Major towns include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The region has a semi-arid climate, with an annual mean rainfall of around 250mm and average daily temperatures (at Mildura) ranging from 32°C in summer to 15°C in winter (MCMA 2006a).

The Mallee CMA region consists of 38% of public land, which is mainly comprised of national parks, reserves and large reaches of riverine and dryland state forest. The remainder of the region is important for dryland farming of sheep and cereals, and irrigated horticulture (MCMA 2006a).

A regional context document has been prepared to compliment the Mallee CMAs EWMPs and should be read in conjunction with this document. (Sunraysia Environmental, 2014)

In 2006, the Mallee CMA engaged consultants (Ecological Associates) to investigate water management options for the Murray River floodplain from Nyah to Robinvale. One of the major outcomes of these investigations was the development of a system of Floodplain Management Units (FMUs). These divide the floodplain into management units which water regimes can be managed independently of another FMU, but which are relatively consistent in their ecological values and land uses. The Mallee CMA has based its environmental water management plans on these FMUs to achieve more effective management of hydrologically connected systems. In addition to this, the Mallee CMA has also used individual FMUs or groupings of FMUs to form Waterway Management Units (WMUs) for planning within its Mallee Waterway Strategy (2014).

The site for this plan is the Tata Creek FMU, hereafter referred to as Tata Creek in this document, on the Murray River floodplain, approximately 4 km northwest of the township of Boundary Bend (Figure 1), between 1228 and 1201 river km. The sub-unit falls within the western section of the Boundary Bend Water Management Unit (WMU).

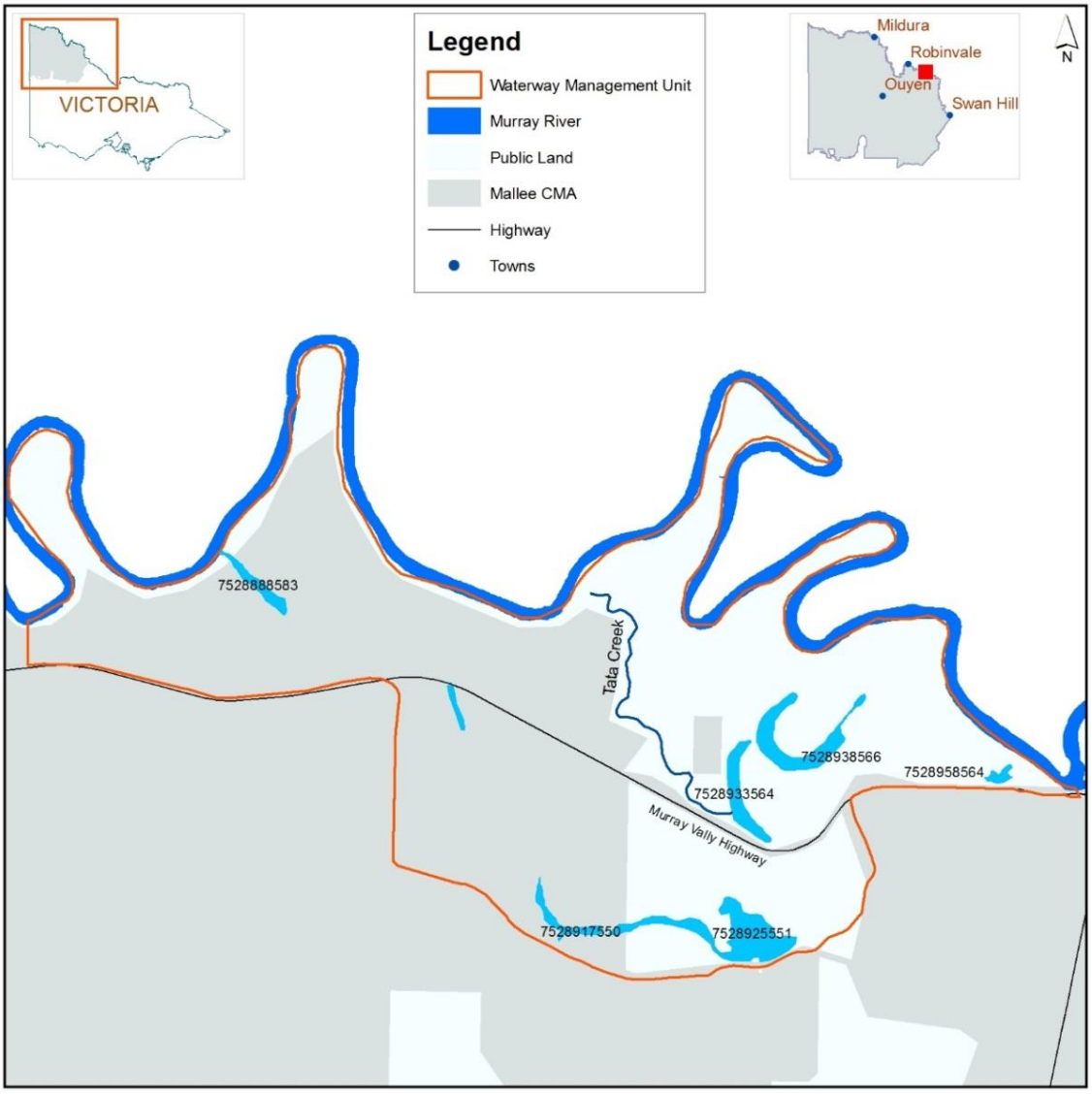


Figure 1. Map of Tata Creek

2.2 Catchment Setting

Tata Creek is located in the Robinvale Plains bioregion, which is characterised by a narrow gorge confined by the cliffs along the Murray River, which is entrenched within older sedimentary rocks. Alluvium deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Dermosols, Vertosols, Chromosols and Sodosols) which support Riverine Grassy Forests and Riverine Grassy Chenopod Woodlands.

The site is located in the Mallee Tract which extends from Wakool Junction to the Darling River Junction at Wentworth. Through this section of the Murray River, the river generally has a single channel within a large trench of 10-20 m (Thoms et al 2000). Tata Creek is located between several key sites on the Murray River: the junction of the Murrumbidgee and Murray Rivers is approximately 14 river kilometres upstream; approximately 11 river kilometres downstream is the Nationally Important Belsar Island Wetlands; and immediately to the north, across the Murray River in New South Wales, is Manie State Forest.

To the south of Tata Creek the landscape follows a pattern typical of the Mallee CMA region, with floodplain giving way to elevated terraces of mallee dunes and mallee vegetation. The mallee dunes adjacent to Tata Creek and surrounding Boundary Bend have experienced significant irrigation development in recent years for a variety of crops including wine grapes, almonds, vegetables and

citrus. Irrigation and grazing occur across parts of the floodplain within the western section of Tata Creek. Tata Creek is bounded by the Murray River to the north, and an elevated embankment enables Murray Valley Highway to traverse the floodplain in the south (Figure 1).

The eastern section of Tata Creek is predominately public land and is a complex area consisting of an anabranch, deep wetlands, and shallow, high level wetlands; in contrast the western section is private land and highly modified with a number of blockages to the natural flow paths of water on the floodplain (Ecological Associates 2006).

2.3 Tata Creek

Tata Creek is located in the Robinvale Plains bioregion within the Mallee Catchment Management Authority (Mallee CMA) region immediately downstream of the township of Boundary Bend and covers 2,131 ha.

The main features of Tata Creek are an eastern section which is predominantly public land consisting of an anabranch, deep wetlands and shallow high level wetlands, and a western section which is private land and has been highly modified for irrigation and grazing.

A major feature within the Tata Creek area is the Murray Valley Highway which runs east-west through the site. Tata North, north of the Murray Valley Highway consists of a forested floodplain area with a deeply incised creek (Tata Creek), two deeper wetlands known as Tata Wetland (#7528 933564) and Racecourse Wetland (#7528 938566) and a series of effluents (Figure 1). South of the Murray Valley Highway the target area of Tata South consists of shallow wetland areas higher on the floodplain including wetland #7528 925551 and a connected flood runner wetland # 7528 917550.

Wetland #752888583 is located within the highly modified grazing land, whilst wetland #7528958564 is a small shallow freshwater marsh in the eastern section of Tata Creek.

Tata Creek supports a variety of vegetation types. In Tata North, River Red Gum forest and woodlands occur on the lower terraces, sedge and marshlands occur within wetland zones, and Black Box woodlands and Lignum occur on higher terraces of the floodplain. Areas of Tata South mainly support Lignum Wetland and Lignum Shrubland (Ecological Associates 2006).

2.4 Target Area

This EWMP focuses on a target area predominantly within the eastern section of Tata Creek, covering 272.6 ha that is able to be inundated through environmental watering.

The target area includes two zones, divided by the Murray Valley Highway:

Tata North:

- a deeply incised creek line, known as Tata Creek;
- Tata Wetland (wetland # 7528 933564);
- Racecourse Wetland (wetland # 7528 938566);

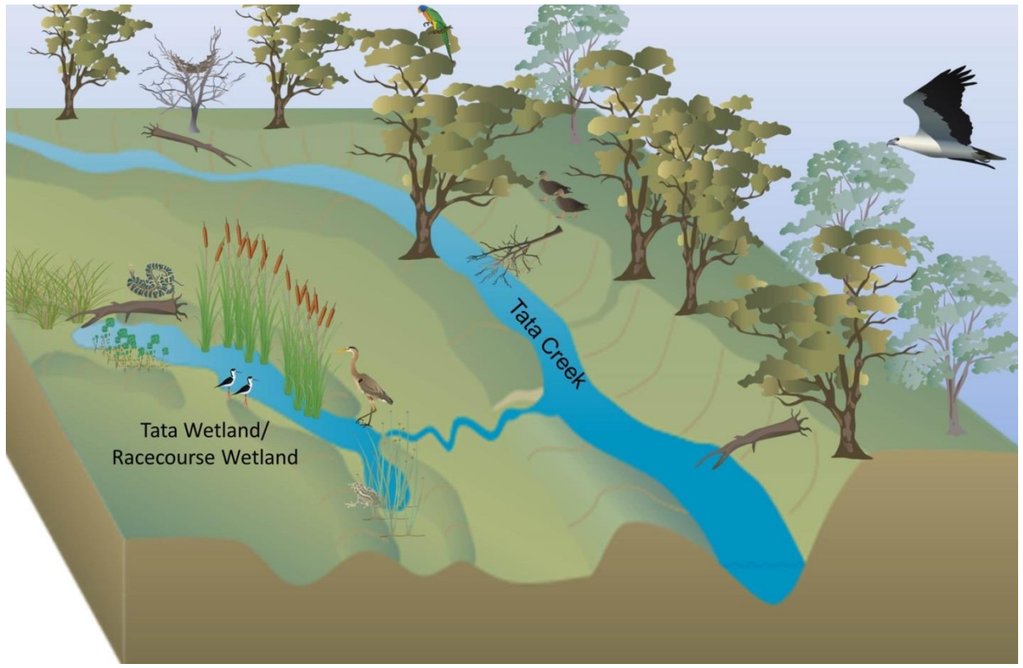
Tata South:

- Black Box/Lignum wetland (wetland # 7528 925551); and
- a connected Flood Runner (wetland # 7528 917550).

The target area within Tata Creek is the extent to which environmental water is able to be managed with proposed infrastructure in place. Wetland #7528 88583 and wetland #7528 958564 are excluded from the target area.

2.5 Conceptualisation of the Site

Tata Creek has been represented in a conceptual model. The model provides a visual representation of the sites processes and components that are discussed throughout this EWMP.



Tata Creek is a deeply incised creek fringed by old **River Red Gum** . **Black Box** occurs higher on the floodplain. Racecourse Wetland and Tata Wetland are hydrologically connected to Tata Creek. The vegetation structure of these wetlands includes emergent **macrophytes** , and herbs and forbs.

Healthy vegetation structure provides habitat potential for birds such as the **Regent Parrot** , and healthy River Red Gum and Black Box provide leaf matter and debris as cover, forage, breeding and feeding sites for reptiles including for the **Inland Carpet Python** . Older Black Box and Red Gum can provide hollows for nests, and **hollow logs** . fallen timber and debris can provide materials for **White-bellied Sea-eagle** and other the stick-nest building native birds. Fallen River Red Gum can provide structure within the wetland for native fish.

Freshwater inflows to the system will be delivered as environmental water to provide a range of feeding, breeding, watering points and habitats for native fauna. This inundation leads to the rapid release of nutrients from the soils, and the seed and egg banks of plants and aquatic invertebrates emerge. This pulse in aquatic macrophytes and invertebrates may provide food for aquatic fauna such as **turtles** and **frogs**, which in turn provides food for **waterbirds** . The wetlands become more productive and surrounding vegetation such as **Eucalypt** species benefit from periodic inundation as water levels rise and fall.

Water Dependent Flora

- River Red Gum
- Black Box
- Emergent & Semi-emergent Macrophytes

Wetland Fauna

- Small Waders
- Large Waders
- Grazing Waterfowl
- Frogs

Habitat Value

- Grasses
- Fallen Timber
- Dead Tree with Stick Nest

Listed Species

- Inland Carpet Python
- Regent Parrot
- White-bellied Sea-eagle

2.6 Land Status and Management

The Tata Creek target area includes the Proposed Murray River Park, the River Murray Reserve and three private land tenures (Figure 2). The Proposed Murray River Park (VEAC 2008) covers the majority of the target area including Tata Creek itself, Tata Wetland, Racecourse Wetland, and a significant part of the Black Box/Lignum Wetland. Public land in this area is managed by Parks Victoria as per the River Red Gum Investigation (VEAC 2008). One private property is located on the floodplain surrounded by the Park (Figure 2). The Flood Runner (wetland #7528 917550) is on private land. The Black Box/Lignum wetland extends eastwards across a narrow private tenure, a road reserve, and a second private tenure (Figure 2). The River Murray Reserve extends along the Murray River frontage and is managed by Parks Victoria. Relevant stakeholders are listed in Table 1.

The Murray Valley Highway runs east-west through the target area and is managed by Vic Roads. A road reserve (managed by Swan Hill Rural City Council) identified as Brooklyn Lane runs north-south and intersects the connection between the Black Box/Lignum Wetland and the Flood Runner.

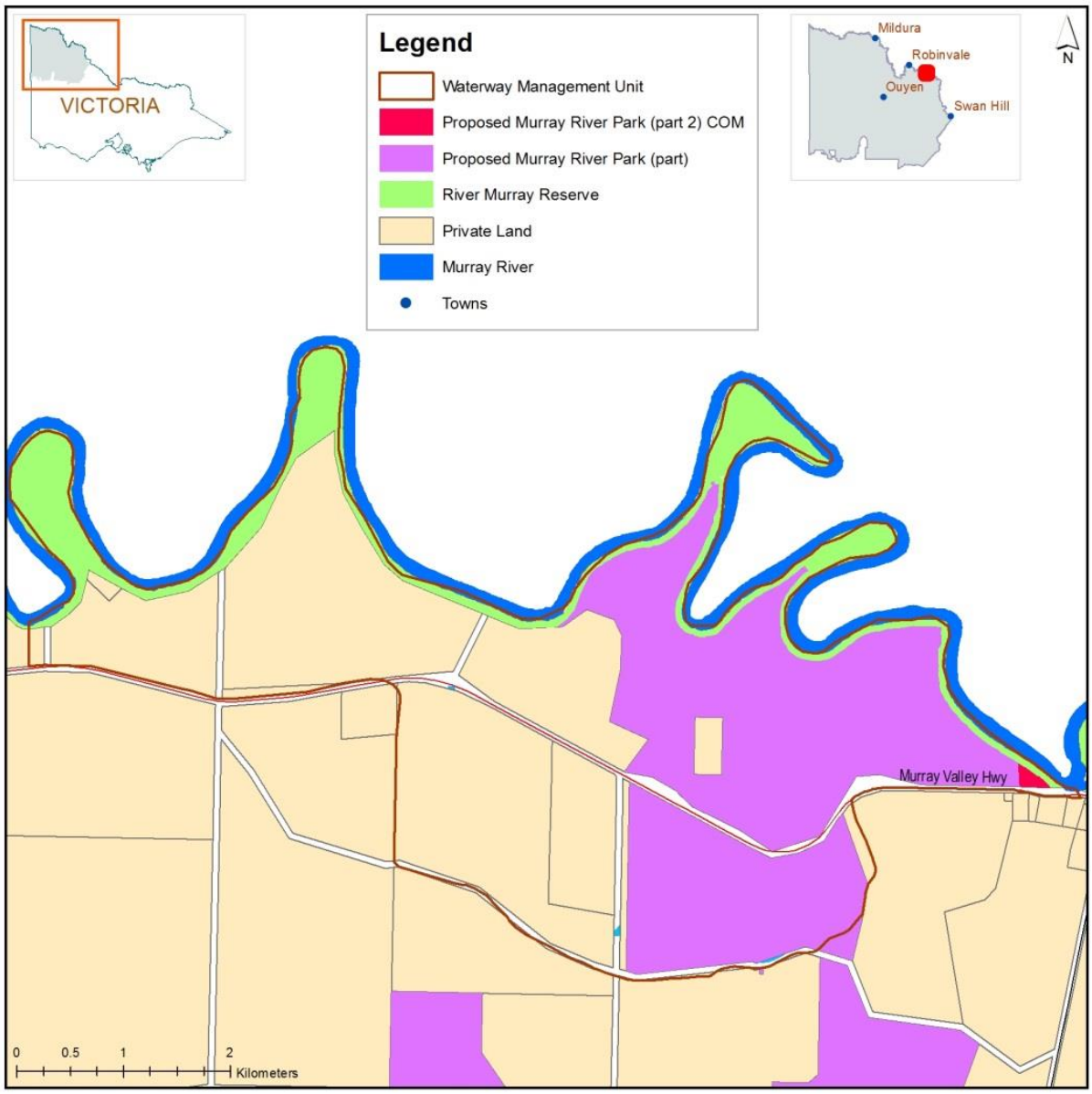


Figure 2. Land management boundaries at Tata Creek

Table 1. Stakeholders for Tata Creek

Group	Role
Parks Victoria	Land Manager
Mallee CMA	Regional environmental management
Department of Environment and Primary Industries	State level environmental management
Goulburn Murray Water	River Murray operations
Swan Hill Rural City Council	Local Government/Land Manager (Brooklyn Lane)
Vic Roads	Land Manager (Murray Valley Highway)
Aboriginal Stakeholders	Aboriginal Stakeholders. Provides assistance in planning and implementation of programs.
Landholders with pump sites and infrastructure within the target area, and/or land adjacent to inundation zone/s	Land user, provides assistance in planning and implementation of programs
Robinvale & Manangatang Landcare Group	Assistance in planning and implementation of programs
Victorian Environmental Water Holder	Determines locations and volumes for environmental water delivery

Figure 3. Junction of Tata Creek (left) and Tata Wetland (right).

2.7 Creek and Wetland Characteristics

A brief overview of the main characteristics of the target area is provided in Table 2.

Table 2. Summary of Tata Creek Characteristics

Characteristics	Description				
Name	Tata Creek	Tata Wetland	Racecourse Wetland	Black Box/Lignum Wetland	Flood Runner
Mapping ID within area	N/A	#7528 933564	#7528 938566	#7528 925551	#7528 917550
Area (ha)	~3.3 km	12.6	20.9	32.9	6.6
Bioregion	Robinvale Plains				
Conservation status	Areas of Endangered, Vulnerable, Depleted and Least Concern				
Land status	Proposed Murray River Park	Proposed Murray River Park	Proposed Murray River Park	Proposed Murray River Park / Road Reserve / Private	Private / Road Reserve
Land manager	Parks Victoria	Parks Victoria	Parks Victoria	Parks Victoria / Landholders / Swan Hill Rural City Council	Landholder
Surrounding land use	Reserve	Reserve	Reserve	Reserve and Farming	Reserve and Farming
Water supply	Receives inflows from Murray River at flows > 40,150 ML/day	Receives inflows from Murray River Tata Creek at flows > 43,160 ML/day	Receives inflows from Murray River via connection to the east, or via Tata Wetland at flows > 73,900 ML/day	Receives inflows from Murray River via Tata Wetland at flows > 141,500 ML/day	Receives inflows from Murray River via Black Box Wetland at flows > 141,500 ML/day
1788 wetland category		Deep Freshwater Marsh	Deep Freshwater Marsh	Deep Freshwater Marsh	Permanent Open Freshwater
2013 wetland category		Deep Freshwater Marsh	Deep Freshwater Marsh	Shallow Freshwater Marsh	Permanent Open Freshwater
Wetland depth at capacity	Unknown	Unknown	Unknown	Unknown	Unknown

2.8 Management Scale

The Tata Creek EWMP proposes a staged implementation of environmental watering. The area inundated following implementation of the two stages is the target area for the EWMP.

The target areas described in the two stages are the areas that are able to be managed with environmental water following the construction of the infrastructure proposed in this EWMP. The target area covers 272.6 ha, of the 2,131 ha of Tata Creek.

2.9 Overview of the Watering Proposal and Inundation Stages

Stage 1 (Figure 4), Tata North, can be achieved with minimum works, whereas Stage 2 (Figure 5), Tata North and Tata South, requires more extensive works.

Stage 1: Tata North

Stage 1 (Figure 4) involves the inundation of approximately 68 ha including Tata Wetland and Racecourse Wetland requiring approximately 776 ML of environmental water. Environmental water will be delivered to Tata Wetland using diesel pumps (P1) which will pump from the Murray River into an effluent which connects to the eastern end of the wetland. By continuing to pump to an inundation height of 51.7 m AHD, Tata Wetland will connect to Racecourse Wetland and Tata Creek. This stage includes the construction of a levee and regulating structure incorporating an access track (R1, L1) on Tata Creek itself (at a natural sill in the bed of the creek) to retain water within the wetlands and upstream creek whilst retaining connectivity for natural flow events. A culvert (C2) is required to provide public access during inundation events (Figure 4).

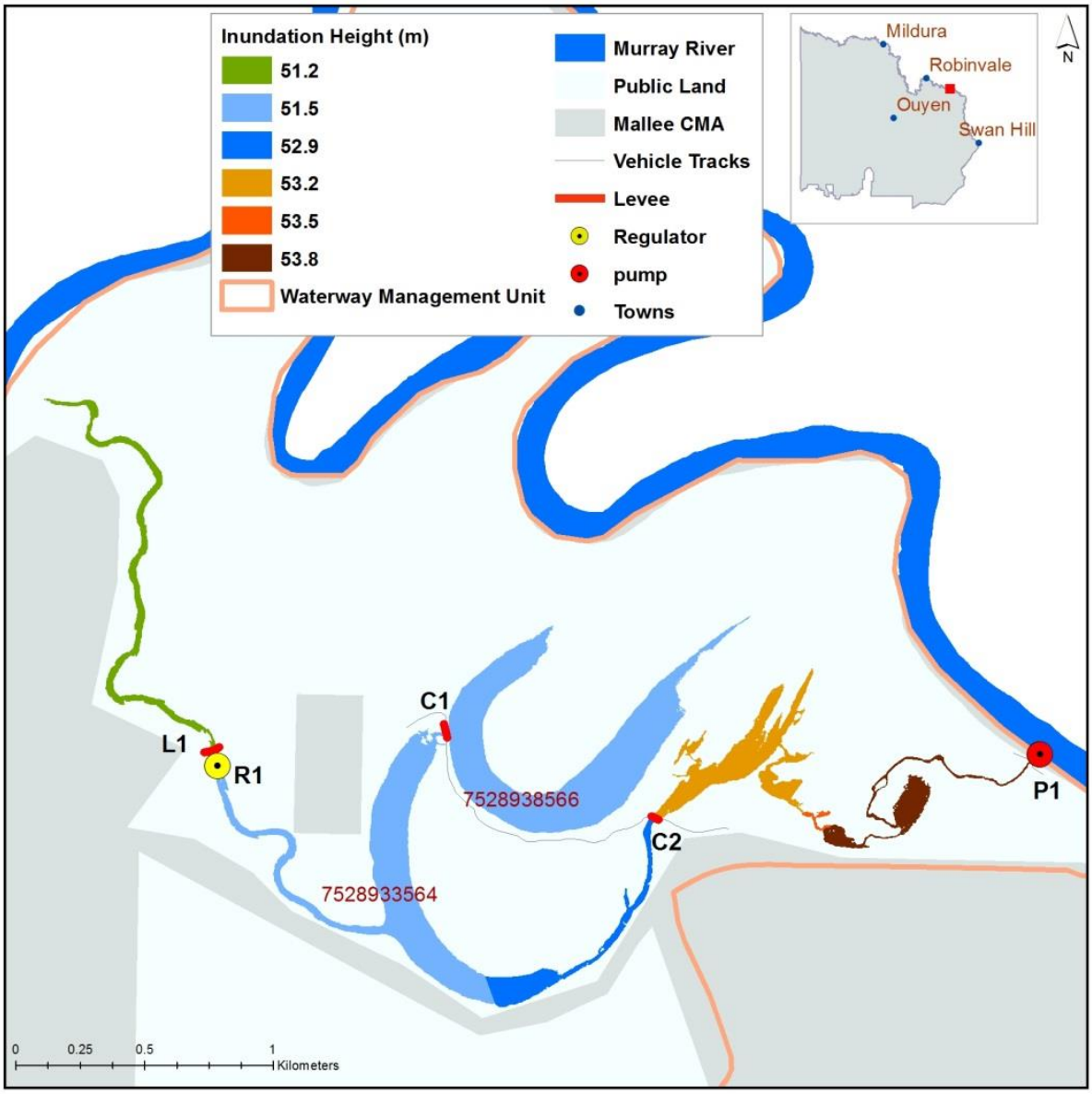


Figure 4. Target area at Tata Creek – Stage 1: Tata North

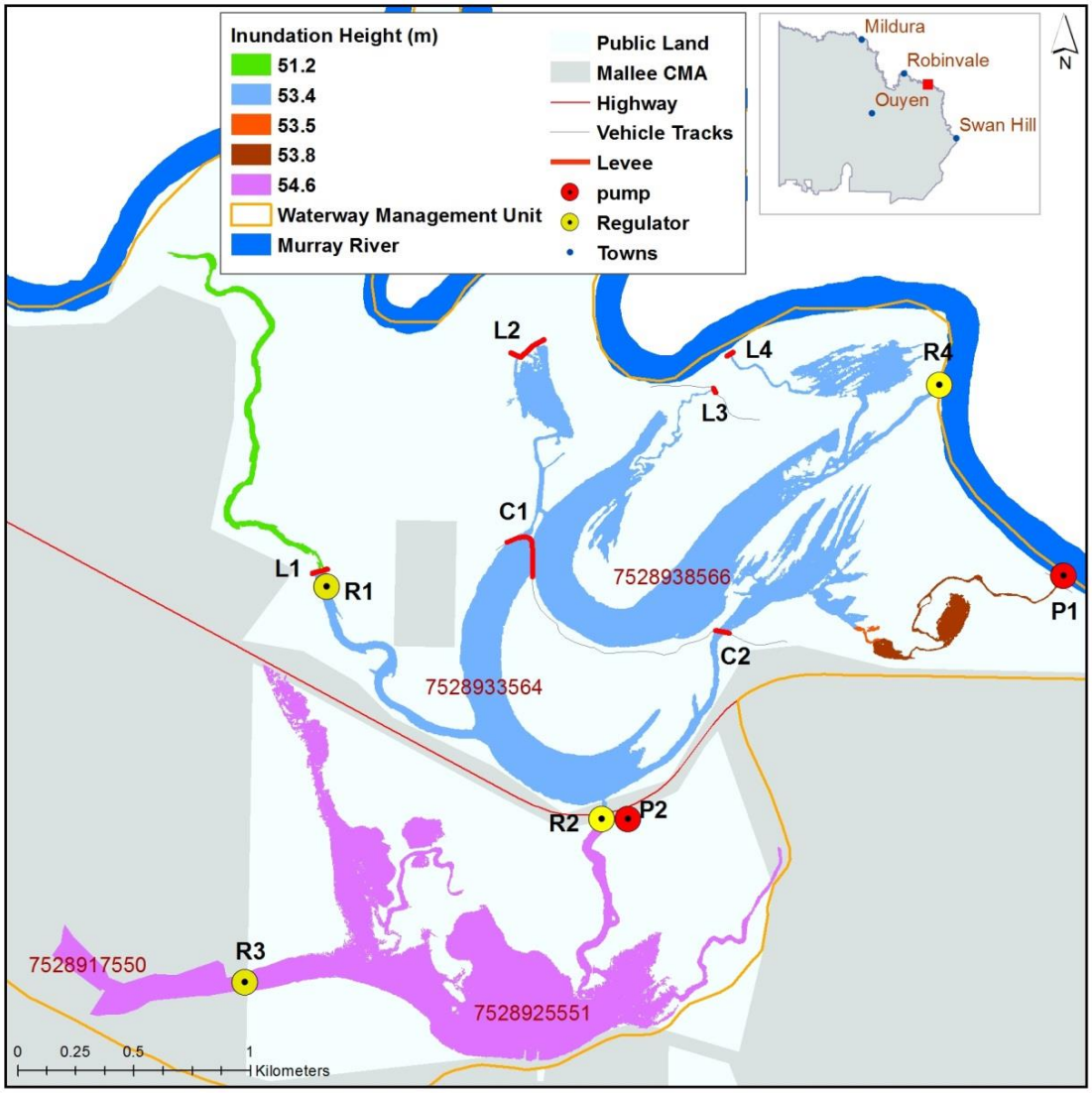


Figure 5. Target area at Tata Creek – Stage 2: Tata North and Tata South

Stage 2: Tata North and Tata South

Stage 2 (Figure 5) involves the inundation of an area of approximately 204.6 ha requiring approximately 2242 ML of environmental water. This stage incorporates Tata Creek itself, Tata Wetland and Racecourse Wetland in Tata North; and the Black Box/Lignum Wetland and the Flood Runner in Tata South.

This stage involves utilising the same pump location on the Murray River (P1) to deliver environmental water to Tata North, and continuing to pump to an inundation level of 53.4 m AHD, increasing the inundation area in Tata North. Structures required at Tata North in addition to Stage 1 works include (Figure 5):

- replacement or refurbishment of the culvert at C1;
- a regulator structure (R4); and
- three levee banks at low break out points on the floodplain (L2, L3, L4)

Stage 2 also includes the option of delivering environmental water to the Black Box/Lignum Wetland and the Flood Runner via a connection with Tata Wetland that flows through a culvert under the Murray Valley Highway. Environmental water delivery to these wetlands requires an additional diesel pump (P2) south of the highway to reach an inundation level of 54.6 m AHD.

To allow for the area south of the highway to be inundated to a higher level without impacting on the wetlands in Tata North, a regulating structure (R2) is proposed immediately south of the highway to manage the connection between Tata Wetland and the Black Box/Lignum wetland. This will allow for the two areas to be managed independently during environmental water delivery while allowing connection during high flow/flood events. An additional regulating structure (R3) is also proposed between the Black Box/Lignum wetland and the Flood Runner to allow for the management of environmental flows and flood events between the two wetlands.

2.10 Related Agreements, Policy, Plans and Activities

Tata Creek is situated on the Victorian floodplain of the Murray River, which is the subject of investigation in many guises. These include salinity management plans, flow studies and Land Conservation Council Reviews. An investigation into River Red Gum Health by the Victorian Environmental Assessment Council (VEAC) in 2008 resulted in the majority of the Tata Creek target area being changed from State Forest status to a Murray River Public Purposes Reserve in 2010.

Mallee River Health Strategy

The Mallee River Health Strategy (MCMA 2006a) refers to Tata Creek as Reach 20 within the M2-1 Boundary Bend Management Zone. The Tata Creek reach is classified as Priority River Classification 4. It describes the values within the management zone which include a number of significant river bends, including Pile Bend (within the Tata Creek target area) and a number of significant species including the Great Egret (*Ardea alba*), Regent Parrot (*Polytelis anthopeplus*) and Carpet Python (*Morelia spilota metcalfei*).

Mallee Waterway Strategy

The Mallee Waterway Strategy (MCMA 2014) identifies Tata Creek itself as a medium priority reach; and Tata Wetland and Racecourse Wetland as medium priority wetlands. Long term Resource Condition Targets include (MCMA 2014):

- improve the condition of riparian habitat associated with high and medium priority waterways by 2022;
- To improve the condition of aquatic habitat associated with high and medium priority waterways by 2022;
- To improve hydrology within high and medium priority waterways by 2022;
- To improve water quality within high and medium priority waterways by 2022;
- To increase the number of Cultural Heritage sites associated with priority waterways which are captured within registered management plans by 2022; and
- To increase community understanding of, and participation in the management of, priority waterways by 2022.

Further information on Management Activities can be found in the Mallee Waterway Strategy (2014).

Regional Context Document for Environmental Water Management Plans: Mallee CMA Region

Additional information on regional agreements, policies, plans and activities can be found in the Context Document for Environmental Water Management Plans, Mallee CMA Region (Sunraysia Environmental 2014).

3 Hydrology and System Operations

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

The target area within Tata Creek is located on the Victorian floodplain of the Murray River (1228 km to 1201 km) approximately 54 km downstream of river gauge (# 414200) Downstream of Wakool Junction and 84 km upstream of river gauge (# 414209) Upstream of Euston Weir. This area receives water from the Murray River and is located downstream of the Murrumbidgee junction.

3.1 Water Management and Delivery

3.1.1 Pre-regulation

Prior to river regulation in the reach of the Murray River below the Murrumbidgee junction, the floodplain experienced inundation more frequently and these events had a greater duration (Ecological Associates 2007b). Natural flows were highest in spring and lowest in autumn. Tata Creek, Tata Wetland and Racecourse Wetland experienced inundation regularly during relatively low river flows (Ecological Associates 2006). These wetlands would have been semi-permanent with flooding persisting throughout the year in a lot of years (Ecological Associates 2007b). The inundation allowed for recruitment and preservation of wetland and floodplain flora species and offered more regular access to a wider range of habitat and food sources for aquatic species, including small and large native fish species.

3.1.2 Post-regulation

Locks and weirs were completed at Mildura (downstream) in 1927 (G-MW 2013), and at Euston (downstream) in 1937 (MDBC [n.d.]), and along with others installed at similar times, have had a significant impact on the flow and flood regime in the river. In this part of the Murray River, the frequency, duration and magnitude of all but the largest floods have been reduced due to effects of major storages in the Murray and its tributaries (Thoms et al. 2000). River regulation and increased consumptive water use have reduced overbank flows that are important for water dependent flora and fauna species. Flows of 15,000 ML/day are most affected and occur less often than pre regulation (Figure 6). Floods generated by flows less than 90,000 ML/day are of shorter duration than under pre-regulation conditions (Figure 6). The interval between flow events above 10,000 ML/day has also increased significantly (Figure 6).

A comparison of daily discharge by month for the pre-regulation and post-regulation (current) conditions is reproduced from Ecological Associates (2007b) in Figure 7. 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).

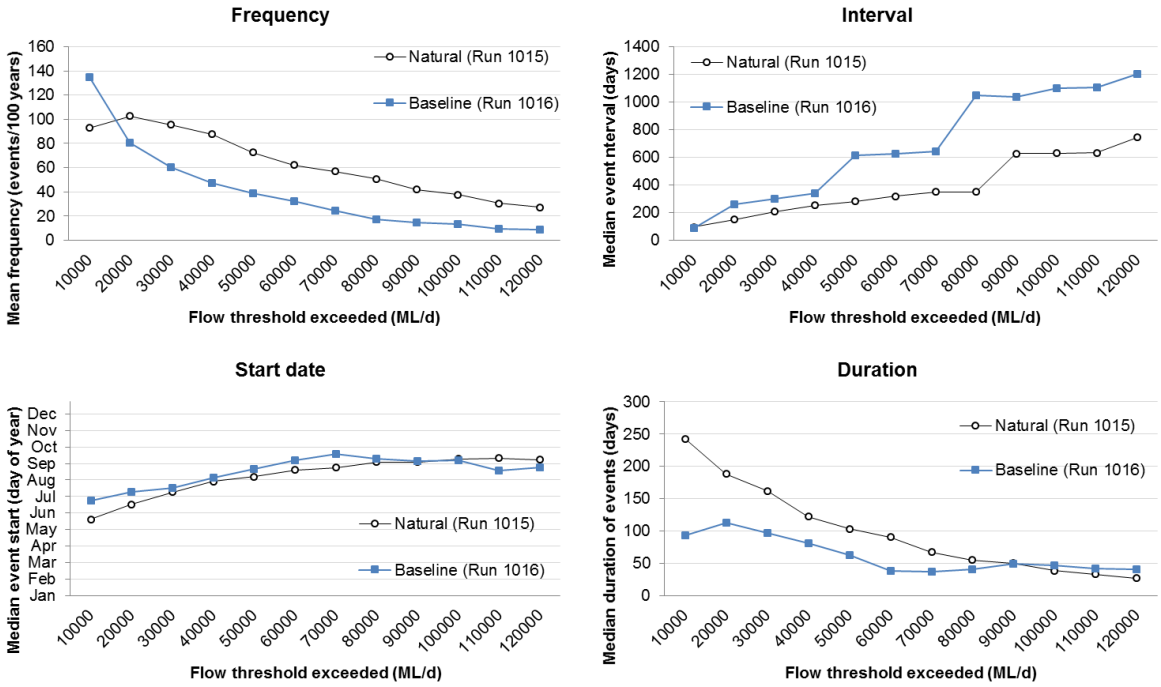


Figure 6. Comparison of Natural (pre-regulation) and Baseline Modelled Flow (post-regulation) scenarios for Euston Downstream (Gippel, 2014).

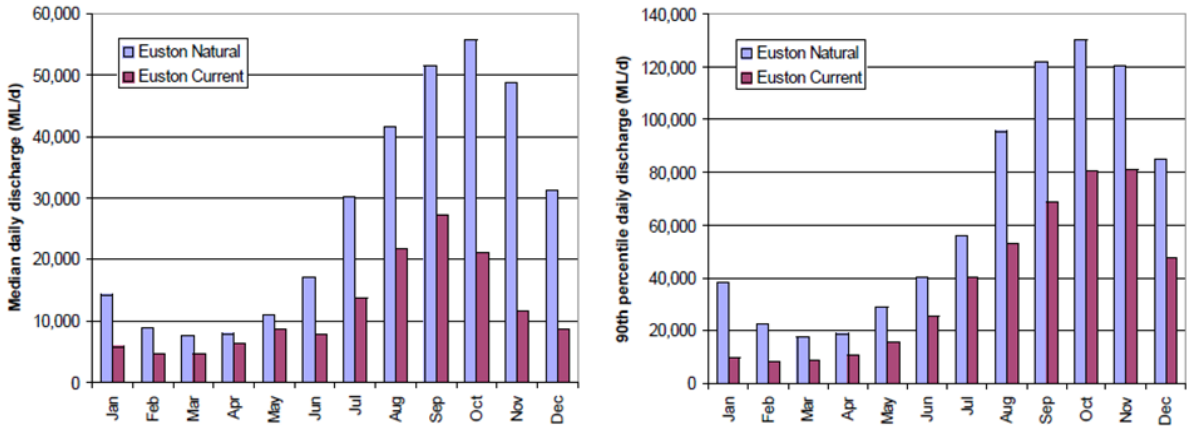


Figure 7. Distribution of median flows and 90th percentile flows for each month in the Murray River through Euston Weir for natural (pre-regulation) and current (post-regulation) conditions Source: derived from MDBC MSM-Bigmod 109-year data (Ecological Associates, 2007b).

3.1.3 Changes to frequency of wetland inundation at Tata Creek

The commence to flow (*ctf*) rates measured in ML/day downstream of Euston Weir for the wetlands within Tata Creek are:

- 40,150 - Tata Creek;
- 43,160 - Tata Wetland;
- 73,900 - Racecourse Wetland*; and
- 141,500 - Black Box/Lignum Wetland & flood runner.

* This *ctf* value is suspected to be incorrect – analysis of LiDAR data suggests there is an upstream effluent (R4, Figure 5) that connects this wetland at flow volumes similar to Tata Wetland.

Spells analysis undertaken by Gippel (2014) was consulted to better understand the frequency of inundation of Tata Creek and the wetlands under post-regulation conditions. The percentage of years with the threshold event from pre-regulation to post-regulation have significantly reduced for all thresholds above 40,000 ML/day, and the durations of these events are also significantly reduced for all flow thresholds (Table 3).

The spells analysis indicates floods of 45,000 ML/day required to engage Tata Creek and fill Tata Wetland occur on average half as often post-regulation, and are of shorter duration.

Table 3. Modelled natural (pre-regulation) and baseline (post-regulation) flows for flow thresholds between 40,000 and 145,000 ML/day downstream of Euston gauge

Natural (N)/ Baseline (B)	Threshold ML/d	Frequency Mean (/10yrs)	Median Interval in days (50% of events are less than)	Median Duration in days (50% of events are shorter than)	Median Event Start date	Percentage of years with Event
N	40,150	8.77	253	122	2nd Aug	87%
B	40,150	4.74	341	81	10th Aug	46%
N	45,000	8.25	272	105	11th Aug	82%
B	45,000	4.12	572	77	19th Aug	39%
N	73,900	5.44	347	56	1st Sept	48%
B	73,900	2.02	665	42	18th Sept	18%
N	141,500	1.32	766	33	14th Sept	12%
B	141,500	.061	5711	52	24th Sept	5%

3.1.4 Current Creek and Floodplain Hydrology

Tata Creek is hydrologically connected to the Murray River at 1213 river km, and commences to flow at 40,150 ML/day. A natural sill is located approximately 2.3 km along the creek, which retains floodwater within the southern section of the creek after a flood event. There is a track crossing at this location providing access to private land (L1, Figure 4).

Water also enters the target area from an upstream connection point at R4 (Figure 5). This connection has a recorded *ctf* value of 73,900 ML/day, although this value may actually be lower, and warrants further investigation. LiDAR suggests a number of other connection points become active as Murray River flows increase (Figure 9).

Racecourse Wetland fills before water flows into Tata Wetland and finally connects Tata Creek (pers. comm. P. Goldring, 28 April 2015) with full flow-through occurring when flows are sufficient to inundate above the height of the natural sill (L1, Figure 4).

Figure 8. Culvert under Murray Valley Highway (from northern side of Highway, looking south)

The wetlands in Tata South (Black Box/Lignum wetland and the flood runner are situated higher on the floodplain, and require Murray River flows greater than 141,500 ML/day to connect, with water passing through three large culverts (approximately 1.5 m diameter) that are positioned beneath the highway (Figure 8). The Murray Valley Highway traverses the floodplain, and is constructed on a large embankment. It forms a major barrier to natural flows during larger flood events.

There are a number of sills, levees, fords and culverts throughout the target area that impede natural flows and, when breached, restrict vehicle access to parts of the bend.

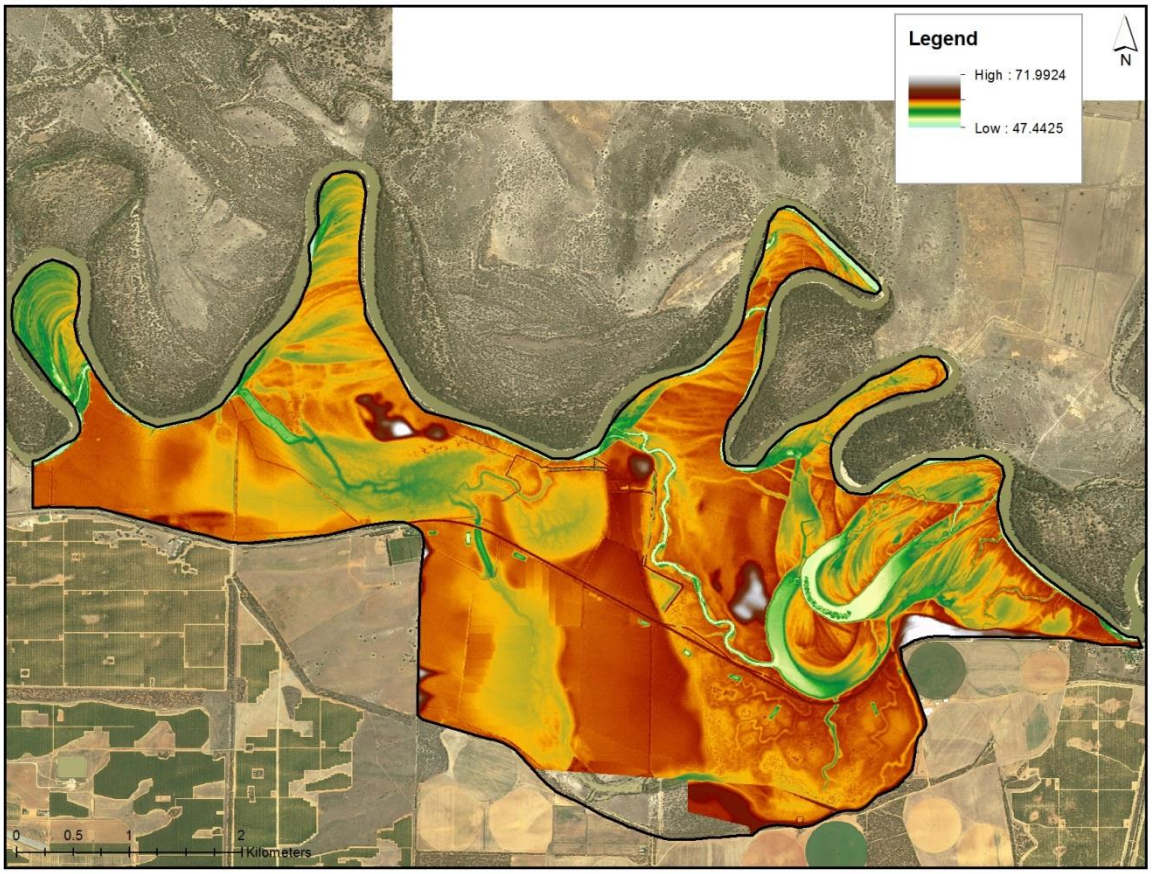


Figure 9. LiDAR map of Tata Creek

3.1.5 Environmental Watering

Environmental watering occurred at Tata Creek in 2005/6 as emergency River Red Gum watering (Kelly, 2006) (Table 4). Water for these events was sourced from the donations from the Sunraysia Irrigation District, along with other unknown sources. The initial purpose of the emergency watering program was that the prolonged dry conditions had resulted in a drastic decline in River Red Gum health. Water was pumped from the location on the Murray River that is proposed in this EWMP. The watering inundated and area of approximately 216 ha in Tata North (182.5 ha) including Racecourse Wetland (20.9 ha) and Tata Wetland (12.6 ha).

Table 4. A summary of recent environmental watering and natural flow events events at Tata Creek

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Area Inundated
2005-06	15th - 28th June 2006	Donation – Sunraysia Irrigation District	257	1450	216 ha, including Racecourse Wetland and Tata Wetland (approx.)
	15th – 28th June 2006	Unknown	1000		
	15th – 28th June 2006	Unknown	193		
2010/11	Spring, Summer and Autumn	Natural flows	0	0	Tata North and South
2011	Spring	Natural flows	0	0	Tata North
2012	Spring	Natural flows	0	0	Tata North
2013	Spring	Natural flows	0	0	Tata North
2016	Spring and Summer	Natural flows	0	0	Tata North and South

Environmental watering has not occurred at Tata South.

The extent of inundation achieved through the delivery of environmental water at Tata Creek can be increased if further infrastructure were to be put in place. The section titled Environmental Water Delivery Infrastructure discusses opportunities for future works.

4 Water Dependent Values

4.1 Environmental Values

Wetlands and waterways on the floodplain support a vast array of flora and fauna. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

4.1.1 Listings and Significance

Fauna

Native species recorded at Tata Creek are listed in Appendix 1. Of special interest and responsibility are the species listed in legislation, agreements or conventions that would benefit from the creek experiencing more frequent inundation. These are summarised in Table 5.

Table 5. Listed fauna recorded at the site

Scientific name	Common name	Type	International agreements	EPBC status	FFG status	DELWP status	Hollow Dependent
Ardea modesta	Eastern Great Egret	B	NL	NL	L	V	
Climacteris picumnus	Brown Treecreeper	B	NL	NL	NL	NT	✓
Haliaeetus leucogaster	White-bellied Sea-Eagle	B	C	Ma, Mi	L	V	
Litoria Raniformis	Growling Grass Frog	A	NL	VU	L	EN	
Morelia spilota metcalfei	Carpet Python	R	NL	NL	L	EN	✓
Nycticorax caledonicus	Nankeen Night Heron	B	NL	NL	NL	NT	
Polytelis anthopeplus	Regent Parrot	B	NL	VU	L	V	✓
Tiliqua occipitalis	Western Blue-tongued Lizard	R	NL	NL	NL	NT	
Todiramphus pyrropygia pyrropygia	Red-backed Kingfisher	B	NL	NL	NL	NT	

Legend
Type: **Reptile, Bird, Amphibian**
EPBC status: **VUlnerable, Marine, Migratory, Not Listed**
International Bird Agreements: **China-Australia Migratory Bird Agreement, Not Listed**
FFG status: **Listed as threatened, Not Listed**
DELWP status: **ENdangered, Vulnerable, Near Threatened, Not Listed**

The species listed in Table 5 include species that forage or nest in or on water or require flooding to trigger breeding and fledging. The list also includes species that are indirectly dependent on water, i.e. they require riparian trees, vigorous ground cover and fallen timber. In order to provide breeding opportunities, habitat elements within Tata Creek such as temporary wetlands and River Red Gum and Black Box communities must be maintained in good condition.

The list includes the Eastern Regent Parrot, which is indirectly dependent on water as they require healthy River Red Gum and Black Box for nesting habitat (Baker-Gabb and Hurley, 2011). Eastern Regent Parrots are reluctant to fly through open areas and require corridors of vegetation between nesting and foraging sites. Regent Parrot surveys (Ecosurveys 2002, 2004) have identified Tata Creek as a flight path for Regent Parrots, linking a known nesting colony in Manie State Forest (NSW) with Mallee vegetation to the south. The same surveys have identified suitable nesting habitat for Regent Parrot within Tata Creek.

Eastern Regent Parrot
(*Polytelis anthopeplus monarchoides*)

Habitat

The eastern Regent Parrot almost exclusively nests in hollows in large River Red Gums close to water. It forages in large blocks of mallee woodland up to 20 km (usually 5-10 km) from nesting sites. It also requires treed flight corridors between nesting and foraging areas.

Breeding

Adults breed from August to December. Up to six eggs are laid and incubated by the female alone for approximately 21 days. The young fledge approximately 42 days after hatching. Over this period males forage and return to feed their mate near the nest hollow by regurgitation. The young are mostly fed by females.

Food Sources

Eastern Regent Parrots feed mainly on plant seeds, and will also feed on buds, flowers and occasionally insects and insect larvae. Most foraging occurs on the ground in mallee woodland where a wide range of seeds from grasses, chenopods, daisies and eucalypts are eaten.

Threats

The key threats to the eastern Regent Parrot include the clearing and degradation of mallee woodland within 20 km of major rivers; loss of remnant vegetated flight corridors; and a decline in suitable nesting trees in River Red Gum habitat through altered hydrological regimes, salinity and timber harvesting.

Species Trajectory

The eastern Regent Parrot has declined in range and abundance over the last 100 years and is now restricted to the lower Murray-Darling Basin region of South Australia, NSW and Victoria. The population is estimated to be no more than 1,500 adult breeding pairs.

Source (including image): Baker-Gabb and Hurley, 2011

A decrease in health and death of River Red Gum along the River Murray as a result of current water regimes, as well as drought, have contributed to the decline of the Regent Parrot. Smith (2004, cited in Baker-Gabb & Hurley 2011) states that River Red Gum forests and woodlands in the Regent Parrot's known distribution are under stress and many nest trees are likely to die due to reduced flooding, drought and prolonged inundation. The inclusion of the Regent Parrot habitat in environmental watering programs, especially known and potential breeding habitat and essential flyways, is a key action listed in the Recovery Plan for this species (Baker-Gabb & Hurley 2011).

There are three historical records of the Commonwealth listed Growling Grass Frog (*Litoria raniformis)* at Tata Creek. This species is usually found in seasonally flooded wetlands with complex aquatic vegetation communities and relies on drought refuges to survive dry periods. The Growling Grass Frog is particularly sensitive to changes in wetland hydrology and prefers annual flooding and long periods of inundation (five to seven months) due to a long larval phase. This frog requires flooding in spring/summer for successful recruitment as this is when it is active and breeding takes place. It can be excluded from wetlands under reduced flood frequency (Rogers & Ralph 2011). As there are no recent records of the Growling Grass Frog within Tata Creek, the site will not be managed specifically for this species. However, it is expected that over-riding management objectives will benefit this and other frog species.

In the Mallee CMA region, the EPBC listed White-bellied Sea-eagle (*Haliaeetus leucogaster)* nests near water in large live or dead trees. They breed between April and August and create stick nests of up to 1.7m across. Known to forage over large expanses of open water, the White-bellied Sea-eagle feeds on fish, birds, reptiles, mammals, crustaceans and carrion. The Victorian population is thought to be as low as 100 breeding pairs (DSE 2003). Deterioration of inland water resources and disturbance of nesting pairs by human activity are listed as threats for this species (Department of the Environment 2015).

There is one record of the Eastern Great Egret at Tata Creek. Egrets mainly forage in shallow freshwater wetlands with emergent vegetation and use overhanging trees for nesting, with River Red Gum being their preferred tree. Egrets require shallow water with dense aquatic vegetation for foraging and feed mainly on fish but also consume shrimp, crayfish, frogs and insects (Rogers and Ralph 2011).

The Inland Carpet Python has been recorded at Tata Creek. In a healthy wetland environment, the areas lining both the creek and the wetlands would provide suitable habitat and cover in the form of thick litter and shrubs, tree hollows and fallen timber, and also a range of food sources. Delivery of environmental watering under this plan will potentially encourage diversity and improve quality of riparian vegetation, increasing the habitat value of the target area for this species.

Waterbirds

As well as the listed species recorded in Table 5, Tata Creek has historically supported a diverse range of waterbirds, with 16 species recorded at this site (Appendix 1).

Australia's waterbirds are often nomadic and take advantage of highly variable and often temporary aquatic resources. The distribution of temporary habitat patches throughout the landscape may facilitate movement and exploitation of available resources for waterbirds (Roshier *et al.* 2001). The provision of environmental water to wetlands is one method of creating such habitat patches for waterbirds, allowing them to move between suitable habitats to survive and reproduce (MDBA 2009).

Waterbird diversity and abundance are influenced by wetland habitat diversity, with different species and feeding guilds using different habitats for breeding and foraging (Haig *et al.* 1998 cited in MDBA 2009). Water depth in particular influences waterbird diversity due to the specific feeding behaviours of different species (Bancroft, Gawlik, & Rutchey, 2002). Managing wetlands to provide diverse habitats such as variable water depth, mud flats, inundated vegetation and areas of deep water increases the likelihood of waterbird diversity (Taft *et al.* 2002).

The wetland types and associated vegetation communities within Tata Creek provide habitat for a variety of waterbird guilds. This habitat diversity will be enhanced by the proposed environmental watering program. The habitat use and food requirements of the waterbird guilds recorded at the site are recorded in

Table 6.

Table 6 Waterbird functional groups and their resource use

Waterbird Group	Food Resource	Habitat Use
Dabbling & Diving Ducks	Generalists; plankton, small invertebrates, plant material	Shallow Water (Dabblers), Deep Water (Divers), littoral zone
Grazing Waterfowl (Swan, Shellduck, Wood Duck)	Plant material, seeds, invertebrates	Shallow Water, littoral zone
Piscivores (Pelican, Cormorants)	Fish	Open and deep water
Large Waders (Spoonbills, Ibis, Egrets, Herons)	Macroinvertebrates, fish, amphibians	Littoral zone
Small Waders (Plovers, Dotterels)	Small invertebrates, seeds	Littoral zone, mudflats

Vegetation Communities

There are twelve water-dependent EVCs identified within the target area (Table 7). One of these (Floodplain Grassy Wetland) is listed as endangered and three are vulnerable within the Robinvale Plains bioregion. The bioregional conservation status of all water dependant EVCs in the target area is shown in Table 7..

For a full list of EVCs within the entire Tata Creek area and details on each see Appendix 2. The EVCs at Tata Creek are illustrated in Figure 10.

Table 7. Conservation status of water dependent EVCs in the target area

EVC no.	EVC name	Bioregional Conservation Status* Robinvale Plains Bioregion
103	Riverine Chenopod Woodland	Depleted
104	Lignum Swamp	Vulnerable
106	Grassy Riverine Forest	Depleted
200	Shallow Freshwater Marsh	Vulnerable
295	Riverine Grassy Woodland	Depleted (Terrestrial BCS)
808	Lignum Shrubland	Depleted
809	Floodplain Grassy Wetland	Endangered
810	Floodway Pond Herbland	Depleted
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted
813	Intermittent Swampy Woodland	Depleted
818	Shrubby Riverine Woodland	Least Concern (Terrestrial BCS)
819	Spike-sedge Wetland	Vulnerable
821	Tall Marsh	Depleted
823	Lignum Swampy Woodland	Depleted

* The bioregional conservation status (BCS) of the wetland EVCs in this plan are based on expert advice but have not yet been formally approved by DEPI. In the case of Riverine Grassy Woodland and Shrubby Riverine Woodland, no preliminary wetland BCS has been advised, consequently the terrestrial BCS has been applied.

The endangered Floodplain Grassy Wetland occurs at two sites within the target area including a section of Tata Wetland. This EVC is naturally quite restricted within the Mallee CMA, however it is presumed to be even rarer due to reduced frequency and extent of inundation events. This EVC occurs on the most flood-prone areas of the floodplain and covers a significant portion of the target inundation area. This endangered EVC is dominated by aquatic grasses which persist as turf during dry phases. On re-flooding these grasses provide habitat and nutrients for aquatic fauna. Trees are typically absent but thickets of River Red Gum (*Eucalyptus camaldulensis*) saplings or scattered mature trees may occur (DSE 2009). This EVC prefers flooding every 7-10 years in a ten year period for durations of 3-9 months (VEAC 2008).

The vulnerable Lignum Swamp covers the majority of the Black Box/Lignum Wetland in Tata South. This typically treeless EVC is widespread in low rainfall areas and is subject to infrequent inundation (DSE 2005). This EVC is dominated by Tangled Lignum, (*Muehlenbeckia florulenta)*, which becomes an extensive aquatic habitat for fish, reptiles and macroinvertebrates when inundated. It is also used as a nesting site by waterbirds, and as a feeding area by raptors, owls, and predatory reptiles (Ecological Associates 2007b).

The vulnerable Shallow Freshwater Marsh covers sections of Racecourse Wetland and areas to the west of Racecourse Wetland. The EVC is dependent on a regular wetting and drying cycle, characteristic of semi-permanent wetlands. Under the appropriate water regime this EVC supports aquatic herbs and emergent sedges which form important habitat for fish, frogs and waterbirds. Under natural conditions this wetland EVC would have flooded almost every year with minimum durations of 4-9 months ponding and a critical interval of three years between events (VEAC 2008).

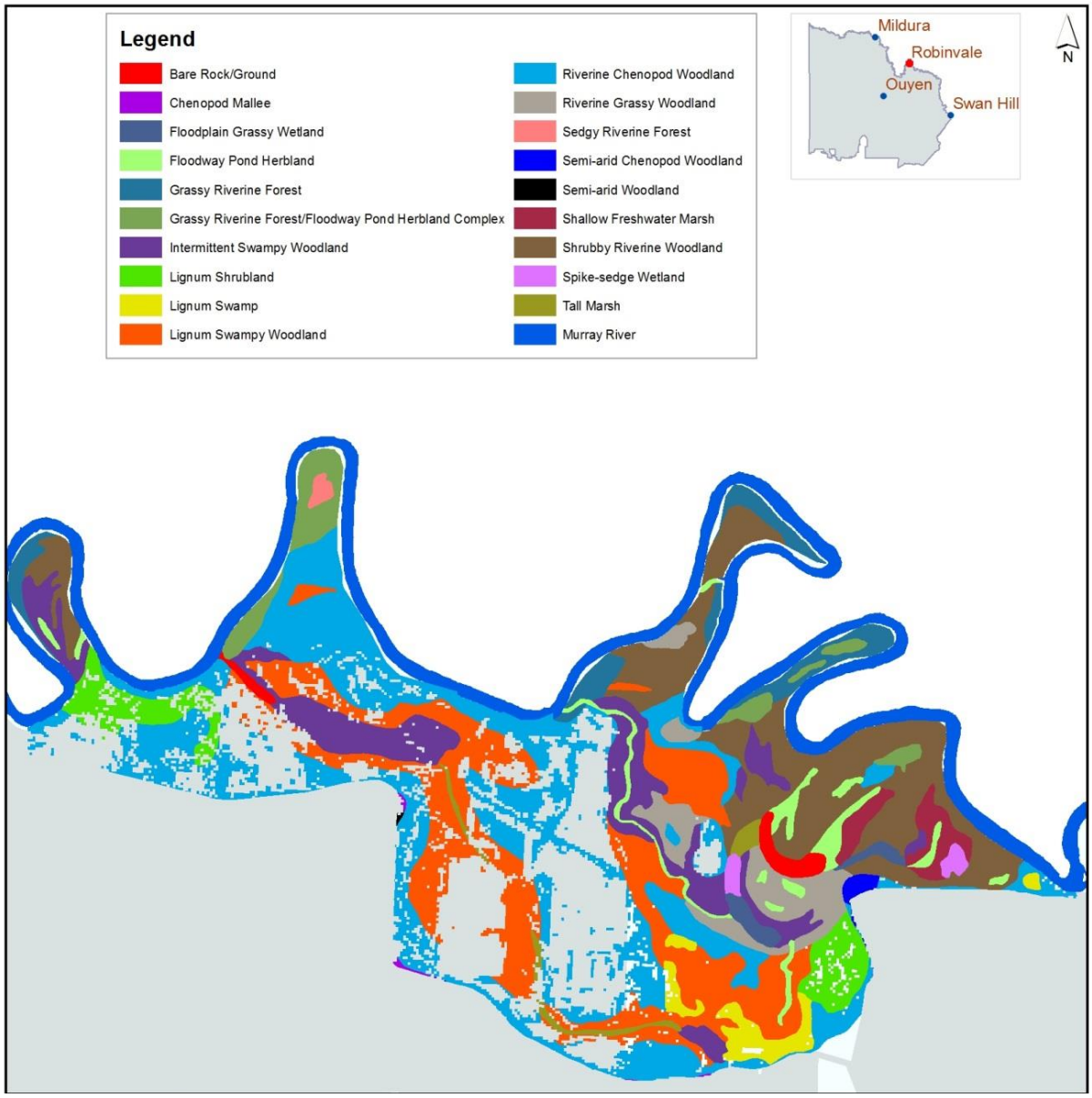


Figure 10. Ecological Vegetation Classes (EVCs) at Tata Creek

Flora

A full list of flora recorded at the site can be found in Appendix 3. Water dependent flora species listed in the various acts and agreements that have been recorded at Tata Creek are listed in Table 8.

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Table 8. Listed flora species recorded at the site

Common Name	Scientific Name	EPBC Status	FFG Status	DELWP status	Water Dependant
Desert Lantern	*Abutilon otocarpum*	NL	NL	V	
Umbrella Wattle	*Acacia oswaldii*	NL	NL	V	
Twin-leaf Bedstraw	*Asperula gemella*	NL	NL	R	✓
Inland Daisy	*Brachyscome trachycarpa*	NL	NL	V	
Spotted Emu-bush	*Eremophila maculata* subsp. *maculata*	NL	NL	R	
Bluish Raspwort	*Haloragis glauca* f. *glauca*	NL	NL	K	
Pale Plover-daisy	*Leiocarpa leptolepis*	NL	L	EN	
Smooth Minuria	*Minuria integerrima*	NL	NL	R	✓
Sand Sida	*Sida ammophila*	NL	NL	V	
Yakka Grass	*Sporobolus caroli*	NL	NL	R	
Annual Spinach	*Tetragonia moorei*	NL	NL	K	

Legend
EPBC **status: Not Listed**
FFG **status: Listed as threatened, Not Listed**
DELWP **status: ENdangered, Vulnerable, Rare, Poorly Known**

Several emergent and semi-emergent macrophytes are recorded at Tata Creek, including:

- Common Nardoo (Marsilea drummondii)
- Short-fruit Nardoo (*Marsilea hirsuta*)
- Spiny Mud-grass (Pseudoraphis spinescens)
- Club Sedge (*Isolepis* spp.)
- Sedge (*Carex* spp.)

Aquatic macrophytes are rooted to the wetland floor with their canopies floating near the water surface. They rise and fall with water levels and provide a physical structure to the aquatic environment as well as providing a food source for waterbirds and habitat for fish and macro invertebrates (Ecological Associates 2007b). Aquatic macrophytes are highly productive wetland habitats providing shelter for macro-invertebrates, and frogs turtles and small-bodied fish that graze on this vegetation and the macro-invertebrates within it (Ecological Associates 2007b). Aquatic macrophytes are dependent on water for growth and reproduction. The ideal flood requirement is 9-12 months (Rogers & Ralph 2011). They may persist in wetlands that are frequently flooded but if summer drying occurs they will die off and be replaced by lake bed herbs (Ecological Associates 2007b).

Emergent macrophytes are often found on the perimeter of ephemerally or seasonally wet locations and can provide essential habitat for frogs and foraging opportunities for waterbirds. Under flooding, native fish will also utilise reed beds and semi-emergent vegetation where they feed on macro-invertebrates and shelter from predators (Ecological Associates 2007b). Emergent macrophytes require annual flooding of approximately 6-12 months depending on species. The return of an inundation cycle more closely mimicking natural conditions may encourage a diversity of species requiring differing water regimes.

The target area is generally surrounded by on overstorey comprised of River Red Gum and Black Box (*Eucalyptus largiflorens*) with a mid-storey of Tangled Lignum. Where wetlands and woodlands are combined in close proximity, such as at Tata Wetland and Racecourse Wetland, conservation significance is high. When flooded, the woodland floor becomes an extension of the wetland habitat, thereby extending food and shelter opportunities for aquatic fauna (Ecological Associates 2006). Inundated woodlands provide habitat and grazing opportunities for fish through snags and debris deposited in the water. They also provide important refuges for birds, reptiles and mammals, in the form of perches and nesting hollows.

Black Box provides essential habitat and foraging opportunities for a range of species including the Inland Carpet Python. Healthy Black Box helps provide important vegetative corridors to other areas above the floodplain for a range of transient native fauna such as the Regent Parrot. Black Box can tolerate a range of conditions from wet to dry (Roberts & Marston 2011), however, under extended periods of dry conditions trees will suffer a decline in health and eventually death (Ecological Associates 2007a).

Tangled Lignum is considered to be the most significant floodplain shrub in mainland Australia due to its extensive distribution, local dominance and value as habitat (Roberts & Marston 2011). Lignum occurs mainly in EVCs in Tata South and, combined with other understorey species offers shelter for a range of birdlife, nesting sites for smaller birds, and cover for reptiles including the Inland Carpet Python.

River Red Gums (Figure 11) are the most widespread eucalypt tree in Australia, occupying riparian habitats along water courses and wetlands (Roberts & Marston 2011). Trees in poor condition have little contribution to the function and productivity of the ecosystem and the quality of woodland habitat is greatly reduced (Roberts & Marston 2011). Healthy River Red Gums contribute to the wetland ecosystem by depositing organic material, and fallen trees and branches provide structural habitat features for native fauna such as the Inland Carpet Python. Older trees can provide perching sites for birdlife, nesting sites for the White-bellied Sea-eagle, and hollows for the Regent Parrot. Healthy River Red Gum stands also provide flight paths for the Regent Parrot.

Figure 11. Tata Creek with fringing River Red Gum, and Black Box visible right of image. This image was taken at the proposed site R1 and L1 shown in Figure 5.

4.1.2 Wetland Depletion and Rarity

The *Mallee CMA Regional Context Document* outlines wetland depletion and rarity within the Mallee CMA Region. The Tata Creek target area contains five wetlands, which have been classified using the Corrick-Norman wetland classification system, as listed in Table 9.

Deep freshwater marsh is the most depleted wetland category in Victoria (-70%) and within the Robinvale Plains bioregion (-37%); and the second most depleted category in the Mallee CMA Region (-45%) (Mallee CMA 2006b). This makes these wetlands within the target area significant in terms of representativeness at a state, regional and bioregional scale. Shallow freshwater marsh is the second most depleted wetland category within Victoria (-60%) and within the Robinvale Plans bioregion (-6%). The prevalence of permanent open freshwater has increased since European settlement within the CMA Region, possibly as an outcome of regulation.

Table 9. Changes in area of the wetlands in the target area by Corrick classification

Category	No of Wetlands in target area	Total area (ha)	Decrease in wetland area from 1788 to 1994		
			% Change in area in Victoria	% Change in area in Mallee CMA	% Change in Robinvale Plains
Deep freshwater marsh	2	33.48	-70	-45	-37
Shallow freshwater marsh	1	32.84	-60	-6	-4
Permanent open freshwater	1	6.56	-6	5	-1

Source: DEPI Biodiversity interactive maps, Mallee Wetland Strategy (Mallee CMA 2006b)

4.1.3 Ecosystem Functions

Healthy creek and wetland ecosystems have the potential to support distinctive communities of plants and animals and provide numerous ecosystem services. These ecosystems can perform important functions necessary to maintain the hydrological, physical and ecological health of the river systems and floodplain. These ecosystem functions can include:

- providing extended foraging, breeding and basking opportunities for frogs and turtles;
- providing extended foraging and breeding habitat for water birds during periods of inundation;
- absorbing and releasing floodwaters;
- in-stream primary production;
- providing organic material to rivers to maintain riverine food chains; and
- providing feeding, breeding and drought refuge sites for native flora and fauna.

Altered water regimes in the target area due to river regulation and extended dry conditions have seen a decrease in the frequency and extent of inundation on the floodplain at Tata Creek. This has reduced the ability for the creek and wetlands to perform these valuable ecosystem functions.

4.2 Social

4.2.1 Cultural Value

The Mallee has been occupied for thousands of generations by Indigenous people with human activity dated as far back as 23,400 years ago. The region's rich and diverse Indigenous heritage has been formed through the historical and spiritual significance of sites associated with this habitation; together with the strong connection Traditional Owners continue to have with the natural landscapes of the Mallee.

Given the semi-arid climate of the region, ready access to more permanent water has been a major determinant of human habitation, and as such the highest density of identified Indigenous cultural heritage sites are located around or close to areas of freshwater sources.

Within the Mallee CMA region, the Murray River and its associated waterways were important habitation areas for multiple Indigenous groups, containing many places of spiritual significance. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria, for both concentration and diversity. They include large numbers of burials, middens, and hunting sites.

Waterways also play a large role in the region's more recent non-Indigenous heritage due to the historical infrastructure (e.g. buildings, irrigation and river navigation structures) they often contain. These places provide links to early industries and settlements and play a key part in the region's identity.

4.2.2 Cultural Heritage

Tata Creek is of significant cultural value to Indigenous and non-Indigenous people, with the area popular for fishing, camping, hunting, and as a meeting place.

One registered indigenous cultural heritage site (AAV 7528-0080), a stone artefact, was identified at Tata Creek during a site inspection (Ecological Associates 2007b). Prior to this inspection no previously registered Aboriginal sites had been documented at this location (Ecological Associates 2007b). There is a high likelihood of Aboriginal cultural heritage sites within Tata Creek because of its location on the Murray River floodplain. The true extent of the number and types of sites present is still unknown.

The Latje Latje people are the recognised traditional owners at Tata Creek. The Latje Latje people and the Robinvale Aboriginal Community continue to value this country through traditional laws and customs.

European heritage reflects the pioneering history of the area. Tata Creek is immediately to the west of the township of Boundary Bend. In 1830 Captain Charles Sturt entered the Murray River from the Murrumbidgee River just upstream of Boundary Bend, where he named the Murray River and continued his journey past the present day Boundary Bend and to the Murray Mouth.

In 1836 during his third expedition Major Thomas Mitchell crossed the Murray River into present day Victoria upstream of Boundary Bend, just downstream of the Murrumbidgee junction. The area was first settled by Europeans in the 1860s. By 1923 when the Boundary Bend Post Office opened, a school and irrigation orchards had been established at Boundary Bend for a number of years. The district has a history of River Red Gum woodcutting and sawmilling sourced from areas such as Tata Creek. The piles at Station Pier, Port Melbourne were said to have been sourced from Tata Creek, with locals referring to the area as 'Pile Bend' for this reason (pers. comm. P. Goldring, February 2015). The Paddle Steamer Hero caught fire and sank in 1957 while working at Boundary Bend transporting Red Gum logs. It was raised in 1998 and transported to Echuca where it was restored.

4.2.3 Recreation

The region is popular for swimming, camping, fishing, boating, four wheel driving, picnics, barbeques and walking and these uses will continue in the proposed Murray River Park.

4.3 Economic

Tata Creek has been used for timber harvesting and livestock grazing in the past. Sections of the proposed Murray River Park within Tata Creek are currently used for domestic firewood collection, and a small private agricultural property is located on the floodplain in Tata North. A small area of private land within Tata South is used for water storage for irrigation.

The river frontage has been gazetted as River Murray Reserve and the majority of the target area is proposed Murray River Park with small areas of private land and a Road Reserve in the south west.

4.4 Significance

Tata Creek is able to support a rich diversity of flora and fauna. The lower terraces of the floodplain support River Red Gum forest and woodland and the higher terraces Back Box woodlands, while areas south of the Murray Valley Highway support Lignum communities. The iconic River Red Gum and Black Box, as the principal sources of hollows, provide essential habitat to a range of species, including the Regent Parrot and the Inland Carpet Python; while Lignum provides shelter and nesting sites for a range of bird species.

Tata Creek has been identified as a flight path for Regent Parrots linking nesting colonies in the north with areas of Mallee vegetation in the south (Ecosurveys 2002, 2004). Within Tata Creek areas of potential nesting habitat have also been identified (Ecosurveys 2004).

The floodplain vegetation is, in places, dense and of good structural diversity. Large expanses of Lignum and Black Box, its associated understorey, leaf litter and fallen timber offer the Carpet Python excellent shelter and breeding sites, as well as opportunities for ambushing prey. Healthy and dense floodplain trees can also provide nest-building materials for bird species including the White-bellied Sea-eagle.

The two deeper wetlands within Tata Creek, in particular Racecourse Wetland, provide potential for refuge and/or extended breeding and foraging areas for native fauna species including fish, waterbirds, frogs and turtles. The creek itself also has the potential to provide significant habitat for fish and aquatic fauna with a number of deep holes, vegetated margins and significant woody debris (Ecological Associates 2007b).

The cultural importance of this site is considered significant as whilst only one site is recorded, the likelihood of additional cultural heritage sites is high. European history dates back to the mid-nineteenth century, which also documents Indigenous cultural ties to the area. The history of timber harvesting and its long history of human visitation make Tata Creek significant to the local communities. The creek itself forms a striking landscape as a deeply incised creek and large expanses of wetland environments.

The values contained within Tata Creek makes this area a priority for protection and enhancement through environmental water management. Of particular significance is the potential to encourage habitat for a range of aquatic species. Equally significant are the River Red Gum, Black Box and Lignum communities. These vegetation groups form the basis for the functioning ecological system and are the primary focus of this plan.

5 Ecological Condition and Threats

5.1 Current Condition

5.1.1 Tata Creek

In 2004, the creek itself was assessed using the Index of Stream Condition (ISC) methodology (Table 10 and Figure 12). Scores for water quality or aquatic life were not calculated because the creek was dry at the time. The overall score was 18, which is considered moderate condition.

Further information on the ISC scoring is provided in the Mallee CMA Regional Context Document (Sunraysia Environmental 2014).

Table 10. ISC sub-index and overall score for Tata Creek itself

ISC sub-index	Reach #20 Score/10
Streamside Zone	6
Physical form	6
Hydrology	1
Water quality	
Aquatic Life	
Overall ISC Score	18 (Moderate)

Figure 12. Photos captured as part of the ISC assessment in 2004. (Source: ISC Website)

5.1.2 Wetlands

The condition of the wetlands within the target area of Tata Creek has not been assessed using the Index of Wetland Condition (IWC) method. The overall condition of the wetlands and floodplain with Target Creek is considered to be relatively good based on local knowledge and anecdotal evidence from previous site inspections, although a decline in health was observed prior to the emergency watering in 2005-06 (Kelly 2006).

5.2 Condition Trajectory

The condition of the wetlands within the Tata Creek target area will decline without regular flooding. Flow events that inundate the entire Tata Creek target area occur less frequently under regulated flow conditions than they did under natural conditions. This has reduced the volume and frequency of flooding at the site.

The existing connectivity of Tata Creek with the Murray River would provide some benefit to wetlands within the target area; however this potential is severely restricted by changes in the duration and frequency of floods caused by river regulation, and construction of a highway embankment across the floodplain.

The reduced flooding duration and frequency will continue to impact the ecology of the wetlands through:

- reduced organic matter recruitment;
- reduced connectivity for movement of organic matter and fish;
- reduced suitable nesting and roosting sites for waterbird species who rely on flooded shrub land and forest;
- lower capacity to provide nesting sites for hollow-dependent birds and reptiles;
- reduced understorey quality as habitat and shelter for birds and reptiles; and
- limited food sources for all waterbird types, reptiles and amphibians through reduced recruitment of terrestrial and aquatic invertebrates and reduced extent of emergent and submergent macrophytes.

Without improvements to flow frequency and extent, the health of the ecosystem of Tata Creek is likely to suffer.

5.3 Water Related Threats

Threats to the water dependent values identified in this plan are the result of such factors as human intervention and climate variability. Some of the threats which may have an impact on Tata Creek include:

- Changed water regime and reduced flow capacity;
- Loss or reduction of wetland and creek connectivity;
- Loss of instream habitat;
- Water quality; and
- Introduction/increase of exotic aquatic and terrestrial flora and fauna (Mallee CMA 2014).

5.3.1 River Regulation

The regulation of the Murray River and man-made impediments to flow has seen the water regime at Tata Creek altered. Flow events of the magnitude required allowing flows into the creek and wetlands are less frequent and of shorter duration. This combined with dry conditions over the last decade affects the vigour of the vegetation and places trees and other vegetation under stress, affecting the productivity and functioning of the floodplain ecosystem, and limits the capacity of water rich in organic matter to be returned to the river.

5.3.3 Introduced Species

Common Carp (*Cyprinus carpio)* may be prevalent throughout Tata Creek during flood events and may persist for extended periods while water remains in Tata Wetland, Racecourse Wetland and Tata Creek itself. Carp are also likely to be persisting in the Flood Runner. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, resulting in loss of habitat for waterfowl (Purdey and Loyn, 2008) and native fish species. This species also competes with the native fish for habitat and food as well as having a detrimental effect on water quality (Mallee CMA, 2003).

The Red Fox (*Vulpes vulpes)*, is a significant threat as a predator to the Inland Carpet Python. Foxes are also a significant threat to freshwater turtles through nest predation. Although the fox is not a water related threat, it may have a substantial impact on water dependent ecological values at the site.

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. These may pose a threat when water is applied as increased water availability can cause weeds to thrive and displace native vegetation. A list of exotic flora species identified at Tata Creek is provided in Appendix 1.

6 Management Objective

6.1 Management Goal

To provide a flow regime that more closely reflects natural events, thus improving the capacity of the target area to provide a productive ecosystem for native flora and fauna.

6.2 Ecological Objectives

Ecological objectives represent the desired ecological outcomes of the site based on the management goal above, as well as the key values outlined in the Water Dependent Values section. The ecological objectives are expressed as the target condition or functionality for each key value.

As with any healthy wetland ecosystem, ecological outcomes are interrelated. The objectives outlined in Table 11, will contribute to wetland productivity and improve the overall health of the system. Improving vegetation condition may provide access to additional feeding sites, breeding sites and habitat for key fauna species including the White-bellied Sea-eagle, the hollow dependent Regent Parrot and Inland Carpet Python, as well as frogs and waterbird guilds, in turn offering a diverse and healthy food web in the target area.

Table 11. Ecological objectives for Tata Creek

Management Zone	Ecological objective	Justification (value based)
Stage 1 – Tata North	Maintain vegetation health and structure in the Red Gum communities (EVCs 106, 295, 809, 811, 813, 818, 823) Maintain vegetation health and structure in the Black Box communities (EVCs 103, 813, 818)	A healthy vegetation structure includes diversity of species and age classes. The vegetation lining the creek and wetlands and the surrounding area is in good condition structurally, with trees of varying age classes. It is important to ensure this condition is maintained, and to assist recruitment of the keystone species: River Red Gum and Black Box. In turn, a healthy vegetation structure may provide important habitat and refuge for terrestrial fauna such as the White-bellied Sea-eagle and the hollow dependent Regent Parrot. Wetland productivity may be improved through deposition of organic matter from all vegetation life forms present, enhancing food web provision.
	Promote aquatic macrophyte diversity and area in the wetland habitats (EVCs 200, 810, 811, 819, 821)	A healthy wetland environment includes a diversity of species including sedges, rushes, herbs and forbs. It is important to promote diversity in the wetlands within the target area to improve habitat and foraging potential for birds and aquatic fauna including frogs, and extend cover for the Inland Carpet Python.
Stage 2 – Tata South	Maintain vegetation health and structure in the Black Box communities (EVCs 103, 813, 823) Maintain vegetation health and structure in the Lignum communities (EVCs 104, 813, 823)	Healthy Lignum communities can offer shelter and feeding sites for reptiles such as the Inland Carpet Python, and important cover for native woodland birds. Healthy Black Box can offer hollows for the Inland Carpet Python, a healthy canopy can offer valuable corridors for the Regent Parrot as it moves between Mallee and Riverine areas.
All	Increase dissolved organic matter, particulate matter and macroinvertebrate productivity	The release of energy and nutrients greatly increases productivity which increases bacteria and invertebrates. Providing food for large aquatic animals. (Ecological Associates, 2013)

Attainment of the ecological objectives is anticipated to have wider benefits for the target area and is expected to result in:

- Maintaining understorey productivity;
- Improving nesting opportunities in flooded trees lining the creek;
- Maintaining seasonal aquatic habitat at Tata North; and
- Improving floodplain productivity at Tata South.

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

River Red Gum, Black Box and Lignum are key floodplain species that support native fauna and contribute to wetland health and productivity. Associated plant species within the mapped EVCs help to form an ecologically sound environment. Through careful management of environmental water, recruitment of keystone species may help maintain the vegetation structure, condition and diversity. In time, some of the River Red Gum, as the key overstorey species lining the creek and wetlands north of the Murray Valley Highway, are likely to fall into the wetlands and provide valuable structural habitat for native fish, frogs and turtles. Maintaining the structure of terrestrial vegetation at Tata Creek is also likely to provide habitat values for native fauna, most significantly, an improvement in nesting hollows for Regent Parrot and nest building materials for the White-bellied Sea-eagle.

In addition to the opportunity to maintain vegetation health and diversity, inundation of the creek and wetlands offers additional foraging sites for waterbirds and additional feeding and breeding sites for native aquatic fauna.

Through environmental watering key habitat niches will potentially be maintained. The recruitment of key flora species may assist over the longer term in the provision of suitable habitat for the Growling Grass Frog and other frog species.

6.3 Hydrological Objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The ecological objectives at this site are centred on improving the vegetation health and structure where possible (Table 11). The hydrological requirements to achieve these objectives are presented in Table 12 and are based on the assumption that maintenance of current health requires less frequent watering with longer intervals between events than for improving condition.

Emergent and semi-emergent macrophytes may occur within Racecourse Wetland and Tata Wetland. Flood requirements vary depending on species, however annual inundation may encourage germination, vegetative growth and/or reproduction (Rogers & Ralph 2011). Durations of six to twelve months are required to sustain vigorous growth. Following natural seasonality is encouraged.

River Red Gum is present around the wetlands, creeks and the wider floodplain north of the Murray Valley Highway. River Red Gum requires 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 important for understorey plant communities however. 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 woodland EVCs throughout the target area. They occur on higher levels of the floodplain and require flooding to occur every three to seven years with durations of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing

of flood events is not crucial 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).

Lignum is a dominant species in three EVCs within the target area, south of the Murray Valley Highway. Lignum can tolerate a wide range of wet and dry conditions. Flood requirements vary with frequencies of one to three years needed to maintain large shrubs with vigorous canopy, and flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but growth will decline and these plants do not accommodate nesting by birds. Durations of three to seven months is required to sustain vigorous canopy, but continuous flooding is detrimental. Although timing of flooding is not crucial for Lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts & Marston 2011).

These water requirements have been used as a guide to develop the hydrological objectives for the Tata Creek target area.

Table 12 Hydrological objectives for the Tata Creek target area

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
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Maintain vegetation health and structure in the Red Gum communities (EVCs 106, 295, 809, 811, 813, 818, 823)	Tata North	2	3	7	1	7	2	3	8	Spring/Summer
Maintain vegetation health and structure in the Black Box communities (EVCs 103, 813, 818)		2	3	3	3	10	2	4	6	Winter/Spring
Promote aquatic macrophyte diversity and area in the wetland habitats (EVCs 200, 810, 811, 819, 821)		3	4	10	0	4	1	6	12	Winter/Spring
Maintain vegetation health and structure in the Black Box communities (EVCs 103,	Tata South	2	3	3	3	8	2	3	4	Winter/Spring
Maintain vegetation health and structure in the Lignum communities (EVCs 104, 813, 823)		2	3	7	1	7	3	4	6	Winter/Spring
Increase dissolved organic matter, particulate matter and macroinvertebrate productivity**	All									

**Ecological objective met by other hydrological objectives

6.3.1 Staged implementation of the watering regime at Tata Creek

The wetland watering regime has been derived from the ecological and hydrological objectives. It is important to note that environmental water can be delivered to the wetlands and creek in Tata North in isolation to those in Tata South; however water cannot be delivered to the southern wetlands without first inundating the northern wetlands. A staged approach has been provided for watering regimes:

- Stage 1: Tata North
- Stage 2: Tata North and Tata South

To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions; however flexibility is encouraged in accordance with the minimum, maximum and optimal hydrological objectives in Table 12. The minimum objectives are likely to be provided in drought or dry years, the optimum objectives in average conditions and the maximum objectives in wet or flood years.

The optimal watering regime for each stage is described in the following pages. Due to the inter-annual variability of these estimates (particularly the climatic conditions, and the capacity for some sites to retain water for several years), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

Stage 1 – Tata North

Stage 1 involves the inundation of approximately 68 ha including part of Tata Creek itself, Tata Wetland and Racecourse Wetland, requiring approximately 780 ML of environmental water. Water can be delivered to Tata Wetland by pumping from the Murray River at pump site P1. Water can then be allowed to flow naturally to Racecourse Wetland, however infrastructure is required to retain water on the floodplain and efficiently inundate the target area:

- A track crossing with culvert at C2; and
- A levee and regulator across Tata Creek to allow access to the Murray River Park and private land (R1, L1).

Water Regime	Inundation area, duration and frequency
Optimal	Inundate Tata Wetland, Racecourse Wetland and Tata Creek through to the regulator structure three years in ten with a maximum interval of seven years between events. Maintain water in the wetlands for at least six months to promote aquatic macrophytes before allowing natural recession through Tata Creek to improve health of fringing River Red Gum. It is expected water will be retained in Tata Wetland and/or Racecourse Wetland for a number of years, resulting in inundation of this area for every year to encourage aquatic macrophyte diversity.

Stage 2 – Tata North and Tata South

Stage 2 will inundate Tata North and also the Black Box/Lignum wetland, the flood runner and part of the floodplain, encompassing an area of approximately 204.6 ha in Tata South. Approximately 2242 ML of environmental water will be required. To achieve inundation of this area additional infrastructure is required.

Positioned higher on the floodplain, Tata South has a requirement for less frequent inundation.

Water Regime	Inundation area, duration and frequency
Optimal	Inundate the Black Box/Lignum wetland three times in ten years with a maximum interval of eight years between events. Maintain water within the wetland for three months to maintain the health of Black Box and Lignum communities, allowing wider floodplain inundation once in ten years for up to two months to maintain elevated Black Box and Lignum communities.

7 Managing Risks to Achieve Objectives

Delivery Plans will be developed for all wetland sites allocated environmental water. A broad risk assessment has been undertaken for the system using the risk rating matrix in Table 13 to identify any major risks which would require mitigation measures; these are outlined in Table 14.Prior to delivering environmental water in any given season, these risks will be further refined as part of the Seasonal Watering Proposal and Environmental Water Delivery Plan process. These documents will provide a greater level of risk analysis and mitigation measures according to conditions observed closer to the proposed delivery (i.e. operational risks). The documents will also include detailed consideration of the impact of proposed mitigation measures on the likelihood and consequence of the risk occurring (residual risk) as this may change according to catchment conditions closer to the proposed delivery. They will clearly outline roles and responsibilities regarding risk management.

Table 13. Risk Rating

		Consequence				
Likelihood		Negligible 1	Minor 2	Moderate 3	Major 4	Extreme 5
	Almost Certain 5	Medium 5	Medium 10	High 15	High 20	High 25
	Likely 4	Low 4	Medium 8	Medium 12	High 16	High 20
	Possible 3	Low 3	Medium 6	Medium 9	Medium 12	High 15
	Unlikely 2	Low 2	Low 4	Medium 6	Medium 8	Medium 10
	Rare 1	Low 1	Low 2	Low 3	Low 4	Medium 5

Table 14: Environmental Water Delivery Risk Assessment

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	Residual Risk		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Quality Assurance	1.0	Current recommendations on environmental flow inaccurate	Possible	Moderate	Medium	Base decisions on existing records and best available knowledge	Rare	Moderate	Low
	1.1	Storage Operator maintenance works affect ability to deliver water	Possible	Moderate	Medium	Keep in contact with G-MW to identify delays to allow for adaptive management	Rare	Moderate	Low
Time	2.0	Limited CMA resource to deliver environmental release	Possible	Minor	Medium	Ensure that environmental water management within the CMA is adequately resourced to undertake required delivery tasks	Rare	Moderate	Low
Cost	3.0	Cost of delivery exceeds available funding	Unlikely	Moderate	Low	CMA to manage delivery and regularly monitor costs	Rare	Moderate	Low
Human	4.0	Environmental releases cause personal injury to river user	Unlikely	Major	High	Ensure land manager/land holder is informed of delivery actions Erect signage where risk is significant	Rare	Moderate	Low

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	Residual Risk		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Environmental	5.0	Releases cause water quality issues (e.g. blackwater, low DO, mobilisation of saline pools, acid-sulphate soils, etc.)	Possible	Minor	Medium	Observe the quality of the water throughout the watering season and manage accordingly	Rare	Moderate	Low
	5.2	Releases followed by heavy rainfall and/or natural high flow events cause flooding of non-target areas	Possible	Minor	Medium	Observe long range weather forecasts, monitor River Murray flows and forecasts, manage delivery to allow additional capacity	Rare	Moderate	Low
	5.3	Improved conditions for non-native species (e.g. carp)	Possible	Moderate	Medium	Adaptive management. Review current research findings and manage water delivery and recession according to current best practice.	Rare	Moderate	Low
	5.4	Sudden reduction in water levels strands native fish	Possible	Moderate	Medium	Monitor recession rates; manage retention/release of water.	Rare	Moderate	Low
	5.5	Proposed infrastructure on eastern inlet to Racecourse Wetland has negative impact on frequency and duration of inundation during natural flood events.	Possible	Moderate	Medium	Determine impacts and modify structure/operational plan if necessary	Rare	Moderate	Low

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	Residual Risk		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Compliance	5.6	Releases promote weed spread	Possible	Moderate	Medium	• Liaise with land managers to control invasive weeds in vicinity of creek • Monitor weed emergence after event	Rare	Moderate	Low
	5.7	Delivery promotes pest animal activity (pigs, foxes, rabbits)	Possible	Moderate	Medium	• Monitor pest animal activity • Liaise with landholders/land manager to control pest animal infestations	Rare	Moderate	Low
	6.0	Environmental water account is overdrawn	Possible	Major	Medium	Ensure delivery contractor is aware of deliver volumes and adheres to delivery plan	Rare	Major	Medium
	6.1	Environmental releases causes flooding of private land	Possible	Minor	Medium	• Monitor delivery, progress of water, pulse pump as required ensuring water remains in target area • Landholder agreements undertaken for flooding on private land. Delivery plans will be developed and approved by VEWH	Rare	Moderate	Low

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	Residual Risk		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Reputation	6.2	Environmental releases cause flooding of access tracks	Possible	Minor	Medium	• Construct track crossings above proposed maximum level of environmental watering • Provide temporary signage where applicable • Include arrangements for this event in the landholder agreements	Rare	Moderate	Low
	7.0	Unable to provide evidence in meeting ecological objective	Possible	Major	Medium	• Need to communicate ecological objectives • Ensure monitoring activities are undertaken • Establish monitoring framework	Rare	Moderate	Low
	7.1	Key stakeholders not supportive of environmental water release	Possible	Minor	Medium	Continue to engage with stakeholders and undertake communications	Rare	Moderate	Low

8 Environmental Water Delivery Infrastructure

8.1 Constraints

The existing arrangements limit the extent of area that can be inundated by environmental watering at Tata Creek. Currently it is possible to deliver environmental water to wetlands in Tata North via pumping, however infrastructure is required to prevent environmental water from returning to the Murray River via the creek and several other points that become connected at higher water levels. Infrastructure is also required to ensure public access and access to a private property.

Delivery of environmental water to Tata South is not possible without infrastructure. To inundate wetlands in Tata South, the water level in Tata North would need to be increased. This increases the number of low break out points that would require levees to retain water on the floodplain. This would also impact on the existing culvert at C1 (Figure 14), which is unable to cope with high volumes of water due to deposition of woody debris and silt. Under natural flows, this crossing is damaged as water that is unable to flow through the culvert overtops the crossing, washing away imported road base (pers. comm. P. Goldring 18 April 2015).

Infrastructure such as permanent levees and regulators, and a culvert upgrade would increase the extent of inundation to the whole target area and prevent water from returning to the Murray River during environmental watering events, while enhancing connectivity to the river during natural flood events.

8.2 Infrastructure and Complementary Works Recommendations

8.2.1 Stage 1 Recommendations

Recommended works for Stage 1 are restricted to Tata North. The works involve the construction of a levee and a regulator (R1, L1) at a natural sill in Tata Creek itself. This will ensure that water is retained in the southern section of the creek, preventing it from returning to the Murray River, while inundating wetlands including Tata Wetland and Racecourse Wetland to a level of approximately 51.7m AHD. Installing a regulator in the proposed structure will enable it to be opened to ensure connectivity along the length of Tata Creek to the Murray River during a natural flood event (Figure 13). Due to vehicular access requirements at this location, further investigations are necessary to determine whether a separate levee (and culvert) below the regulator is needed, or if the levee and regulator should be designed to enable vehicle passage.

It would also be necessary to raise the track crossing at C2 to provide public access. A culvert would allow flow through of water during inundation.

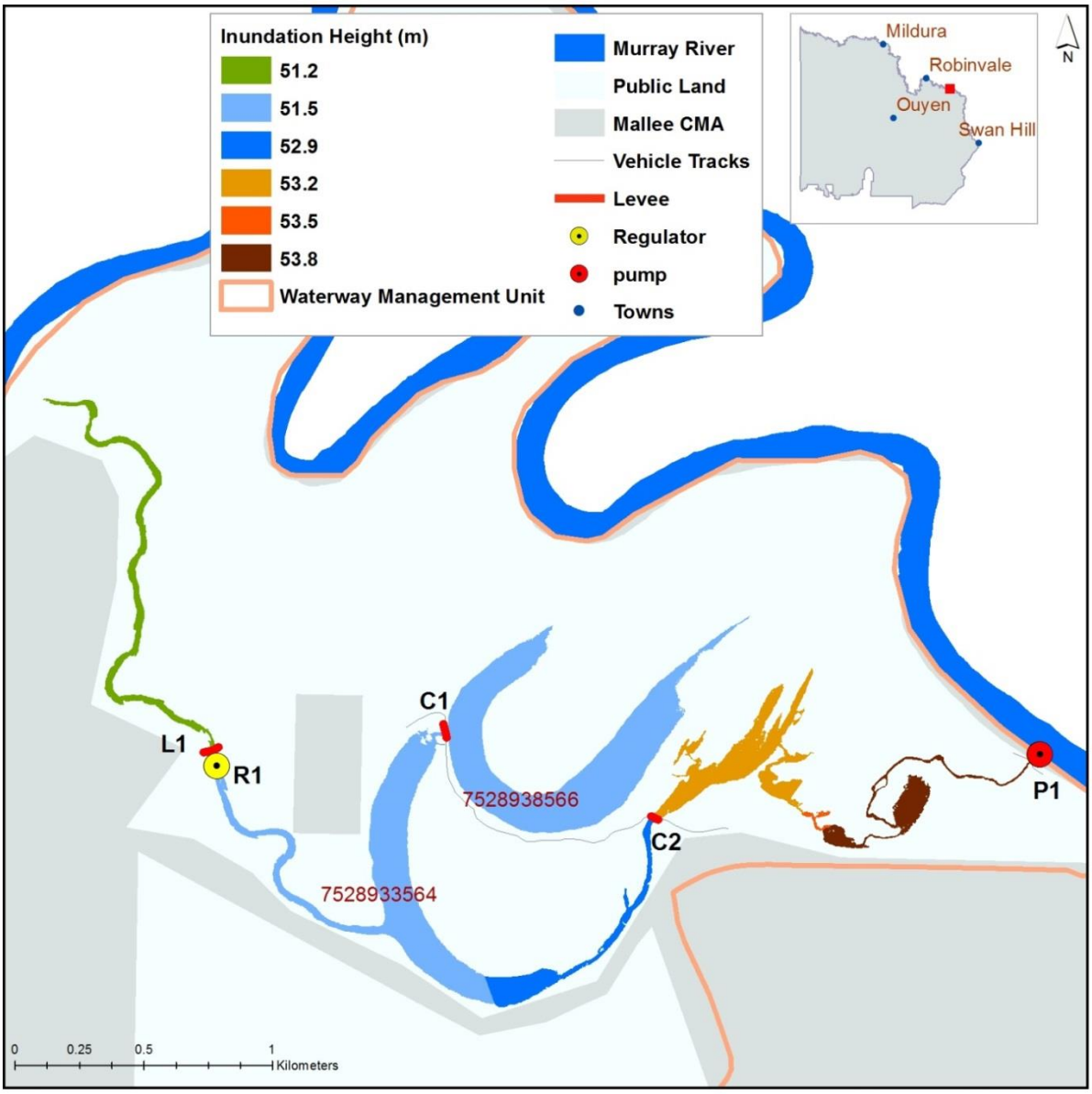

Figure 13. Anticipated inundation extent (68ha) of Tata Creek with proposed Stage 1 infrastructure in place.

8.2.2 Stage 2 Recommendations

Tata North

Recommended works for Stage 2 in Tata North involve the construction of three levees at natural low points (L2, L3, L4) to retain water on the floodplain and prevent it from returning to the Murray River; and the reconstruction of a track crossing and culvert (C1) to ensure access is maintained during environmental watering events and to facilitate flow. This will enable the area north of the highway to be inundated to a target level of 53.4m AHD (Figure 14).

Tata South

Recommended works for Stage 2 in Tata South involve the construction of a levee with a regulator (R2) immediately south of an existing culvert under the Murray Valley Highway that connects Tata Wetland to the Black Box/Lignum wetland (Figure 15). This will enable environmental water south of the highway to be managed independently by pumping from this location over the proposed weir to the wetlands in Tata South to a target level of 54.6m AHD without significantly impacting on water levels in Tata North. The installation of a regulator within this structure will enable it to be opened to ensure connectivity during a flood event. A regulator (R3) is also proposed at the connection between the Black Box/Lignum wetland and the Flood Runner. This will enable the Black Box/Lignum wetland which is on public land (Proposed Murray River Park) to be managed independently from the Flood Runner which is on private land, while still allowing connectivity when desired.

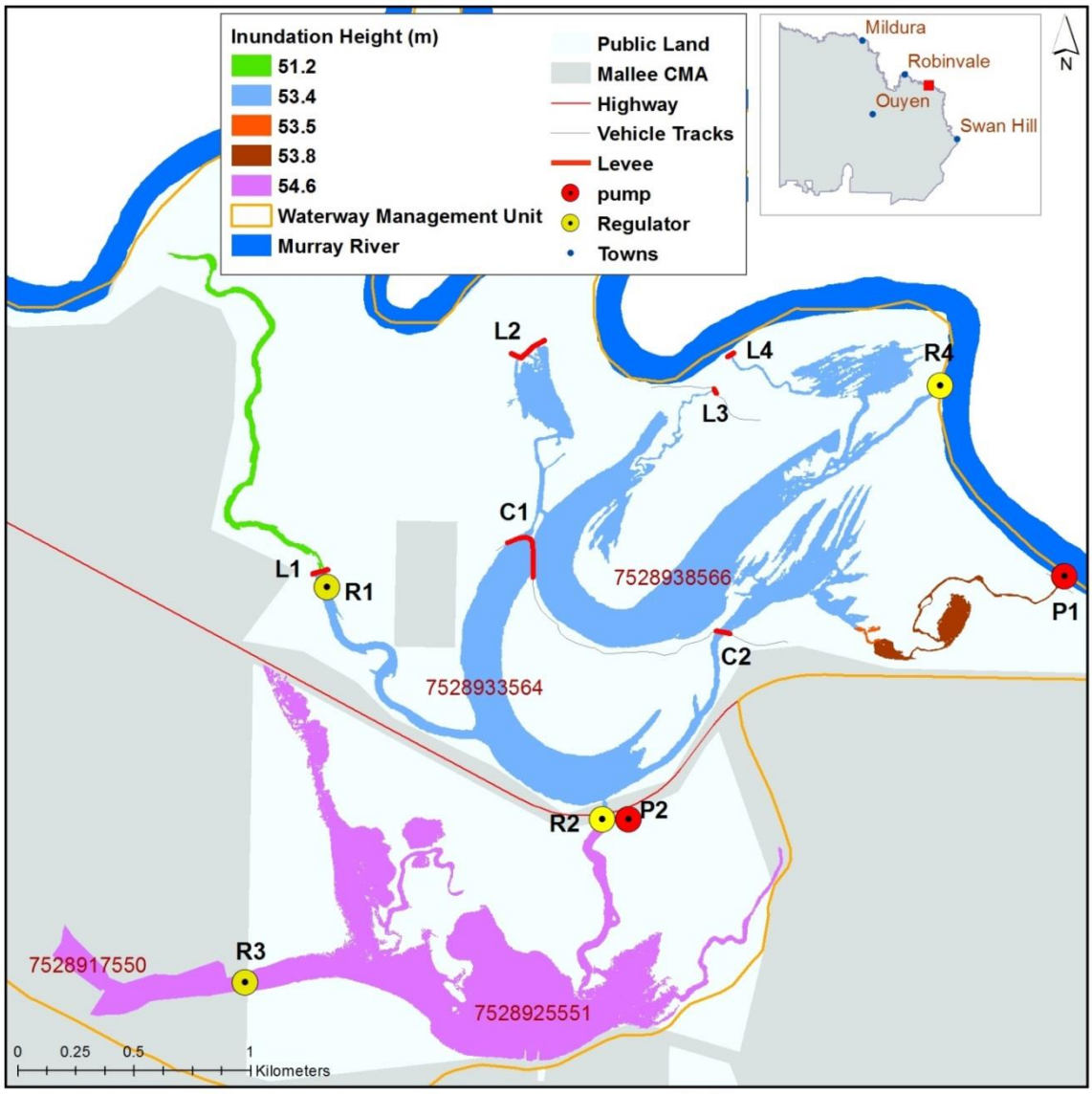

Figure 14. Anticipated inundation extent (272.6ha) of Tata Creek target areas with proposed Stage 2 infrastructure in place.

Figure 15. Effluent connecting Tata Wetland and the Black Box/Lignum wetland looking south toward the Black Box/Lignum wetland from the southern side of the Murray Valley Hwy

9 Demonstrating Outcomes

9.1 Monitoring Priorities at the Site

Monitoring of the impact of environmental watering events is proposed as outlined in Table 15.

Table 15. Proposed Monitoring for Tata Creek

Objective	Hypotheses	Indicator(s)	Frequency
Improve/ Wetland Vegetation Condition	Delivery of environmental water as per plan will improve vegetation structure and condition	Photo points IWC/ISC assessments	Annual Every 5 years
Assess habitat potential	Improving the vegetation structure and condition leads to improved habitat potential for threatened species	Assessment of habitat potential of EVCs Surveys of Regent Parrot and possible nesting sites Surveys of Carpet Python and log counts	Every 5 years Every 5 years Every 5 years

Photo point monitoring will be conducted before and after watering events at Tata Creek to measure the success of environmental water in improving wetland and riparian vegetation communities.

Event based monitoring may be used to measure water quality, particularly in areas where irrigators are drawing water, or may be concerned about water quality, and to gauge the viability of discharging water back to the Murray River.

Other incidental observations that may occur in the course of the monitoring methods above, such as visitation by waterbirds and other species to the wetlands during and after watering events, may be utilised.

Detailed monitoring of environmental water delivery to Tata Creek would be dependent on funding from the State or Commonwealth governments.

10 Consultation

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, landholders, the Department of Environment, Land, Water and Planning (DELWP) and local interest groups. Several meetings were held during the development phase to seek input and gather information from experts and stakeholders as well as meetings with the DELWP and other CMAs involved in the development of the guidelines for the plans. Table 16 outlines consultation undertaken in the development of this plan.

Table 16. Consultation Process for development of the WMU sub-unit Environmental Water Management Plan

Meeting date	Stakeholders	Details
May 2015	Local landholders/Irrigators	Two landholders were unavailable; further follow up is required. Feedback from one local landholder was: his property was on elevated land and would not be impacted by any future watering events.
May 2015	Mid Murray Field Naturalist Club	Presentation on the Tata EWMP.
TBA	Parks Victoria	Initial discussion to introduce concept of plan
TBA	Indigenous Groups	Face-to-face discussions/on-Country visits
TBA	Boundary Bend community	Presentation and review of draft plan
TBA	Vic Roads Swan Hill Rural City Council	Discussion regarding concept of plan (level of consultation will depend on final location of proposed structures)
TBA	Local landholders/irrigators Boundary Bend community	Preparation for environmental watering event
February 2015	Mallee CMA – Land and Water Advisory Committee	Discuss ecological objectives and proposed environmental watering actions
02 March 2015	Aboriginal Reference Group	Discuss proposed environmental watering actions and direct engagement strategies with Traditional Owners

11 Knowledge Gaps and Recommendations

This plan is based on best information at the time of writing. In some cases this information is scarce or outdated. Further investigation and information collection will continue and the results of this further work will continue to build a better picture of the site and add rigor to future planning. Some areas where further knowledge would be beneficial are outlined in Table 17.

Table 17. Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Priority level	Responsibility
Index of Wetland Condition/ Index of Stream Condition Assessments	IWC/ISC assessments undertaken to establish baseline condition and as the basis for ongoing monitoring of improvement over time	1	Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA
Accurate *ctf* values and understanding of floodplain hydrology for Tata Wetland and Racecourse Wetland. In particular sequence of connection from Tata Creek vs connection to the east of Racecourse Wetland during natural flood events	Incorporate local knowledge and experience from environmental watering, and determine floodplain hydrology. Update records accordingly.	2	
Selection of best infrastructure combination to provide private property access across Tata Creek	Seek design options and costings for levee and regulator (L1/R1, Figure 14) to enable vehicular access as well as water management and fish passage	3	
Full extent of cultural Heritage values	Cultural heritage assessment and mapping of values within target area	4	
Impact of watering program on native vegetation	Continue to investigate and understand the range of species at the site, including surveys of vegetation, including aquatic macrophytes.	5	
Preferred location of proposed regulator in between Black Box/Lignum wetland and the Flood Runner	Investigate land tenure and location of existing utilities and embankments and determine best location for structure	6	
Current management of the Flood Runner and existing infrastructure (banks, regulators, channels etc.)	Consult with landholder and investigate management issues/constraints.	7	

Knowledge and data gaps	Action recommended	Priority level	Responsibility
Stakeholder Agreements	Prior to the infrastructure upgrades proposed in this EWMP it is recommended that agreements with stakeholders and landholders be developed. These agreements should include details of the roles in management of the infrastructure, financial responsibilities for the infrastructure etc.	8	
Landholder Management Agreements	Landholder agreements should be signed outlining the proposed watering regimes and any inundation of private land.	9	
Feasibility of Infrastructure and complementary works	Undertake feasibility assessment and costing of the additional works identified by Mallee CMA which would benefit environmental watering at the target area.	10	
Operating rules for structures	Development of operating rules for structures and each wetland within the target area.	11	

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Appendix 1: Flora and fauna species list

Flora – Native

Scientific Name	Common Name	Victorian Advisory List
Abutilon otocarpum	Desert Lantern	Vulnerable
Acacia ligulata	Small Cooba	
Acacia oswaldii	Umbrella Wattle	Vulnerable
Acacia stenophylla	Eumong	
***Alternanthera denticulata* s.l.**	Lesser Joyweed	
***Alternanthera denticulata* s.s.**	Lesser Joyweed	
Amyema miquelii	Box Mistletoe	
Asperula gemella	Twin-leaf Bedstraw	Rare
Asperula spp.	Woodruff	
Atriplex leptocarpa	Slender-fruit Saltbush	
Atriplex pumilio	Mat Saltbush	
Atriplex semibaccata	Berry Saltbush	
***Atriplex* spp.**	Saltbush	
Atriplex vesicaria	Bladder Saltbush	
Austrostipa scabra* subsp. *falcata	Rough Spear-grass	
Austrostipa spp.	Spear Grass	
Boerhavia dominii	Tah-vine	
Brachyscome lineariloba	Hard-head Daisy	
Brachyscome trachycarpa	Inland Daisy	Vulnerable
Bulbine semibarbata	Leek Lily	
Calandrinia eremaea	Small Purslane	
Calocephalus sonderi	Pale Beauty-heads	
Calotis hispidula	Hairy Burr-daisy	
Calotis scabiosifolia* var. *scabiosifolia	Rough Burr-daisy	
Carex spp.	Sedge	
Centipeda cunninghamii	Common Sneezeweed	

Scientific Name	Common Name	Victorian Advisory List
Centipeda minima s.l.	Spreading Sneezeweed	
Chenopodium desertorum	Frosted Goosefoot	
Chenopodium nitrariaceum	Nitre Goosefoot	
Crassula colorata	Dense Crassula	
Crassula sieberiana s.l.	Sieber Crassula	
Cynodon dactylon	Couch	
Dodonaea viscosa subsp. *angustissima*	Slender Hop-bush	
Duma florulenta	Tangled Lignum	
Dysphania pumilio	Clammy Goosefoot	
Einadia nutans	Nodding Saltbush	
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush	
Enneapogon avenaceus	Common Bottle-washers	
Enteropogon acicularis	Spider Grass	
Eremophila maculata subsp. *maculata*	Spotted Emu-bush	Rare
Eucalyptus camaldulensis	River Red-gum	
Eucalyptus largiflorens	Black Box	
Eucalyptus microcarpa	Grey Box	
Euphorbia drummondii	Flat Spurge	
Geococcus pusillus	Earth Cress	
Goodenia fascicularis	Silky Goodenia	
Goodenia glauca	Pale Goodenia	
Goodenia spp.	Goodenia	
Hakea tephrosperma	Hooked Needlewood	
Haloragis glauca f. glauca	Bluish Raspwort	Poorly known
Helichrysum luteoalbum	Jersey Cudweed	
Isolepis spp.	Club Sedge	
Leiocarpa leptolepis	Pale Plover-daisy	Endangered
Lepidium spp.	Peppercress	
Maireana brevifolia	Short-leaf Bluebush	

Scientific Name	Common Name	Victorian Advisory List
***Maireana decalvans* s.l.**	Black Cotton-bush	
Maireana erioclada	Rosy Bluebush	
Marsilea drummondii	Common Nardoo	
Marsilea hirsuta	Short-fruit Nardoo	
Minuria integerrima	Smooth Minuria	Rare
Olearia pimeleoides	Pimelea Daisy-bush	
Oxalis perennans	Grassland Wood-sorrel	
Paspalidium jubiflorum	Warrego Summer-grass	
Persicaria prostrata	Creeping Knotweed	
Pimelea micrantha	Silky Rice-flower	
Pseudoraphis spinescens	Spiny Mud-grass	
Ranunculus pentandrus* var. *platycarpus	Inland Buttercup	
Rhagodia spinescens	Hedge Saltbush	
Rhodanthe corymbiflora	Paper Sunray	
Rumex brownii	Slender Dock	
Rytidosperma caespitosum	Common Wallaby-grass	
Rytidosperma setaceum	Bristly Wallaby-grass	
Salsola tragus	Prickly Saltwort	
Salsola tragus* subsp. *tragus	Prickly Saltwort	
***Salvia* spp.**	Sage	
Sclerochlamys brachyptera	Short-wing Saltbush	
Sclerolaena diacantha	Grey Copperburr	
Sclerolaena muricata* var. *villosa	Grey Roly-poly	
Sclerolaena tricuspis	Streaked Copperburr	
***Senecio glossanthus* s.l.**	Slender Groundsel	
Senecio runcinifolius	Tall Fireweed	
Senna form* taxon *'filifolia'	Fine-leaf Desert Cassia	
Senna form* taxon *'petiolaris'	Woody Cassia	
Sida ammophila	Sand Sida	Vulnerable

Scientific Name	Common Name	Victorian Advisory List
Sida corrugata	Variable Sida	
Sida trichopoda	Narrow-leaf Sida	
Solanum esuriale	Quena	
Sporobolus caroli	Yakka Grass	Rare
Sporobolus mitchellii	Rat-tail Couch	
Stelligera endecaspinis	Star Bluebush	
Swainsona procumbens	Broughton Pea	
Tetragonia moorei	Annual Spinach	Poorly known
Vittadinia cervicularis* var. *cervicularis	Annual New Holland Daisy	
Vittadinia cervicularis* var. *subcervicularis	Annual New Holland Daisy	
***Vittadinia dissecta* s.l.**	Dissected New Holland Daisy	
Vittadinia dissecta* var. *hirta	Dissected New Holland Daisy	
Vittadinia gracilis	Woolly New Holland Daisy	
***Vittadinia* spp.**	New Holland Daisy	
Wahlenbergia fluminalis	River Bluebell	
Wahlenbergia gracilis	Sprawling Bluebell	
Zygophyllum aurantiacum* subsp. *aurantiacum	Shrubby Twin-leaf	
Zygophyllum iodocarpum	Violet Twin-leaf	

Flora – Exotic

Scientific Name	Common Name
Arctotheca calendula	Cape weed
Asparagus officinalis	Asparagus
Asphodelus fistulosus	Onion Weed
Avena barbata	Bearded Oat
***Avena* spp.**	Oat
Brassica tournefortii	Mediterranean Turnip
Bromus diandrus	Great Brome
Bromus rubens	Red Brome
Chondrilla juncea	Skeleton Weed
Cirsium vulgare	Spear Thistle
Conyza bonariensis	Flaxleaf Fleabane
Conyza sumatrensis* var. *sumatrensis	Tall Fleabane
Cotula bipinnata	Ferny Cotula
***Hordeum murinum* s.l.**	Barley-grass
Hypochaeris glabra	Smooth Cat's-ear
Lamarckia aurea	Golden-top
Lepidium africanum	Common Peppercress
Lolium rigidum	Wimmera Rye-grass
Malva parviflora	Small-flower Mallow
Marrubium vulgare	Horehound
Medicago minima	Little Medic
Medicago polymorpha	Burr Medic
Monoculus monstrosus	Tripteris
Parapholis incurva	Coast Barb-grass
Pentameris airoides* subsp. *airoides	False Hair-grass
Phalaris minor	Lesser Canary-grass
Phyla canescens	Fog-fruit
***Polygonum aviculare* s.l.**	Prostrate Knotweed
Reichardia tingitana	False Sow-thistle

Scientific Name	Common Name
Rostraria pumila	Tiny Bristle-grass
Schismus barbatus	Arabian Grass
Silene apetala* var. *apetala	Mallee Catchfly
Sisymbrium erysimoides	Smooth Mustard
Sisymbrium irio	London Rocket
***Solanum nigrum* s.l.**	Black Nightshade
***Sonchus asper* s.l.**	Rough Sow-thistle
Sonchus oleraceus	Common Sow-thistle
***Spergularia rubra* s.l.**	Red Sand-spurrey
***Spergularia rubra* s.s.**	Red Sand-spurrey
Vulpia myuros	Rat's-tail Fescue
Xanthium spinosum	Bathurst Burr
***Xanthium strumarium* spp. agg.**	Noogoora Burr species aggregate

Fauna - Native

Scientific Name	Common Name	Victorian Advisory List
Accipiter fasciatus	Brown Goshawk	
Acrobates pygmaeus	Feathertail Glider	
Anas gracilis	Grey Teal	
Anhinga novaehollandiae	Darter	
Ardea modesta	Eastern Great Egret	Vulnerable
Ardea pacifica	White-necked Heron	
Barnardius zonarius barnardi	Mallee Ringneck	
Cacatua galerita	Sulphur-crested Cockatoo	
Chenonetta jubata	Australian Wood Duck	
Climacteris picumnus victoriae	Brown Treecreeper (south-eastern ssp.)	Near threatened
Colluricincla harmonica	Grey Shrike-thrush	
Corcorax melanorhamphos	White-winged Chough	
Corvus coronoides	Australian Raven	
Dacelo novaeguineae	Laughing Kookaburra	
Egretta novaehollandiae	White-faced Heron	
Elseyornis melanops	Black-fronted Dotterel	
Entomyzon cyanotis	Blue-faced Honeyeater	
Eolophus roseicapilla	Galah	
Geopelia striata	Peaceful Dove	
Grallina cyanoleuca	Magpie-lark	
Gymnorhina tibicen	Australian Magpie	
Haliaeetus leucogaster	White-bellied Sea-Eagle	Vulnerable
Lichenostomus penicillatus	White-plumed Honeyeater	
Limnodynastes fletcheri	Barking Marsh Frog	
Litoria raniformis	Growling Grass Frog	Endangered
Macropus rufus	Red Kangaroo	
Manorina melanocephala	Noisy Miner	

Scientific Name	Common Name	Victorian Advisory List
Microcarbo melanoleucos	Little Pied Cormorant	
Morelia spilota metcalfei	Carpet Python	Endangered
Nycticorax caledonicus hillii	Nankeen Night Heron	Near threatened
Ornithorhynchus anatinus	Platypus	
Pardalotus striatus	Striated Pardalote	
Pelecanus conspicillatus	Australian Pelican	
Petrochelidon nigricans	Tree Martin	
Phalacrocorax carbo	Great Cormorant	
Phalacrocorax sulcirostris	Little Black Cormorant	
Philemon citreogularis	Little Friarbird	
Platalea flavipes	Yellow-billed Spoonbill	
Platycercus elegans flaveolus	Yellow Rosella	
Polytelis anthopeplus monarchoides	Regent Parrot	Vulnerable
Psephotus haematonotus	Red-rumped Parrot	
Rhipidura leucophrys	Willie Wagtail	
Tadorna tadornoides	Australian Shelduck	
Threskiornis molucca	Australian White Ibis	
Threskiornis spinicollis	Straw-necked Ibis	
Tiliqua occipitalis	Western Blue-tongued Lizard	Near threatened
Todiramphus pyrropygia pyrropygia	Red-backed Kingfisher	Near threatened
Todiramphus sanctus	Sacred Kingfisher	
Trichosurus vulpecula	Common Brushtail Possum	

Appendix 2: Ecological vegetation classes

Description of each EVC in the Tata Creek WMU sub-unit

EVC no.	EVC name	Bioregional Conservation Status Robinvale Plains	Description
97	Semi-arid Woodland	Vulnerable	Non-eucalypt woodland or open forest to 12 m tall, of low rainfall areas. Occurs in a range of somewhat elevated positions not subject to flooding or inundation. The surface soils are typically light textured loamy sands or sandy loams.
98	Semi-arid Chenopod Woodland	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.
103	Riverine Chenopod Woodland	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.
104	Lignum Swamp	Vulnerable	Typically treeless shrubland to 4 m tall, with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall areas on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.
106	Grassy Riverine Forest	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are infrequent, on deposited silts and sands, forming fertile alluvial soils. River Red Gum forest to 25 m tall with a groundlayer dominated by graminoids. Occasional tall shrubs present.
158	Chenopod Mallee	Vulnerable	Open to very open mallee woodland to 12 m tall (almost invariably dominated by Eucalyptus gracilis) supported by thin Woorinen deposits typically overlying gypsiferous and sodic clays. Characterised by the dominance of saltbushes and semi-succulent understorey shrubs.

EVC no.	EVC name	Bioregional Conservation Status	Description
200	Shallow Freshwater Marsh	Vulnerable	Shallow Freshwater Marsh occupies open sheets of water which are usually perennial although contract in size during the drier months. Large stands of River Red Gum or Lignum are often found around shallow freshwater marshes, with reeds, rushes and Cane Grass, or low-growing herbs and sedges, dominating the vegetation. Shallow Freshwater Marsh also occurs on deep brown anaerobic) silts where creeks and rivers broaden and flow slows as the water enters floodplains.
295	Riverine Grassy Woodland	Depleted (Terrestrial BCS)	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils. River Red Gum woodland to 20 m tall with a groundlayer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.
808	Lignum Shrubland	Depleted	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.
809	Floodplain Grassy Wetland	Endangered	Wetland dominated by floating aquatic grasses (which persist to some extent as turf during drier periods), occurring in the most flood-prone riverine areas. Typically treeless, but sometimes with thickets of saplings or scattered more mature specimens of River Red Gum *Eucalyptus camaldulensis.* Restricted, Murray River floodplain, primarily within Barmah Forest
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted (both EVCs)	EVC complex

EVC no.	EVC name	Bioregional Conservation Status	Description
813	Intermittent Swampy Woodland	Depleted	Eucalypt (- Acacia) woodland with (variously shrubby) rhizomatous sedgy - turf grass understorey, at best development dominated by flood-stimulated species in association with flora tolerant of inundation. The floristics are variable and often appear modified as a consequence of disturbance. Riverine floodplains of north-west and lake verges of Wimmera and southern Mallee.
816	Sedgy Riverine Forest	Depleted	Eucalypt forest (to woodland) with understorey dominated by larger sedges (to sedgy-herbaceous or sedgy-grassy), floristics with some affinities to Red Gum Swamp. Floodplains of less arid Riverina and Wimmera (absent from further north-west).
818	Shrubby Riverine Woodland	Least Concern (Terrestrial BCS)	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. Dominant tree species; *Eucalyptus largiflorens Eucalyptus camaldulensis*
819	Spike-sedge Wetland	Vulnerable	Low sedgy vegetation of seasonal or intermittent wetlands, dominated by spike-sedges and usually species-poor. Typically treeless, but sparse eucalypts (mostly E. camaldulensis) can be present in marginal sites. Scattered in drier lowlands, including western volcanics, Riverina floodplains and Wimmera.
821	Tall Marsh	Depleted	Wetland dominated by tall emergent graminoids, typically in thick species-poor swards. Rushland, sedgeland or reedbed - locally closed or in association or fine-scale mosaic with Aquatic Herbland (e.g. along floodway lagoons). At optimum development, the vegetation is treeless, but sparse Eucalyptus camaldulensis (or in higher rainfall areas, E. ovata) are dispersed through some sites where sufficient dry periods occur to allow their survival. Scattered across lowland Victoria.

EVC no.	EVC name	Bioregional Conservation Status	Description
823	Lignum Swampy Woodland	Depleted	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.

Appendix 3: 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.

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; and
- 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.

Separate contingency plans have been developed in the event that suspected human remains are discovered during the conduct of the activity.

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

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.

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.

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.

Curation and Further Analysis

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

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