



Little Murray Weir Pool - Aquatic and  
Semi-aquatic Flora Survey and  
Assessment Following Weir Pool  
Lowering: 2011 Revision

NVIRP

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# Contents

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<b>1</b>	<b>Introduction</b> -----	<b>1-1</b>
1.1	Introduction	1-1
1.2	Scope of Work	1-2
1.3	Background	1-2
1.4	Site Description	1-3
1.5	Methodology	1-5
<b>2</b>	<b>Review of Existing Sources</b> -----	<b>2-1</b>
2.1	Matters of EPBC Act and FFG Act Conservation Significance	2-1
<b>3</b>	<b>Vegetation Mapping</b> -----	<b>3-1</b>
3.1	EVC Condition	3-1
3.2	Vegetation Mapping	3-2
<b>4</b>	<b>Ecological Vegetation Classes</b> -----	<b>4-1</b>
4.1	EVCs of the Little Murray River	4-1
<b>5</b>	<b>Threatened Plant Species</b> -----	<b>5-1</b>
<b>5.1</b>	<b>Identification of Threatened Plant Species</b>	5-1
<b>6</b>	<b>Survey 2: Vegetation Established Below High Water Level</b> -----	<b>6-1</b>
<b>6.1</b>	<b>Bank survey</b>	6-1
<b>7</b>	<b>Evaluation of Impacts</b> -----	<b>7-1</b>
7.1	EPBC Matters of NES	7-1
7.2	FFG Act	7-1
7.3	EVC Bioregional Conservation Significance	7-3
<b>8</b>	<b>Conclusions and Recommendations</b> -----	<b>8-1</b>
8.1	Conclusions	8-1
8.2	Recommendations	8-1
<b>9</b>	<b>References</b> -----	<b>9-1</b>

# Figures, Tables and Appendices

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## Figures

Figure 1. Location of the Little Murray River.....	1-3
Figure 2. Map of the Little Murray heading east from the Little Murray Weir showing EVCs of the aquatic and riparian zones. ....	3-3
Figure 3. Map of the Little Murray continuing from Map 1 showing EVCs of the aquatic and riparian zones.....	3-4
Figure 4. Map of the Little Murray continuing from Map 2 showing EVCs of the aquatic and riparian zones.....	3-5
Figure 5. Map of the Little Murray continuing from Map 3 showing EVCs of the aquatic and riparian zones.....	3-6
Figure 6. Map of the Little Murray at the eastern end at Fish Point Weir, showing EVCs of the aquatic and riparian zones.....	3-7
Figure 7. Riverine Grassy Woodland on the Little Murray River.....	4-2
Figure 8. Grassy Riverine Forest/Riverine Swamp Forest Complex on the Little Murray River.....	4-3
Figure 9. Billabong Wetland Aggregate on a billabong adjoining the Little Murray River.....	4-4
Figure 10. Tall Marsh along the banks of the Little Murray River.....	4-5
Figure 11. Lignum Swampy Woodland on the Little Murray River.....	4-6
Figure 12. Exposed river bank along western section of Little Murray River.....	6-3
Figure 13. <i>Myriophyllum papillosum</i> highly disturbed by cattle trampling.....	6-3
Figure 14. <i>Eleocharis sphacelata</i> trampled and grazed by stock.....	6-4
Figure 15. Eroded riverbank with undercut and fallen eucalypt trees.....	6-5

## Tables

Table 1. EVCs present and predicted to occur at the Little Murray.....	3-2
Table 2. Plants established below the high water level, during bank exposure in July 2011.....	6-1
Table 3. Conservation significance of EVCs present at the Little Murray.....	7-3

## Appendices

Appendix A	Plant Species
Appendix B	Site Waypoints

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## 1.1 Introduction

Ecological Associates was engaged by the Northern Victorian Irrigation Renewal Project (NVIRP) to assess the aquatic and riparian vegetation along the Little Murray River potentially impacted by modernisation works. These works form part of the reconfiguration, rationalisation and modernisation of the Goulburn-Murray Irrigation District (GMID). A component of the works involves the decommissioning of the Little Murray Weir in the Swan Hill Irrigation Region.

The Little Murray Weir was constructed in the early 1900's to raise the water level of the Little Murray River to allow water to be gravity fed to the No. 9 Channel, which at the time serviced Swan Hill, Tyntynder Flats and Woorinen Irrigation Regions. The current weir structure is in poor condition and has an estimated remaining life of 18 to 25 years with the replacement cost between \$15-20 million. Given the limited remaining life of the structure and the potential water savings that can be generated, the weir is proposed to be decommissioned as part of the Northern Victorian Irrigation Renewal Project.

The decommissioning of the weir will involve removing the weir gates and drop bars and allowing the concrete sill and apron to remain to provide a low level weir pool upstream of the weir. The crest of the weir currently operates to provide a Full Supply Level of 69.21 m AHD, which results in the formation of the Little Murray Weir Pool. The weir pool extends approximately 37 km upstream to Fish Point Weir, and receives unregulated inflows from the Murray and Loddon Rivers, and regulated flows from the 6/7 Channel Outfall, the Lake Boga Outfall, and the Pental Island Pump Station. The weir is maintained at or near the Full Supply Level of 69.21 m AHD throughout the irrigation season (August - May). During the non-irrigation season (May - August) the weir pool is dewatered.

Post decommissioning of the weir, the crest of the weir will be lowered to 67 m AHD, therefore reducing the volume of water held in the weir pool during the irrigation season and offering substantial water savings.

A flora survey was conducted by Ecological Associates in March 2010, when the weir pool was operating at full supply level (Ecological Associates 2010). In June 2011, a second flora survey was completed when the weir pool had been drawn down for maintenance purposes. The objective of the second assessment was to identify any additional aquatic and semi-aquatic plant communities that may have been submerged and not identified during the initial survey. It was intended that this survey be conducted with the weir level as close as possible to the proposed operating level (67 m AHD); however, high flows from the River Murray meant that the level during the survey week was between 67.91 and 67.98 m AHD (S. Morath pers. comm.).

This report amends the previous report (Ecological Associates 2010) by incorporating the findings of the 2011 survey.

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## 1.2 Scope of Work

A vegetation survey was required to assess the potential for the modifications to impact on matters of conservation significance under the *Environment Protection and Biodiversity Conservation (EPBC) Act* and *Flora and Fauna Guarantee (FFG) Act*. Advice was required on the significance of the impacts and the opportunities to avoid or minimise impacts. These opportunities may include incorporating the water requirements of listed matters in the operating regime for Little Murray water levels.

The specific tasks were to:

- review existing records of *EPBC Act* and *FFG Act* listed species, communities and threatening processes from the site and its vicinity;
- map aquatic and semi-aquatic plant communities associated with the Little Murray Weir Pool;
- report the plant communities present and their composition;
- revisit the site when it was being operated nearer to the proposed operating level to identify any additional aquatic and semi-aquatic plant communities associated with the weir pool;
- report the conservation status of plant species under the *EPBC Act* and *FFG Act* and report the locations of species of conservation significance;
- review the nature of impacts associated with the proposed option and report the likely significance of impacts on *EPBC Act* and *FFG Act* listed species, communities and threatening processes in relation to the EPBC Significant Impact Guidelines (DEWHA 2009a); and
- report the findings and provide maps of plant communities and any issues of conservation significance.

## 1.3 Background

Under the *Victorian Environment Effects Act 1978*, project works that could potentially have a significant effect on the environment may be referred to the Minister for Planning for advice on whether an Environmental Effects Statement is required. The Minister might typically require a proponent to prepare an Environmental Effects Statement when:

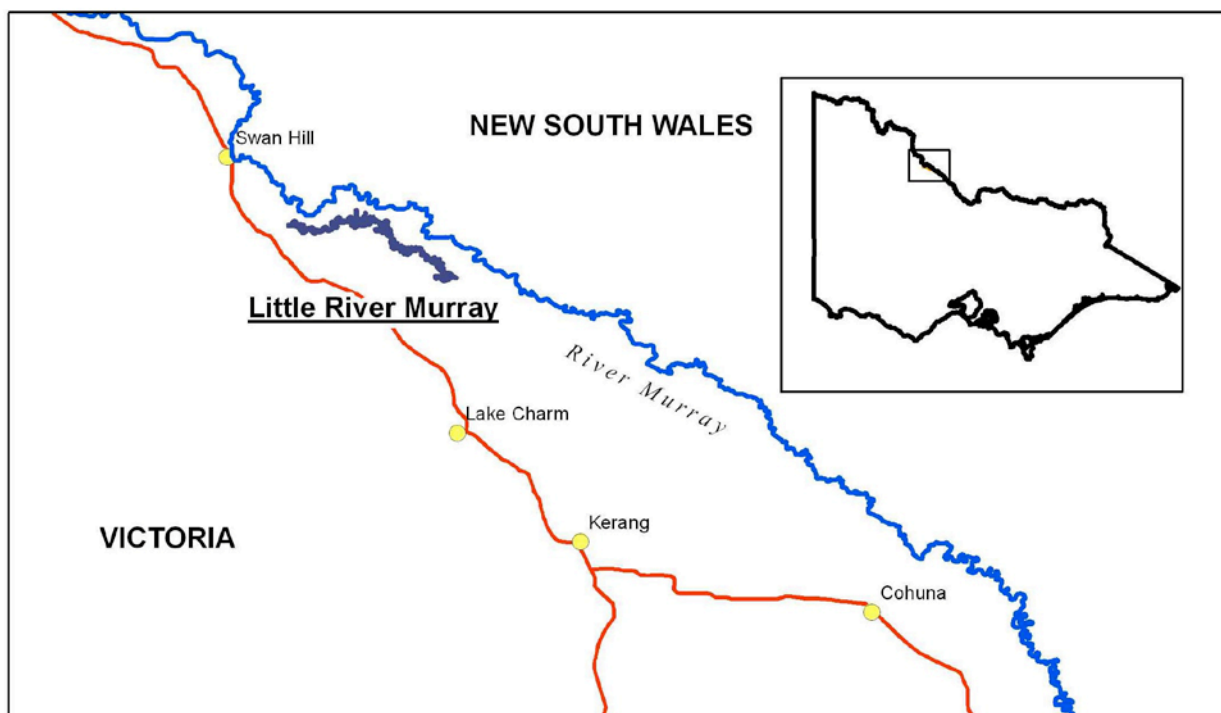
- there is a likelihood of regional or State significant adverse impacts on the environment;
- there is a need for integrated assessment of potential environmental effects of a project and relevant alternatives; and
- normal statutory processes would not provide a sufficiently comprehensive, integrated and transparent assessment.

The Commonwealth *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* administers protective measures for matters of National Environmental Significance (NES) listed in the schedules of the Act. This report assesses potential impacts to the following matters of NES:

- threatened ecological communities; and
- plant species.

## 1.4 Site Description

The Little Murray River is situated south-east of Swan Hill and south-west of the River Murray (Figure 1). The Little Murray occurs in the Murray Fans bioregion of Victoria and the area falls within the management area of the North Central Catchment Management Authority (NCCMA). The study area includes the Little Murray River and its adjacent aquatic and semi-aquatic habitat between Little Murray Weir and Fish Point Weir. Aquatic and semi-aquatic habitat includes the riparian corridor as far from the channel as may potentially be affected by a reduction in weir level.



**Figure 1. Location of the Little Murray River**

The Murray Fans Bioregion consists of a flat to gently undulating landscape on recent, unconsolidated sediments (DPI 2008). There is evidence of former stream channels, braided old river meanders and palaeochannels and broad floodplain areas associated with major river systems. The vegetation is a mosaic of Plains Grassy Woodland, Pine Box Woodland, Riverina Plains Grassy Woodland and Riverina Grassy Woodland ecosystems (DPI 2008).

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Over 80% of the vegetation cover in the Murray Fans Bioregion within the North Central Catchment has been cleared and biodiversity assets and the operation of ecological processes are in poor to very poor condition across the landscape (NCCMA 2003).

Ecological Vegetation Classes are classifications established in the Native Vegetation Framework under Victorian legislation.

The predominant Ecological Vegetation Classes (EVCs) in the Bioregion are Riverine Chenopod Woodland and Riverine Swamp Forest. Riverine Chenopod Woodlands consist of eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Riverine Swamp Forests consist of open eucalypt forest to 25 m tall in flood-prone areas, with a grassy-herbaceous ground layer (NCCMA 2003).

Threats to the native vegetation in the Murray Fans Bioregion include salinity, rising water tables, alteration to soil and water nutrient balances, habitat fragmentation, grazing and changed hydrological regimes that affect rivers and wetlands. Important issues facing threatened flora species are stock grazing, loss of habitat, environmental flows, introduced predators and weeds (NCCMA 2003).

The land area surrounding the Little Murray River is a mosaic of cleared areas and patches of remnant native vegetation. The dominant EVCs reported to occur in the vicinity of the Little Murray River from the *Biodiversity Interactive Map* (DSE 2009a) are Riverine Chenopod Woodland (EVC 103), Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812) and Riverine Grassy Woodland (EVC 295).



## 1.5 Methodology

### *Pre-Survey*

Existing EVC mapping along the Little Murray and adjacent wetlands was reviewed from aerial photography interpretation prior to commencing the field work. Polygons were refined using ArcMap 9 based on contrasting vegetation textures at a scale of approximately 1:2,000.

Flora and fauna records recently collated by SKM (2009) for the study area were reviewed and additional information was sought on plant species likely to be present from Department of Sustainability and Environment (DSE) officers at Swan Hill and Peter McRostie from the NCCMA.

We reviewed matters of conservation significance potentially affected by the proposed weir pool modifications from the DEWHA (2009b) database and other sources. These matters included Communities of Flora and Fauna and Potentially Threatening Processes under the *FFG Act* and Ecological Communities under the *EPBC Act*.

### *Survey 1*

The Little Murray River and its riparian zone were assessed by boat from 23 – 26 March 2010, when the weir was operating at full supply level.

Vegetation mapping was conducted using a GPS-linked GETAC tablet PC running ArcMap 9. All EVCs present on the site were described in terms of the structure and condition of the vegetation, mapped and their component plant species identified. The conservation significance of plant communities and plant species was reported for Victorian and Commonwealth listings.

The presence of threatened species was determined through detailed regular searching of vegetation along the system. Searches targeted 79 sites where vegetation was in good condition or where the structure or condition of vegetation varied.

### *Survey 2*

An additional flora survey of the Little Murray River and its riparian zone was conducted by boat from 12 – 14 July 2011. During this survey period, the weir level ranged from 67.91 - 67.98 m AHD. The weir pool had been drawn down to sill level (67.00 m AHD) in mid-May; however, high levels in the River Murray resulted in pool heights ranging from 67.50 – 67.90 m AHD from the end of May through to mid-July.

A detailed search of the exposed riverbanks was conducted between Fish Point Weir and the Little Murray Weir, recording all plant species established below the high water mark. In addition, each of the

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previously mapped vegetation associations was searched for the presence of plant species that were not identified during the initial flora survey.

### 2.1 Matters of EPBC Act and FFG Act Conservation Significance

Threatened species or communities previously recorded in the vicinity of the study area based on a search of the EPBC Protected Matters Search Tool and the Flora Information System and were recently collated by SKM (2009) and these were reviewed.

A recent review *EPBC Act* issues pertaining to the NVIRP and the Goulburn-Murray Irrigation District, (Ecological Associates 2009) included the Little Murray area and was consulted to identify potential issues related to this study.

Species observed during the survey were checked against the *EPBC Act* list of threatened flora species (DEWHA 2009b).

The *FFG Act* Threatened List (DSE 2009c) was consulted to identify species of state conservation significance.

Additional information on plant species likely to be present in the study area was sought from staff of the NCCMA and DSE.

#### *Plant Communities*

The EPBC Protected Matters Search Tool reports three threatened ecological communities that may be present in the study area:

- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (Endangered);
- Weeping Myall Woodlands (Endangered); and
- White Box – Yellow Box – Blakely’s Gum Grassy Woodland and Derived Native Grassland (Critically Endangered).

The field survey determined that none of these threatened ecological communities were present in the study area.

- None of the plant communities present in the study area are listed under the FFG Act.
- The EVCs present in the study area have the following bioregional conservation status:
- Riverine Grassy Woodland (EVC 295) – vulnerable
- Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812) – vulnerable
- Billabong Wetland Aggregate (EVC 334) – depleted
- Tall Marsh (EVC 821) – least concern

- 
- Lignum Swampy Woodland (EVC 823) – vulnerable

### *Threatening Processes under the FFG Act*

The project is potentially relevant to five threatening processes listed under the *FFG Act* (DSE 2009b):

- degradation of native riparian vegetation along Victorian rivers and streams;
- habitat fragmentation as a threatening process for fauna in Victoria;
- invasion of native vegetation by *Rubus fruticosus* agg.;
- invasion of native vegetation by ‘environmental weeds’; and
- wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing.

### 3.1 EVC Condition

To provide an indication of the condition of the vegetation in the EVCs, four subjective categories were devised and used during assessment. These are described below.

#### *Poor*

In this category, tree health was poor to moderate with only the older trees of the overstorey having a reasonable demographic range. Few young trees were present and there was little or no recruitment. There was a variable degree of historic timber harvesting. The understorey was extremely depauperate in diversity and cover with weeds forming a high proportion of the total vegetation cover. The understorey had been heavily grazed often to the point that plants were completely lacking from this layer.

#### *Moderate*

Native vegetation was generally confined between the channel and levee on the floodplain and was cleared beyond the levee in this category. Tree health was moderate to good and the overstorey trees showed a reasonable demographic range. There was evidence of tree felling. Diversity and cover of the understorey was well below the benchmark and weed cover was moderate to high, with *\*Salix babylonica* in the overstorey and *\*Phyla canescens* in the ground layer. The understorey had been moderately to heavily grazed.

#### *Good*

Tree health was moderate to good with the overstorey trees showing a relatively broad demographic range with ongoing recruitment. There were minor to moderate levels of historic timber harvesting. Understorey cover and diversity approached the benchmark and weeds were abundant, especially *\*Phyla canescens*. The understorey had been lightly grazed or had not been grazed.

#### *Excellent*

None of the EVCs observed during the survey were in excellent condition. In the condition of excellent, tree health would be good and the overstorey tree demography would have a broad range with evidence of ongoing recruitment. Timber harvesting would be minor or there would be no evidence of timber harvesting. The understorey diversity and cover would be at or above the benchmark and weeds would be present but only as a minor component. The understorey would be ungrazed or have a possible history of some grazing

### 3.2 Vegetation Mapping

Maps showing the position and extent of the different EVCs, their condition categories and assessment waypoints (Appendix B) are presented in Figure 2 – Figure 6.

Ground-truthing during the survey revealed that actual EVCs present in the study area differed in several instances from EVCs reported from the *Biodiversity Interactive Map* (DSE 2009a).

The *Biodiversity Interactive Map* (DSE 2009a) predicted the presence of seven EVCs along the Little Murray River. The field survey revealed that of these only two are present and an additional three that were not mapped are also present. The existing EVC mapping in this area is coarse and unreliable at the scale of this assessment.

**Table 1. EVCs present and predicted to occur at the Little Murray**

EVC	Predicted by DSE Mapping	Present at Site
Riverine Grassy Woodland (EVC 295)	Yes	Yes
Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812)	Yes	Yes
Riverine Chenopod Woodland (EVC 103)	Yes	No
Riverine Swamp Forest (EVC 814)	Yes	No
Lignum Swamp (EVC 104)	Yes	No
Chenopod Grassland (EVC 829)	Yes	No
Grassy Riverine Forest (EVC 106)	Yes	No
Billabong Wetland Aggregate (EVC 334)	No	Yes
Tall Marsh (EVC 821)	No	Yes
Lignum Swampy Woodland (EVC 823)	No	Yes

The survey showed that of the EVCs listed above, only EVC 295 and EVC 812 were actually present along the Little Murray, and the following EVCs were described in addition to these:

Riverine Grassy Woodland (EVC 295) is the dominant EVC present along most parts of the river course of the Little Murray. Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812) is dominant towards the eastern end of the river near Fish Point Weir. There is a large area of Tall Marsh (EVC 821) at the western end of the river near Little Murray Weir and patches of this EVC also occur in other parts of the river. EVCs represented by patches along the river course include Billabong Wetland Aggregate (EVC 334), mostly associated with wetlands adjoining the Little Murray and Lignum Swampy Woodland (EVC 823). Dense stands dominated by *\*Salix babylonica* in which the trees extend into the channel are mapped as areas of non-native vegetation.

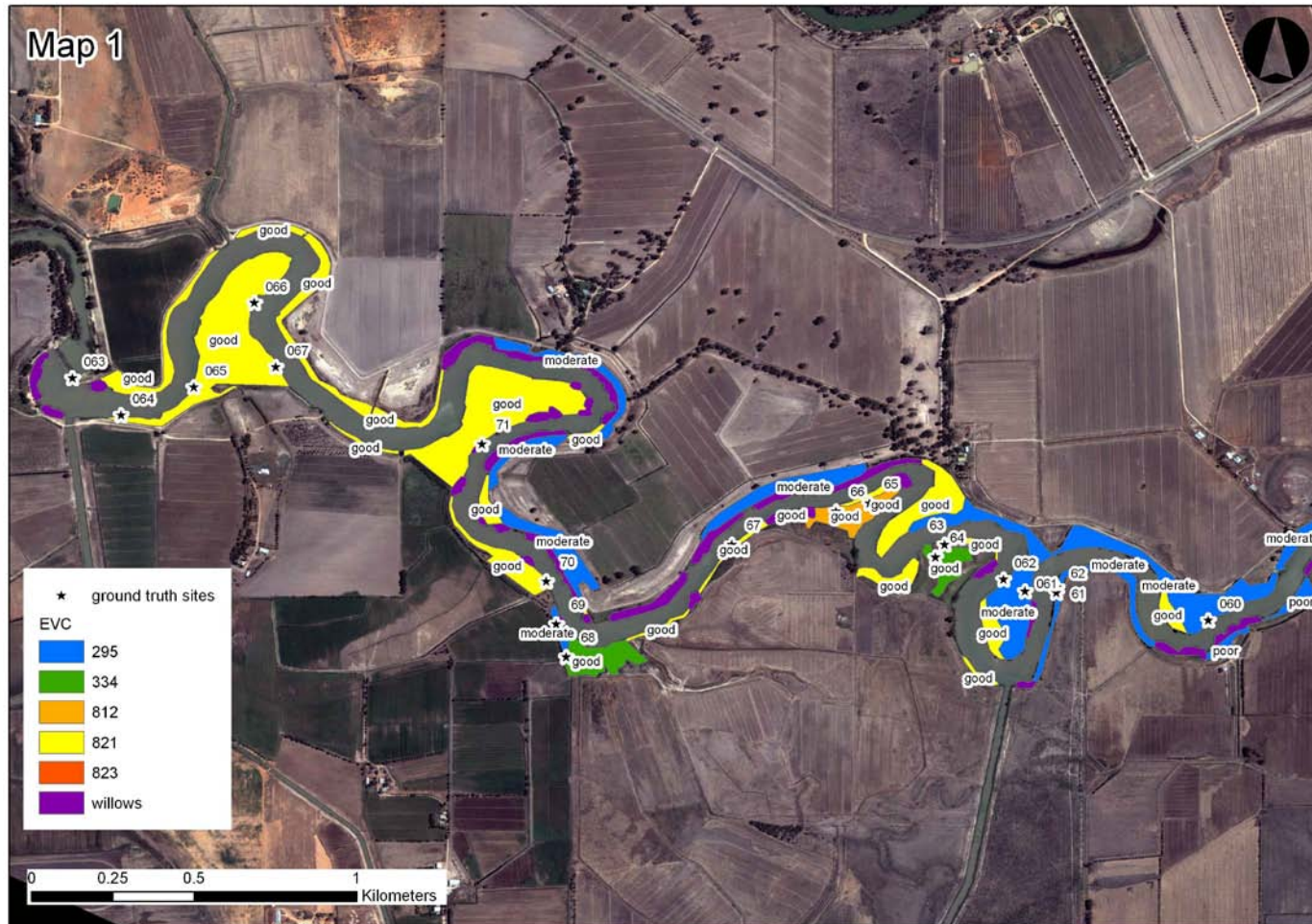


Figure 2. Map of the Little Murray heading east from the Little Murray Weir showing EVCs of the aquatic and riparian zones.



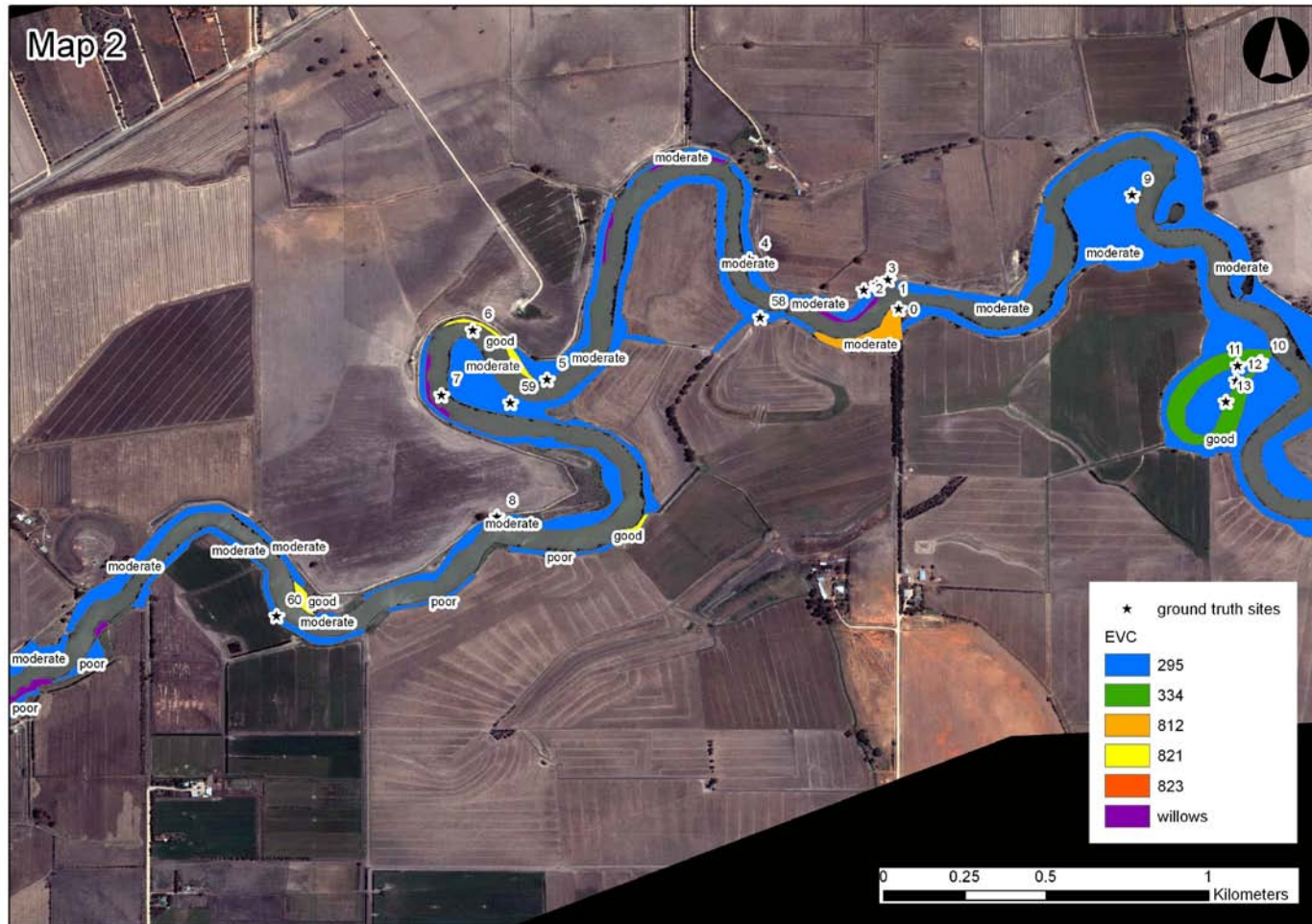


Figure 3. Map of the Little Murray continuing from Map 1 showing EVCs of the aquatic and riparian zones.



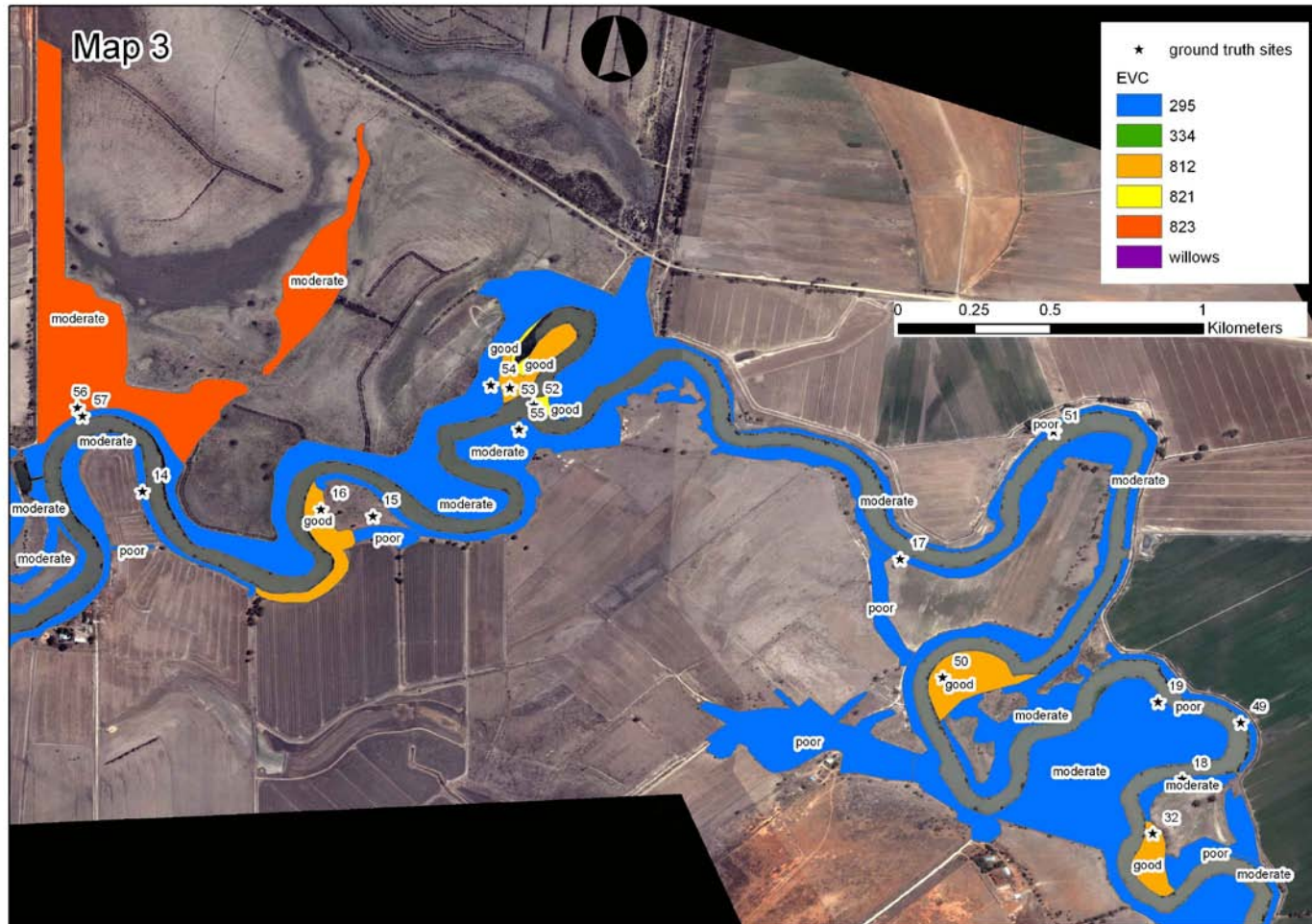


Figure 4. Map of the Little Murray continuing from Map 2 showing EVCs of the aquatic and riparian zones.







Figure 6. Map of the Little Murray at the eastern end at Fish Point Weir, showing EVCs of the aquatic and riparian zones.

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## 4.1 EVCs of the Little Murray River

Five EVCs are present. These are described below and their component species are given in the list of species found during the survey (Appendix A). The initial flora survey (March 2010) identified 82 native and 60 introduced plant species (Ecological Associates 2010; Appendix A). The second flora survey (June 2011) identified an additional eight native species and five introduced species (Appendix A).

The distribution of species within each EVC has been updated based on information collected in the second survey (Appendix A). The EVCs associated with eleven native and three introduced species were updated to reflect their wider distribution.

The increase in the number of species and their distribution is largely due to the timing of the survey (winter as opposed to late summer), as well as good summer rainfall. Many of these species (e.g. *Myosurus minimus*, *Cotula* sp., *Ranunculus pumilio*, *Senecio runcinifolius*) are common only in wet years.

### *EVC 295: Riverine Grassy Woodland*

Riverine Grassy Woodland occurs on the floodplains of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils (DSE 2004). The community consists of *Eucalyptus camaldulensis* woodland to 20 m tall with a ground layer dominated by grasses and is sometimes lightly shrubby or has chenopod shrubs (DSE 2004). It has a bioregional conservation status of vulnerable.

This EVC is the dominant plant community present in the aquatic and riparian zones of the Little Murray River and occupies the main body of the river between Little Murray Weir and Fish Point Weir (Figure 2 – Figure 6). The western part of the river course is dominated by Tall Marsh (EVC 821) (Figure 2) and a relatively long section of the western extreme is dominated by Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812) (Figure 6).

There is reasonable species diversity in this EVC, with 72 native species recorded. *Eucalyptus camaldulensis* dominates the overstorey and isolated *E. largiflorens* trees are present along some parts of the watercourse (Figure 7). Isolated *Acacia stenophylla* and *Exocarpos aphyllus* are present as midstorey species and the understorey consists of various densities of shrubs and herbs but these are mostly sparsely scattered in the understorey. Chenopod shrubs present include *Sclerolaena muricata* var. *villosa*, *Maireana decalvans*, *Rhagodia spinescens* and sparse *Atriplex* spp. and herbaceous species include *Vittadinia* spp., *Senecio* spp. and *Wahlenbergia fluminalis*. Species present in damp or wet soil at the water's edge include *Cyperus* spp., *Pratia concolor*, *Marsilea drummondii*, *Eleocharis* spp. and *Juncus* spp. Aquatic species include *Myriophyllum* spp., *Azolla filiculoides* and *Bolboschoenus medianus* (Appendix A).

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This EVC is generally in moderate condition, with a depleted understorey, but most of the mature *Eucalyptus camaldulensis* trees are in reasonable health. The understorey is severely degraded in some areas where plants are totally lacking from understorey and ground layers due to heavy grazing.

No species of conservation significance were found in this EVC during the survey.

This EVC generally contains many weeds and a species dominating the ground layer in most parts of the site is *Phyla canescens*. Other common weeds include *Cirsium vulgare*, *Lycium ferocissimum*, *Helmintotheca echioides*, *Paspalum distichum* and *P. dilatatum* (Appendix A).



**Figure 7. Riverine Grassy Woodland on the Little Murray River**

### ***EVC 812: Grassy Riverine Forest/Riverine Swamp Forest Complex***

This plant community complex consists of open eucalypt forest to 25 m tall over a grassy-herbaceous ground layer and occurs on flood-prone areas (DSE 2004). EVC 812 occurs on broad shallow floodways and low-lying river terraces prone to reasonably regular flooding (DSE 2004). It has a bioregional conservation status of vulnerable.

EVC 812 dominates both banks of the Little Murray River towards the eastern end, approaching and surrounding Fish Point Weir. Smaller patches occur intermittently along the river course, generally in moist areas.

The overstorey of this EVC consists of tall *Eucalyptus camaldulensis* trees generally in good health (Figure 8). Sparse *Acacia stenophylla* trees are present below these tall River Red Gums. Patches of dense or sparse healthy *Muehlenbeckia florulenta* are present in the understorey and there are shrubs, herbs and



grasses in the ground layer. These species include chenopods such as *Atriplex semibaccata*, *Maireana brevifolia* and *Enchylaena tomentosa*. Sedges present include *Juncus* spp., *Carex tereticaulis*, *Cyperus exaltatus* and *Bolboschoenus medianus*. Herbaceous plants include *Alternanthera denticulata*, *Mentha australis*, *Eclipta platyglossa* and *Vittadinia* sp. Grasses include *Setaria jubiflora*, *Austrodanthonia setacea* and *Enteropogon acicularis* (Appendix A).

Condition of this EVC is mostly moderate, with a large area of good quality vegetation at the eastern end surrounding Fish Point Weir. An area of poor quality vegetation is also present at the eastern end of the Little Murray. Several smaller patches of this EVC along the main body of the river are in good condition (Figure 2 – Figure 6).

No species of conservation significance were found in this EVC during the survey.

Many weeds occur in this EVC. Common species include *\*Phyla canescens* and *\*Paspalum* spp. Other species present include *\*Gnaphalium polycaulon*, *\*Rumex crispus*, *\*Bromus diandrus*, *\*Sonchus* spp., *\*Hypochaeris* spp., and *\*Xanthium* spp.



**Figure 8. Grassy Riverine Forest/Riverine Swamp Forest Complex on the Little Murray River**

### ***EVC 334: Billabong Wetland Aggregate***

This EVC collectively describes the various zones of vegetation associated with lagoons or billabongs on floodplains (DSE 2006). Components of Billabong Wetland Aggregate include aquatic herbland, aquatic sedgeland, tall marsh, dwarf floating aquatic herbland and floodway pond herbland. These occur in major river systems, mainly in cooler areas (DSE 2006). This EVC has a bioregional conservation status of depleted.

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This EVC is present in small patches along the main body of the river (Figure 2 – Figure 6) and in billabongs connected to the main body of the watercourse.

Along the Little Murray, this EVC consists mainly of elements of aquatic herbland and aquatic sedgeland, along with some elements of floating aquatic herbland (Figure 9). Aquatic herbland species include *Pratia concolor*, *Crassula helmsii*, *Cotula coronopifolia* and *Marsilea drummondii*. Aquatic sedgeland species include *Eleocharis acuta* and *Cyperus exaltatus*. Some riverine species are also present around the edges of billabongs, such as *Maireana decalvans*, *Sclerolaena muricata* var. *villosa* and *Austrodanthonia setacea* (Appendix A). During the June 2011 survey, the majority of this EVC was inundated and consisted of floating aquatic herbland, dominated by *Azolla filiculoides*.

Billabong Wetland Aggregate is mostly in good condition along the Little Murray.

No species of conservation significance were found in this EVC during the survey.

Weed species present include *\*Trifolium* sp., *\*Lactuca serriola* and *\*Citrullus lanatus*.



**Figure 9. Billabong Wetland Aggregate on a billabong adjoining the Little Murray River**

### *EVC 821: Tall Marsh*

This EVC describes a wetland dominated by tall emergent graminoids, typically in thick species-poor swards (DSE 2006). This EVC may consist of rushland, sedgeland or reedbed and may be locally closed or associated with aquatic herbland. The vegetation is treeless at optimum development but sparse River Red Gum may occur in drier areas (DSE 2006). This EVC has a bioregional conservation status of least concern.

This EVC often occurs as a thin band of vegetation at the water's edge, either on its own or in the aquatic zone of EVC 295 or EVC 812. EVC 821 is dominant at the western end of the river in the vicinity of Little Murray Weir and eastwards of the weir (Figure 2). Smaller patches are present further along the river towards the western end (Figure 3 – Figure 4).

Dominant species include *Phragmites australis*, *Typha domingensis*, *Juncus* spp. and *Cyperus* spp. (Figure 10). Sparse *Muehlenbeckia florulenta* is often present among the *P. australis* and *T. domingensis*. *Calystegia sepium* is often found climbing on *P. australis*. Sedges include *Juncus* spp., *Cyperus sanguinolentus* and *Schoenoplectus validus*. Other species include *Epilobium hirtigerum* and the aquatic species *Persicaria* spp., *Myriophyllum* spp. and *Crassula helmsii*.

Tall Marsh is in good condition throughout the site. The cover of *Phragmites australis* and *Typha domingensis* is particularly dense along the water's edge. No species of conservation significance were found in this EVC during the survey.

Weed species consistently present include *\*Paspalum dilatatum* and *\*P. distichum*. *\*Juncus acutus* is often present as a tall species, along with rambling *\*Rubus fruticosus* and *\*Aster subulatus*.



**Figure 10. Tall Marsh along the banks of the Little Murray River**



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### *EVC 823: Lignum Swampy Woodland*

Lignum Swampy Woodland is a tall, mostly dense shrub layer, dominated by tangled *Muehlenbeckia florulenta*, associated with eucalypt/acacia low woodland (DSE 2006). The ground layer includes a component of obligate wetland flora that is able to persist over dry periods. This EVC has a bioregional conservation status of vulnerable.

This EVC is present as two large remnants beyond the thin strip of Riverine Grassy Woodland more or less in the central section of the Little Murray (Figure 4) and as smaller patches further eastwards along the river course, mostly further landward from the river beyond the Riverine Grassy Woodland (Figure 5).

Dominant species include *Muehlenbeckia florulenta*, with *Eucalyptus largiflorens*, *Acacia stenophylla* and sometimes stunted *Eucalyptus camaldulensis* in the overstorey (Figure 11). This vegetation often occurs on higher terraces beyond the riparian zone. Other species include chenopod shrubs such as *Atriplex* spp., *Einadia nutans* and *Sclerolaena muricata* and smaller shrublets such as *Pseudognaphalium luteoalbum* and *Vittadinia gracilis*.

Lignum Swampy Woodland is in moderate condition at the study site with some evidence of tree felling and moderate to heavy grazing.

No species of conservation significance were found in this EVC during the survey.

Weeds are slightly less abundant than in the riverine zone and include *\*Aster subulatus*, *\*Cirsium vulgare*, *\*Bromus* spp. and *\*Hordeum marinum*.



**Figure 11. Lignum Swampy Woodland on the Little Murray River**

### 5.1 Identification of Threatened Plant Species

One terrestrial species of conservation significance under the *FFG Act* (DSE 2009c) was found during the survey: *Atriplex acutibractea* subsp. *acutibractea* (Pointed Saltbush). This species was found at waypoint 46 (see Appendix B), on the southern bank of the Little Murray River, on an artificial embankment upslope from an area where water was artificially entering the Little Murray. This area was disturbed and was not mapped as an area of native vegetation. The embankment was situated between an area of EVC 823 and an area of EVC 295 (Figure 5). There was a healthy population of at least 25 plants present on the embankment. *Atriplex acutibractea* subsp. *acutibractea* is a short-lived perennial shrub, uncommon and scattered throughout mallee areas.

No plant species listed under the *EPBC Act* were observed.

# Survey 2: Vegetation Established Below High Water Level

## 6.1 Bank survey

Over the three day survey, the weir pool level was between 67.91 and 67.98 m AHD. This was approximately 1.3 m below full supply level. The weir pool had been operated at a lowered level of around 67.50 – 67.90 m AHD in the preceding 2 months, allowing for the establishment of semi-aquatic and terrestrial species on the exposed banks.

The exposed bed of the Little Murray currently meets the definition of EVC 107 Lake Bed Herbland. This EVC represents areas subject to prolonged inundation where, following exposure, ruderal mud-flat herbs or terrestrial shrubs may colonise. However, when the river is operated at a new level on a long-term basis, the exposed bank will most likely develop EVC 821 Tall Marsh or EVC 334 Billabong Wetland Aggregate.

Twenty native species and six introduced plant species were observed (Table 2). The abundance of most of these plants was very low, with only a few patches of plants dispersed along the entire length of the river. The great majority of the exposed bed had no vegetation and was bare mud.

Two floating aquatic species (*Azolla filiculoides* and *Lemna disperma*) were recorded within the river itself; however, due to the relatively strong current at the time of the survey these were present at very low abundance.

None of the species recorded below the high water mark are listed as threatened under the *EPBC Act* or *FFG Act*.

**Table 2. Plants established below the high water level, during bank exposure in July 2011**

Family	Species	Common name	EPBC	FFG
<b>NATIVE SPECIES</b>				
ASTERACEAE	<i>Centipeda cunninghamii</i>	Common Sneezeweed		
ASTERACEAE	<i>Senecio glomeratus</i>	Annual Fireweed		
ASTERACEAE	<i>Senecio quadridentatus</i>	Cotton Fireweed		
AZOLLACEAE	<i>Azolla filiculoides</i>	Pacific Azolla		
CARYOPHYLLACEAE	<i>Spergularia marina</i>	Salt Sand-spurrey		
CRASSULACEAE	<i>Crassula helmsii</i>	Swamp Crassula		
CHENOPODIACEAE	<i>Atriplex leptocarpa</i>	Slender-fruit Saltbush		
CYPERACEAE	<i>Carex tereticaulis</i>	Rush Sedge		
CYPERACEAE	<i>Eleocharis sphacelata</i>	Tall Spike-rush		
HALORAGACEAE	<i>Myriophyllum papillosum</i>	Robust Milfoil		
JUNCACEAE	<i>Juncus usitatus</i>	Common Rush		

## Survey 2: Vegetation Established Below High Water Level

## SECTION 6

Family	Species	Common name	EPBC	FFG
JUNCAGINACEAE	<i>Triglochin procera</i>	Water-ribbons		
LEMNACEAE	<i>Lemna disperma</i>	Common Duckweed		
LYTHRACEAE	<i>Lythrum hyssopifolia</i>	Lesser Loosestrife		
MARSILEACEAE	<i>Marsilea drummondii</i>	Common Nardoo		
ONAGRACEAE	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Clove-strip		
POLYGONACEAE	<i>Persicaria decipiens</i>	Slender Knotweed		
POLYGONACEAE	<i>Rumex bidens</i>	Mud Dock		
POLYGONACEAE	<i>Rumex</i> sp.	Dock		
RANUNCULACEAE	<i>Ranunculus pumilio</i> var. <i>pumilio</i>	Ferny Small-flower Buttercup		
INTRODUCED SPECIES				
ASTERACEAE	* <i>Cirsium vulgare</i>	Spear Thistle		
ASTERACEAE	* <i>Gnaphalium polycaulon</i>	Indian Cudweed		
BRASSICACEAE	* <i>Rorippa palustris</i>	Marsh Yellow-cress		
JUNCACEAE	* <i>Juncus acutus</i>	Spiny Rush		
POLYGONACEAE	* <i>Acetosella vulgaris</i>	Sheep Sorrel		
RANUNCULACEAE	* <i>Ranunculus sceleratus</i> subsp. <i>sceleratus</i>	Celery Buttercup		

Most of the established plants were recorded along the banks of the western section of the Little Murray River, downstream of Waypoint 1 to the Little Murray Weir (Figure 3). Parts of this river section consist of gradually sloping banks with up to 2 – 3 m of bank exposed below the high water level, mostly covered in moss and algae (Figure 12), or highly disturbed through trampling by cattle. These areas were usually adjacent to Riverine Grassy Woodland (EVC 295). Plant establishment was very sparse, and often highly disturbed by trampling or grazed by stock (Figure 13, Figure 14). No plant establishment was observed beneath stands of willows.





**Figure 12. Exposed river bank along western section of Little Murray River**



**Figure 13. *Myriophyllum papillosum* highly disturbed by cattle trampling**



**Figure 14. *Eleocharis sphacelata* trampled and grazed by stock**

The section of river upstream of Waypoint 1, through to the Fish Point Weir is mostly bounded by Riverine Grassy Woodland (EVC 295) or Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812), with very steep, undercut banks. Many of the eucalypt trees growing close to the water's edge have been undermined or have fallen into the river (Figure 15). Plant establishment below the high water level along this section of the river was minimal.

Although the weir pool level during the second flora survey was approximately 1 m higher than the proposed operating level, it is unlikely that submerged aquatic plant species were present below this level and were undetected. The growth of aquatic plants is limited by water depth and turbidity, hence plants are unlikely to have established at a depth of more than 1.3 m below full operating level.





**Figure 15. Eroded riverbank with undercut and fallen eucalypt trees**

### 7.1 EPBC Matters of NES

No plant species or threatened ecological communities of NES are potentially affected by the project.

### 7.2 FFG Act

The *Flora and Fauna Guarantee Act* provides a legal framework to recognise matters of ecological importance and ensure they are addressed in planning decisions. The Act does not provide thresholds for significant impacts. The *FFG Act* matters identified below should be considered in the design of the project with the intention of promoting the relevant objectives of the Act:

- to conserve Victoria's communities of flora and fauna;
- to manage potentially threatening processes;
- to ensure that any use of flora or fauna by humans is sustainable; and
- to ensure that genetic diversity of flora and fauna is maintained.

#### *Plant Species*

- One terrestrial plant species listed under the *FFG Act* was found during the survey, *Atriplex acutibractea* subsp. *acutibractea* (Pointed Saltbush). This species is not located in an area prone to waterlogging or flooding and is not dependent on waterlogging or flooding. It will not be affected by the project.
- No other plant species listed under the *FFG Act* were present.

#### *Plant Communities*

No plant communities listed under the *FFG Act* were present at the site.

#### *Threatening Processes*

The project is potentially relevant to five threatening processes listed under the *FFG Act*.

**Degradation of native riparian vegetation along Victorian Rivers.** Riparian vegetation on the Little Murray is likely to be adapted to the current water regime. Riparian vegetation may suffer from reduced water availability as water levels are lowered with impacts including loss of vigour in Red Gum and Black Box trees, reduced tree recruitment and reduced extent of riparian understorey vegetation. Lowered water levels may promote the movement of regional saline groundwater towards the Little Murray River, further contributing to vegetation decline.



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Much of the riverbank along the Little Murray River is highly degraded due to trampling by livestock, particularly cattle. This activity damages established plants, restricts the colonisation of new plants, and can promote the spread of environmental weeds that readily invade disturbed sites. Lowering the water level may provide even greater stock access to the water's edge and limit the potential for revegetation of the newly exposed banks.

The banks along the eastern section of the Little Murray are highly eroded and undercut. As a result, many large eucalypt trees along this stretch of the river are extremely unstable or have fallen into the river. Furthermore, continual erosion and the steepness of the bank has prevented the establishment of aquatic and semi-aquatic vegetation. Streambank erosion can be caused through a number of mechanisms, including flood events, soil characteristics, removal or disturbance of protective riparian vegetation, or wave action when water levels are kept stable. Lowering the weir pool to a new stable level may lead to further bank erosion and undercutting, causing further loss of large eucalyptus trees along the water's edge, and limiting revegetation of the riparian zone.

**Habitat fragmentation as a threatening process for fauna in Victoria.** The Little Murray represents a substantial linear fragment of vegetation in an area that has been developed for irrigated agriculture and has been extensively cleared. The riparian woodland and shrubland vegetation on the Little Murray potentially provides habitat for a range of protected fauna including carpet python and breeding waterbirds. Substantial degradation of the riparian vegetation of the Little Murray could represent further fragmentation of habitat in the area.

**Invasion of native vegetation by *Rubus fruticosus* agg.** Blackberry is present in the riparian vegetation of the Little Murray. It is possible that Blackberry will colonise areas of the river bank that are exposed by falling water levels before native plants become established.

**Invasion of native vegetation by 'environmental weeds.'** A number of environmental weeds are present in the riparian vegetation of the Little Murray River including *Juncus acutus*, *Pennisetum clandestinum*, *Phalaris aquatica* and *Xanthium strumarium*. These species readily colonise disturbed areas where they become established and exclude colonisation by native plants. The lowering of water levels may provide a suitable site for the spread of these weeds.

**Wetland loss and degradation as a result of changes in water regime, dredging, draining, filling and grazing.** A lowered water level in the Little Murray River will reduce the overall extent of surface water and the extent of wetland habitat. The extent of wetland vegetation will decline and the habitat available for wetland-dependent fauna, such as fish and waterbirds, will be reduced.

### 7.3 EVC Bioregional Conservation Significance

Victoria’s Native Vegetation Framework: a Framework for Action accounts for bioregional conservation significance of EVCs in proposals to clear native vegetation. The nature and extent of impacts on riparian vegetation at the Little Murray River (if any) is not yet known. If vegetation is impacted, the bioregional conservation significance of EVCs will need to be considered (Table 3).

**Table 3. Conservation significance of EVCs present at the Little Murray**

<b>EVC</b>	<b>Bioregional Conservation Significance</b>
Riverine Grassy Woodland (EVC 295)	vulnerable
Grassy Riverine Forest/Riverine Swamp Forest Complex (EVC 812)	vulnerable
Billabong Wetland Aggregate (EVC 334)	depleted
Tall Marsh (EVC 821)	least concern
Lignum Swampy Woodland (EVC 823)	vulnerable

### 8.1 Conclusions

Five EVCs were identified during the survey and these were generally in moderate condition.

The river system is generally depauperate of aquatic and semi-aquatic plants.

Unrestricted stock access and bank erosion are currently the greatest threats to the condition of native vegetation.

No plant communities of conservation significance (*EPBC Act* and *FFG Act*) were found at the study site during the survey.

No aquatic or semi-aquatic plant species of conservation significance (*EPBC Act* and *FFG Act*) were found during either of the flora surveys.

One terrestrial species of conservation significance (*FFG Act*) was found during the survey and this species is the chenopod shrub *Atriplex acutibractea* subsp. *acutibractea* (Pointed Saltbush).

Lowering the water level will not affect any plants or plant communities of conservation significance under the *EPBC Act* or *FFG Act*.

Every attempt was made to thoroughly assess the vegetation. However, it is possible that inconspicuous plants or plants that emerge at different times of year may not have been observed at the time of the survey.

The proposed new weir pool level will increase the width of each bank. In the eastern section of the Little Murray where the bank gradient is lower the width will generally be increased by 5 to 10 m and in some places as much as 20 m. Plants are present within the system that can revegetate these exposed areas. Flat or gently sloping banks are likely to become colonised by emergent reeds and rushes, such as *Phragmites australis*, *Eleocharis sphacelata* and *Thypha domingensis*, with submerged aquatic plants such as *Myriophyllum papillosum* establishing in deeper water. Exposed mudflats that remain damp over spring and early summer may promote the colonisation of species such as *Ludwigia peploides*, *Rumex bidens* and *Cotula* sp.

### 8.2 Recommendations

Steps should be taken to provide protection of the population of *Atriplex acutibractea* subsp. *acutibractea*, the *FFG* species found during the survey. These could involve interaction with the landholder/s in the area and possibly the collection of seed for propagation of the species in other suitable sites along the river.

Undercutting is a significant issue on the banks of the Little Murray and is mainly a consequence of holding the waterbody at a stable level for prolonged periods. The erosion at the waters edge is concentrated in a very narrow band and has created steep and overhanging banks and destabilised trees.

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While overhanging banks and snags provide important habitat for fish, excessive erosion, together with unrestricted stock access has impacted on the quality of riparian vegetation. Vertical banks provide very little area for aquatic vegetation to establish, as there is little intermediate habitat between the terrestrial zone at the top of the bank and the deep aquatic zone at the base of the bank. A gently sloping bank provides a range of aquatic habitats between these two extremes and will support reeds, sedges and mudflat herbfield species. This plant community relies on seasonal inundation, and a water regime that provides a peak in winter or spring and gradual exposure over summer is most likely to support diverse and extensive riparian vegetation. Riparian vegetation will, in turn, support aquatic fauna, by providing foraging and sheltering habitat for native fish, birds, turtles, snakes and other fauna.

It is therefore recommended that the new water level for the Little Murray is not held constant, but involves a seasonal water fluctuation that reduces bank erosion and promotes diversity in riparian vegetation.

Stock impact significantly on the quality and extent of riparian vegetation. Unrestricted stock access will limit the potential for vegetation to establish on the banks exposed by a lower water level and will promote bank erosion. It is recommended that stock access to the channel is restricted.

Measures available to further assess or manage the impacts of lowered water levels in the Little Murray include:

- developing a weed management program prior to lowering the weir pool to identify weeds with the potential to benefit from lowered water levels and to apply appropriate weed management and monitoring protocols;
- developing a program of revegetation to compensate for the potential decline in vegetation health and wetland extent while also helping to manage the spread of environmental weeds;
- determining the relationship between regional groundwater levels and Little Murray River water levels to evaluate the potential for salinisation of the system and, if required, to determine an optimal water level to manage saline groundwater inflows.

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# Appendix A

## Plant Species Lists

**Table A - 1. List of Native and Introduced Plant Species indicating their conservation status and their occurrence within each EVC**

1 = EVC 295: Riverine Grassy Woodland

2 = EVC 334: Billabong Wetland Aggregate

3 = EVC 812: Grassy Riverine Forest/Riverine Swamp Forest Complex

4 = EVC 821: Tall Marsh

5 = EVC 823: Lignum Swampy Woodland

# Additional plant species recorded during the second survey (July 2011)

Plant species recorded in additional EVCs during the second survey are indicated in **bold**.

Family	Species	Common name	EPBC	FFG	1	2	3	4	5
<b>NATIVE SPECIES</b>									
AMARANTHACEAE	<i>Alternanthera denticulata</i>	Lesser Joyweed			x		x		
ASTERACEAE	<i>Brachyscome ciliaris</i> var. <i>ciliaris</i>	Variable Daisy			x				x
ASTERACEAE	<i>Centipeda cunninghamii</i>	Common Sneezeweed			x		x		x
ASTERACEAE	# <i>Cotula australis</i>	Common Cotula			x		x		x
ASTERACEAE	# <i>Cotula coronopifolia</i>	Water Buttons					x	x	x
ASTERACEAE	<i>Eclipta platyglossa</i>	Yellow Twin-heads			x	x	x	x	
ASTERACEAE	<i>Euchiton sphaericus</i>	Annual Cudweed			x		x		x
ASTERACEAE	<i>Minuria cunninghamii</i>	Bush Minuria			x				
ASTERACEAE	<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed					x		x
ASTERACEAE	<i>Senecio cunninghamii</i>	Shrubby Groundsel			x		x		x
ASTERACEAE	# <i>Senecio glomeratus</i>	Annual Fireweed			x				x
ASTERACEAE	# <i>Senecio pinnatifolius</i>	Variable Groundsel			x				x
ASTERACEAE	<i>Senecio quadridentatus</i>	Cotton Fireweed			x		<b>x</b>		<b>x</b>
ASTERACEAE	# <i>Senecio runcinifolius</i>	Tall Fireweed					x		x
ASTERACEAE	<i>Vittadinia cervicularis</i>	Waisted New Holland Daisy			x		x		
ASTERACEAE	<i>Vittadinia cuneata</i> var. <i>cuneata</i>	Fuzzweed			x				

# Appendix A

## Plant Species Lists

Family	Species	Common name	EPBC	FFG	1	2	3	4	5
ASTERACEAE	<i>Vittadinia gracilis</i>	Woolly New Holland Daisy			x		x		x
AZOLLACEAE	<i>Azolla filiculoides</i>	Pacific Azolla			x	x	x	x	x
CAMPANULACEAE	<i>Pratia concolor</i>	Poison Pratia			x	x			
CAMPANULACEAE	<i>Wahlenbergia fluminalis</i>	River Bluebell			x	x	x		
CARYOPHYLLACEAE	# <i>Spergularia marina</i>	Salt Sand-spurrey			x				x
CHENOPODIACEAE	<i>Atriplex acutibractea</i> subsp. <i>acutibractea</i>	Pointed Saltbush		x					
CHENOPODIACEAE	<i>Atriplex leptocarpa</i>	Slender-fruit Saltbush					x		
CHENOPODIACEAE	<i>Atriplex lindleyi</i> subsp. <i>lindleyi</i>	Balduo			x				x
CHENOPODIACEAE	<i>Atriplex semibaccata</i>	Berry Saltbush			x		x		x
CHENOPODIACEAE	<i>Atriplex suberecta</i>	Lagoon Saltbush			x				x
CHENOPODIACEAE	<i>Einadia nutans</i>	Climbing Saltbush			x				x
CHENOPODIACEAE	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	Ruby Saltbush			x		x		x
CHENOPODIACEAE	<i>Maireana brevifolia</i>	Short-leaf Bluebush			x		x		
CHENOPODIACEAE	<i>Maireana decalvans</i>	Black Cotton-bush			x	x			
CHENOPODIACEAE	<i>Rhagodia spinescens</i>	Spiny Saltbush			x		x		
CHENOPODIACEAE	<i>Salsola tragus</i>	Prickly Saltwort			x		x		x
CHENOPODIACEAE	<i>Sclerolaena muricata</i> var. <i>villosa</i>	Five-spined Bindyi			x	x			x
CONVOLVULACEAE	<i>Calystegia sepium</i>	Greater Bindweed			x	x			
CRASSULACEAE	<i>Crassula helmsii</i>	Swamp Crassula			x	x		x	
CYPERACEAE	<i>Bolboschoenus medianus</i>	Marsh Club-rush			x		x		
CYPERACEAE	<i>Carex tereticaulis</i>	Rush Sedge			x		x	x	
CYPERACEAE	<i>Cyperus exaltatus</i>	Splendid Flat-sedge				x	x		x
CYPERACEAE	<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge			x				
CYPERACEAE	<i>Cyperus sanguinolentus</i>	Dark Flat-sedge						x	
CYPERACEAE	<i>Eleocharis acuta</i>	Common Spike-sedge			x	x	x	x	x
CYPERACEAE	<i>Eleocharis sphacelata</i>	Tall Spike-rush			x				
CYPERACEAE	<i>Fimbristylis aestivalis</i>	Summer Fringe-rush						x	

# Appendix A

## Plant Species Lists

Family	Species	Common name	EPBC	FFG	1	2	3	4	5
CYPERACEAE	<i>Schoenoplectus validus</i>	Club-rush						x	
EUPHORBIACEAE	<i>Chamaesyce drummondii</i>	Caustic Weed			x		x		x
FABACEAE	<i>Acacia mearnsii</i>	Black Wattle						x	
FABACEAE	<i>Acacia stenophylla</i>	River Cooba			x		x	x	x
HALORAGACEAE	<i>Myriophyllum crispatum</i>	Upright Milfoil				x			
HALORAGACEAE	<i>Myriophyllum papillosum</i>	Robust Milfoil			x		x	x	
JUNCACEAE	<i>Juncus amabilis</i>				x		x		
JUNCACEAE	<i>Juncus aridicola</i>	Tussock Rush			x				
JUNCACEAE	<i>Juncus flavidus</i>	Gold Rush			x	x		x	
JUNCACEAE	<i>Juncus ingens</i>	Giant Rush					x	x	
JUNCACEAE	<i>Juncus subsecundus</i>	Finger Rush			x	x			
JUNCACEAE	<i>Juncus usitatus</i>	Common Rush			x	x	x		
JUNCAGINACEAE	<i>Triglochin procera</i>	Water-ribbons			x	x	x	x	x
JUNCAGINACEAE	<i>Triglochin striata</i>	Streaked Arrowgrass			x				
LAMIACEAE	<i>Mentha australis</i>	River Mint					x		
LYTHRACEAE	<i>Lythrum hyssopifolia</i>	Lesser Loosestrife			x			x	x
MARSILEACEAE	<i>Marsilea drummondii</i>	Common Nardoo			x	x	x		x
MYOPORACEAE	<i>Myoporum insulare</i>	Common Boobialla			x				
MYRTACEAE	<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i>	River Red Gum			x		x	x	x
MYRTACEAE	<i>Eucalyptus largiflorens</i>	Black Box			x				x
ONAGRACEAE	<i>Epilobium hirtigerum</i>	Hairy Willow-herb			x			x	
ONAGRACEAE	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose			x	x	x	x	
OXALIDACEAE	<i>Oxalis perennans</i>	Native Sorrel			x				
POACEAE	<i>Austrodanthonia caespitosa</i>	Common Wallaby-grass					x		
POACEAE	<i>Austrodanthonia setacea</i>	Small-flower Wallaby-grass			x	x	x		
POACEAE	<i>Austrostipa nodosa</i>	Tall Spear-grass			x				
POACEAE	<i>Chloris truncata</i>	Windmill Grass			x		x		
POACEAE	<i>Cynodon dactylon</i> var. <i>pulchellus</i>	Water Couch			x	x	x		
POACEAE	<i>Enteropogon acicularis</i>	Umbrella Grass			x	x	x		
POACEAE	<i>Lachnagrostis filiformis</i>	Perennial Blown-grass			x		x		x



# Appendix A

## Plant Species Lists

Family	Species	Common name	EPBC	FFG	1	2	3	4	5
POACEAE	<i>Phragmites australis</i>	Common Reed			x		x	x	x
POACEAE	<i>Setaria jubiflora</i>	Warrego Summer-grass			x		x		x
POACEAE	<i>Setaria parviflora</i>	Yellow Foxtail						x	
POACEAE	<i>Sporobolus mitchellii</i>	Rat-tail Couch			x				x
POLYGONACEAE	<i>Muehlenbeckia florulenta</i>	Lignum			x		x		x
POLYGONACEAE	<i>Persicaria decipiens</i>	Slender Knotweed			x	x		x	
POLYGONACEAE	<i>Persicaria lapathifolia</i>	Pale Knotweed					x	x	x
POLYGONACEAE	<i>Persicaria prostrata</i>	Creeping Knotweed					x		
POLYGONACEAE	<i>Polygonum plebeium</i>	Small Knotweed			x				x
POLYGONACEAE	# <i>Rumex bidens</i>	Mud Dock						x	
POLYGONACEAE	<i>Rumex tenax</i>	Shiny Dock			x			x	
POTAMOGETONACEAE	<i>Potamogeton crispus</i>	Curly Pondweed				x			
#RANUNCULACEAE	# <i>Myosurus australis</i>	Mousetail			x		x	x	x
RANUNCULACEAE	# <i>Ranunculus pumilio</i> var. <i>pumilio</i>	Ferny Small-flower Buttercup			x				x
RUBIACEAE	<i>Asperula gemella</i>	Twin-leaf Bedstraw			x		x		x
SANTALACEAE	<i>Exocarpos aphyllus</i>	Leafless Cherry			x		x		x
TYPHACEAE	<i>Typha domingensis</i>	Bulrush			x		x	x	
ZYGOPHYLLACEAE	<i>Nitraria billardierei</i>	Nitre-bush			x	x			
<b>INTRODUCED SPECIES</b>									
ANACARDIACEAE	* <i>Schinus molle</i>	Pepper Tree			x				
ASTERACEAE	* <i>Aster subulatus</i>	Aster-weed			x			x	x
ASTERACEAE	* <i>Cirsium vulgare</i>	Spear Thistle			x		x	x	x
ASTERACEAE	* <i>Conyza bonariensis</i>	Flax-leaf Fleabane			x				x
ASTERACEAE	* <i>Cotula coronopifolia</i>	Water Buttons				x			
ASTERACEAE	* <i>Dittrichia graveolens</i>	Stinkwort			x				
ASTERACEAE	#* <i>Gnaphalium polycaulon</i>	Indian Cudweed			x		x	x	x
ASTERACEAE	* <i>Helminthotheca echioides</i>	Ox-tongue			x		x		
ASTERACEAE	* <i>Hypochaeris glabra</i>	Smooth Cat's Ear					x		
ASTERACEAE	* <i>Hypochaeris radicata</i>	Rough Cat's Ear			x		x		x
ASTERACEAE	* <i>Lactuca serriola</i>	Prickly Lettuce			x	x	x		
ASTERACEAE	* <i>Sonchus asper</i>	Rough Sow-thistle					x		

# Appendix A

## Plant Species Lists

Family	Species	Common name	EPBC	FFG	1	2	3	4	5
ASTERACEAE	* <i>Sonchus oleraceus</i>	Common Sow-thistle			x		x		
ASTERACEAE	* <i>Xanthium spinosum</i>	Bathurst Burr			x		x		
ASTERACEAE	* <i>Xanthium strumarium</i>	Noogoora Burr					x		
BORAGINACEAE	* <i>Heliotropium europaeum</i>	Common Heliotrope			x		x		
BORAGINACEAE	* <i>Heliotropium supinum</i>	Creeping Heliotrope			x				
BRASSICACEAE	#* <i>Capsella bursa-pastoris</i>	Shepherd's Purse							x
BRASSICACEAE	* <i>Lepidium africanum</i>	Common Peppercross			x	x			
BRASSICACEAE	* <i>Rorippa palustris</i>	Marsh Yellow-cress						x	
BRASSICACEAE	* <i>Sisymbrium erysimoides</i>	Smooth Mustard			x		x		
CARYOPHYLLACEAE	* <i>Spergularia diandra</i>	Lesser Sand-spurrey				x			
CHENOPODIACEAE	* <i>Atriplex prostrata</i>	Creeping Saltbush				x			
CHENOPODIACEAE	* <i>Chenopodium murale</i>	Nettle-leaf Goosefoot			x				
CUCURBITACEAE	* <i>Citrullus lanatus</i>	Bitter Melon			x	x	x		
CYPERACEAE	* <i>Cyperus eragrostis</i>	Umbrella Sedge			x	x	x		
FABACEAE	* <i>Medicago polymorpha</i>	Burr-medic			x				x
FABACEAE	* <i>Trifolium</i> sp.	Clover				x			x
FABACEAE	* <i>Trifolium arvense</i>	Hare's Foot Clover			x				
FABACEAE	* <i>Trifolium</i> sp.	Clover			x	x			
GERANIACEAE	* <i>Geranium</i> cf. <i>molle</i>	Soft Geranium				x			
JUNCACEAE	* <i>Juncus acutus</i>	Spiny Rush			x	x		x	
JUNCACEAE	* <i>Juncus articulatus</i>	Jointed Rush			x		x	x	
LAMIACEAE	* <i>Marrubium vulgare</i>	Horehound			x				x
MALVACEAE	* <i>Abutilon theophrasti</i>	Swamp Lantern-bush			x				
MALVACEAE	* <i>Malva parviflora</i>	Small-flowered Marshmallow			x		x		
MELIACEAE	* <i>Melia azedarach</i>	Syringa			x				
PLANTAGINACEAE	* <i>Plantago lanceolata</i>	Ribwort			x				
POACEAE	* <i>Avena</i> sp.	Oats					x		
POACEAE	* <i>Bromus catharticus</i>	Prairie Grass			x				
POACEAE	* <i>Bromus diandrus</i>	Great Brome			x		x	x	x

# Appendix A

## Plant Species Lists

Family	Species	Common name	EPBC	FFG	1	2	3	4	5
POACEAE	* <i>Bromus hordeaceus</i> subsp. <i>hordeaceus</i>	Soft Brome			x				
POACEAE	* <i>Bromus rubens</i>	Red Brome			x				
POACEAE	* <i>Cynodon dactylon</i> var. <i>dactylon</i>	Couch			x	x			x
POACEAE	* <i>Hordeum marinum</i>	Sea Barley-grass			x		x		x
POACEAE	* <i>Lolium rigidum</i>	Wimmera Ryegrass				x			
POACEAE	* <i>Lolium</i> sp.	Ryegrass			x		x		
POACEAE	* <i>Paspalum dilatatum</i>	Paspalum			x	x	x	x	x
POACEAE	* <i>Paspalum distichum</i>	Water Couch			x	x	x	x	
POACEAE	* <i>Pennisetum clandestinum</i>	Kikuyu			x	x			
POACEAE	* <i>Phalaris aquatica</i>	Phalaris				x			
POACEAE	* <i>Polypogon monspeliensis</i>	Annual Beard- grass				x			
POLYGONACEAE	* <i>Acetosella vulgaris</i>	Sheep Sorrel			x				
POLYGONACEAE	* <i>Rumex crispus</i>	Curled Dock			x		x		x
RANUNCULACEAE	* <i>Ranunculus sceleratus</i> subsp.	Celery Buttercup			x		x	x	x
ROSACEAE	* <i>Rosa canina</i>	Dog Rose			x		x		
ROSACEAE	* <i>Rubus fruticosus</i> agg.	Blackberry			x			x	
SALICACEAE	* <i>Populus</i> sp.	Poplar						x	
SALICACEAE	* <i>Salix babylonica</i>	Weeping Willow			x			x	
SOLANACEAE	* <i>Lycium ferocissimum</i>	Boxthorn			x		x		x
SOLANACEAE	* <i>Solanum nigrum</i>	Black Nightshade			x		x		x
URTICACEAE	* <i>Urtica urens</i>	Stinging Nettle			x				x
VERBENACEAE	* <i>Phyla canescens</i>	Lippia			x		x		x
VITACEAE	* <i>Vitis vinifera</i>	Common Grape Vine					x	x	
ZYGOPHYLLACEAE	* <i>Tribulus terrestris</i>	Caltrop			x				

# Appendix B

## Site Waypoints

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### *List of Site Waypoints*

Waypoint	Easting	Northing
1	742991	6078516
2	742967	6078607
3	742905	6078576
4	742938	6078593
5	742620	6078679
6	742101	6078323
7	741919	6078480
8	741835	6078282
9	741964	6077904
10	743587	6078850
11	743895	6078328
12	743838	6078318
13	743833	6078273
14	743805	6078208
15	744390	6078299
16	745005	6078201
17	744866	6078227
18	746415	6078022
19	747151	6077280
20	747093	6077534
21	747800	6075474
22	749901	6075255
23	750752	6074033
24	751791	6073385
25	751511	6073452
26	750194	6074610
27	749452	6075062
28	748529	6074724
29	748528	6074724
30	748459	6075013
31	747901	6075419
32	747606	6075377
33	747067	6077103
34	751770	6073102
35	752511	6071837
36	752625	6071931
37	752027	6072758
38	751642	6073190
39	751146	6073738
40	750954	6073925
41	750548	6074461
42	750419	6074463
43	749590	6075227
44	749611	6075231
45	749101	6075213
46	748787	6074596
47	748724	6074612
48	747500	6075409
49	747438	6076229
50	747313	6077461

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# Appendix B

## Site Waypoints

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Waypoint	Easting	Northing
51	746518	6077630
52	746837	6078428
53	745447	6078553
54	745384	6078612
55	745332	6078622
56	745405	6078475
57	744222	6078577
58	744235	6078550
59	742642	6078499
60	742007	6078254
61	741401	6077614
62	740320	6077541
63	740319	6077525
64	740042	6077680
65	740018	6077643
66	739857	6077812
67	739771	6077790
68	739507	6077695
69	739082	6077361
70	739060	6077462
71	739038	6077594
72	738887	6078020
060	195898	6075504
061	195434	6075578
062	195379	6075612
063	193018	6076152
064	193144	6076042
065	193323	6076134
066	193467	6076398
067	193528	6076203

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