



Fourth Creek Survey and Management Plan

Report to the Campbelltown City Council

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1. SUMMARY

This report presents the results of an assessment of the biodiversity and habitat values of Fourth Creek within the Campbelltown City Council boundaries and presents management recommendations for improving the terrestrial and watercourse habitat and condition. The creek was initially surveyed in May 2016 and re-surveyed in November 2016 following flooding in late winter and spring 2016.

For the purposes of this report, Fourth Creek is divided into two distinct zones, the Upper section (Stradbroke Road to Montacute Road) and the Lower Section (Montacute Road to the Golf Course). The two sections are divided into nine subsections, described in detail and prioritised for biodiversity and habitat restoration and management. Management priorities are given at the section scale and prioritised in Table 1.

The Upper Section is characterised by a near continuous canopy of large River Red Gums, including many with hollows which are potential nesting sites for birds, possums and lizards. Almost the entire riparian zone has been revegetated with a mix of native shrubs and small trees, most of which are locally native. The range of planted species is diverse but lacks groundlayer species, particularly native grasses and groundcovers. The establishment of a native groundlayer is desirable for improving biodiversity and habitat but can make maintenance more difficult and should therefore only be undertaken if additional maintenance can be resourced. Woody weeds and exotic trees are regularly controlled and this task will be on-going as the adjacent urban matrix provides a constant source of weeds. Non-woody weeds, particularly Periwinkle, also threaten the biodiversity and habitat values of the Upper Section and require control. Additionally, there have been plantings of non-local native Australian species with high weed potential that require control. Minimal erosion was observed in the Upper Section in the initial May survey but there was extensive erosion following the 2016 flooding, with the channel bed deepening by at least half a metre in most sections and subsequent erosion of the banks.

The Lower Section has a much sparser cover of River Red Gums than the Upper Section, with few large trees with hollows. Residents in this area have opposed past revegetation efforts and there are only a few small areas where revegetation has been successful. Most of the Lower Section is maintained as an open park of mown exotic grasses and broadleaf weeds. As a consequence of the current management there are fewer high threat weeds than in the Upper Section. In the May survey it was observed that much of the watercourse in the Lower Section had been impacted by erosion (both deepening and widening), and many erosion control works have been undertaken. In the November survey it was observed that the degree of erosion in the Lower Section was not much different to prior to the floods, with some areas improved as a result of rocks being naturally deposited.

It is recommended that an erosion management plan be undertaken for the entire length of the creek in Campbelltown City Council, incorporating a survey of bed levels, channel dimensions and a risk assessment.

Fourth Creek Management Plan

Table 1 Management priorities for Fourth Creek

Section	Sub-section	Priority of Sub-section	Management action Priority			
			Very High	High	Medium	Low
Upper	1	High	Asset protection erosion management works	Removal of high threat woody weeds (including non-local native species)	Control of moderate threat weeds	Control of Desert Ash and Caster Oil Plant seed sources Engage with adjacent landholders regarding 'garden creep'
	2	Medium		Removal of high threat non-woody weeds	Spot weed around existing revegetation	
	3	High			Revegetation of groundlayer species in areas of good weed control	
	4	Low			Revegetation to support erosion management	
	5	High	Monitor for and remove watercourse weeds	Prepare and implement erosion management plan Short-term erosion management actions		
Lower	6	Low	Monitor for and remove watercourse weeds	Removal of high threat woody weeds (including non-local native species)	Control moderate threat weeds	Control regeneration from potential weed plantings
	7	Low		Removal of high threat non-woody weeds	Revegetation on upper banks coordinated with local community engagement	Spot weed around existing revegetation
	8	Low				Engage with adjacent landholders regarding 'garden creep'
	9	Low		Prepare and implement erosion management plan		

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3. INTRODUCTION

3.1 PROJECT OBJECTIVES

This project was undertaken to:

- Assess the biodiversity and habitat values of Fourth Creek
- Identify major weed issues and options for management, and
- Identify opportunities for strategic revegetation for both erosion control and habitat enhancement.

Ultimately, the aim of this work is to assist the Campbelltown City Council to take a coordinated approach to the management of Fourth Creek to ensure all aspects of management contribute to good environmental outcomes and community expectations.

3.2 FOURTH CREEK

Fourth Creek catchment originates in the western Mount Lofty Ranges and traverses Adelaide Plains for a distance of some four kilometres before joining the Torrens River. From Morialta Conservation Park to the Lochiel Park Golf Club, the Creek flows through a riparian corridor purchased by the City of Campbelltown for flood control and creek management. The Council has been working on improvements to Fourth creek since the 1980's with erosion control and channel stabilisation works, protection of large gums, development of recreational facilities as well as revegetation works with other organisations. The council is committed to continuing improvement of the creek corridor for stormwater management, water quality, visual amenity and accessibility for the community while protecting and enhancing the remnant native vegetation to provide habitat and resources for the local wildlife.

Fourth Creek has been identified as a corridor for wildlife movement between Morialta Conservation Park and the River Torrens. The corridor contains significant areas of native vegetation, including many large River Red Gums (*Eucalyptus camaldulensis* var. *camaldulensis*) and areas of understorey revegetation.

The Fourth Creek catchment upstream of Stradbroke Road is almost the entirely contained within Morialta Conservation Park and vegetated with native vegetation. Within the Campbelltown City Council area the native vegetation has been largely cleared except for remnant River Red Gums lining the riparian corridor. A survey of the riparian reserve in Rostrevor was undertaken in June 1999 and August 2000 and found ten native species, with one noted as being extinct in 2000 (Brewer 2000; see Appendix 1).

Pre-European vegetation of Fourth Creek would have been River Red Gum woodland, with SA Blue Gum woodlands on the adjacent plains. The pre-European vegetation is described in more detail in Brewer (2009) and Kraehenbuel (1996).

The channel bed is lined with sand, gravel and cobblestones, and the adjacent banks are unconsolidated sediments with gravel and cobblestone. It is highly likely that, prior to vegetation clearance and urbanisation, the alignment of the watercourse would have been highly mobile, shifting during high flow events in response to sediment deposition, vegetation growth.

3.3 EXISTING PLANS AND STRATEGIES

The Council's Strategic Plan (Campbelltown City Council 2010) is framed around five key themes: quality living, leadership, city planning, environmental responsibility and local economy. Goal 4 is *"An enhanced local environment delivered in partnership with the community"* and relevant to this project is Objective 4.1: *"Valuable recreation and open spaces enhanced through effective planning and management."* Strategies to achieve this objective include

- Conserving and enhancing local biodiversity through formal and informal landscaping and
- Improve and develop local seed banks to maintain biodiversity.

The Council also has obligations to manage stormwater to meet current standards and environmental requirements.

The Council has recently completed a Chain of Trails Master Plan (Swanbury Penglase 2014) for all creeks in the Campbelltown region, including Fourth Creek. The Master Plan includes a preliminary assessment of biodiversity values and erosion issues and recommendations to conserve and enhance biodiversity and mitigate erosion. The Master Plan sets a framework for developing and improving the trail network through the creek reserves and incorporates sustainable trail development principles (Government of South Australia). The Master Plan also promotes the use of local native species for plantings.

The Adelaide and Mt Lofty Ranges Natural Resources Management Plan (AMLR NRMB 2013) identifies the following targets to be achieved by 2028:

- Target 2: Aquatic ecosystems and groundwater condition is maintained or improved by 2028
- Target 7: Condition and function of ecosystems (terrestrial, riparian) recovered from current levels
- Target 13: Increase participation in natural resources management activities by 20%

4. WATERCOURSE MANAGEMENT PLAN

4.1 OVERVIEW

Fourth Creek is divided into two distinct sections: the Upper Section (Stradbroke Road to Montacute Road, Map 1) and the Lower Section (Montacute Road to the River Torrens, Map 2). The features and management requirements differ broadly between these two sections, but there are also more subtle differences within the upstream and downstream sections. Therefore the management plan identifies and describes nine subsections and specific actions to achieve the objectives of these.

4.2 MANAGEMENT OBJECTIVES

The objectives for managing Fourth Creek are:

- *To prevent any further decline in condition of the watercourse and riparian habitats*
- *To restore the condition of the watercourse and riparian habitats*
- *Maintain and enhance the amenity and recreational values of the creek corridor*
- *Coordinated management across Council to achieve multiple objectives.*

4.3 STRATEGIC FRAMEWORK

In order to assist the Council to most effectively allocate funds to manage and restore creek-lines within the study area, each management subsection has been assigned an overall priority and the management requirements within each subsection are prioritised.

The overall priority of the subsections for management is derived from a basic assessment of the ecological value of the sections based on:

- Naturalness (remnant native overstorey, revegetation, habitats, weed threat, modifications to channel form, erosion)
- Diversity and richness (number of native plant species, range of habitats).

More natural and more diverse sites are considered a higher priority on the basis that less resources are required to these areas and they have more to lose than highly modified and low diversity sites.

Management actions within each section were prioritised based on the following ecological criteria:

Very high - short term action required in to mitigate threats from flooding and capitalise on benefits of flooding

High – action required to prevent the condition of the site deteriorating

Medium – action required to improve the condition of the site (relatively low level of resources required compared with the benefits)

Low – action required to improve the condition of the site (relatively high level of resources required compared with the benefit, or low cost and low level of benefit).

Some actions may be re-prioritised as circumstances change, such as where external funding becomes available for certain types of work or other related measures are being implemented (e.g. as part of the implementation of the Trails Master Plan or erosion control measures).

4.4 SURVEY METHOD

An initial survey of Fourth creek was undertaken on the 30th and 31st of May 2016. Sections and subsection of creek line were delineated in the field based on common features occurring throughout a section. For each section the following were recorded:

- Native and introduced vegetation species in the riparian zone and the watercourse
- Condition of riparian and watercourse vegetation (based on abundance and diversity of native species and exotic species)
- Riparian habitat features (hollows, fallen timber, leaf litter, groundcover, shrubs, overstorey and other)
- Watercourse habitat features (deeper pools, logs, rocks, other)
- High threat weeds
- Erosion and Channel modification
- Safety issues
- Other management issues

High threat weeds were mapped in the field using handheld GPS (Garmin GPSMap 62pc).

The following features were subjectively assessed to derive overall priority:

- Remnant Native Vegetation: the proportion of native vegetation covering the site, and the range of native species.
- Weed Risk: the proportion of weed cover, and the risk of those weeds spreading through the site and the wider area (Croft et. al. 2005).
- Revegetation: areas already revegetated were considered to have a higher value for biodiversity and creek health.
- Habitats: areas with a greater range and number of habitats were given a higher value, habitats included large remnant trees with hollows, shrubs, reed beds, permanent pools, large woody debris in pools, open water and submerged aquatic vegetation.
- Channel form: unmodified channel form was given a higher priority than modified channels (eg widened).
- Erosion: presence or absence.

A second survey was undertaken on the 10th and 14th of November to identify changes in the above features in response to flood events that occurred after the first survey.

Plants are referred to by their common name throughout the report, with a list of scientific names in Appendix 1. A full list of all plant species observed is given in Appendix 1.

The report was prepared in consultation with staff from Campbelltown City Council.

4.5 UPPER SECTION: STRADBROKE ROAD TO MONTACUTE ROAD

4.5.1 Description

The Upper Section of the Fourth Creek begins at Stradbroke Road, on the south-eastern boundary of the City of Campbelltown and extends downstream to Montacute Road.

The section is characterised by having an almost continuous canopy of mature River Red Gums, including some very large old trees, many with hollows, with understorey revegetation along the most of the length. Where the creek reserve is wider, the revegetation extends onto the floodplain in parts, but the groundlayer is primarily mown introduced grasses and broadleaf weeds. The revegetation is estimated to range from three to fifteen years in age and consists of a relatively diverse mix of mainly of local native shrubs and small trees. The groundlayer is dominated by Kikuyu, however local native groundlayer species have been established in a few areas. There were no remnant native species of conservation significance, but several Rock Correas, rated as rare in South Australia, have been planted. See Table 5 for a full list of local native species observed (including common and scientific names).

Concrete walls, large rocks and gabions have been installed to mitigate bank erosion in various locations and subsection 4 has been entirely concrete lined. Only minor erosion issues were observed during the May surveys in the upper section, but significant erosion was observed in the second survey. The channel bed has deepened and widened along most of the length, leading to erosion of the banks and undermining of existing erosion control structures. Pools have scoured out below many in-stream structures; these pools will provide aquatic habitat where water persists for longer that may benefit aquatic fauna, but some may pose a risk to the structures and a potential safety risk. The channel scouring has exposed old concrete weirs which may have been installed to mitigate channel deepening. Along much of the watercourse the riparian reserve is very narrow with sections of roads and paths close to the channel are at risk from the erosion.

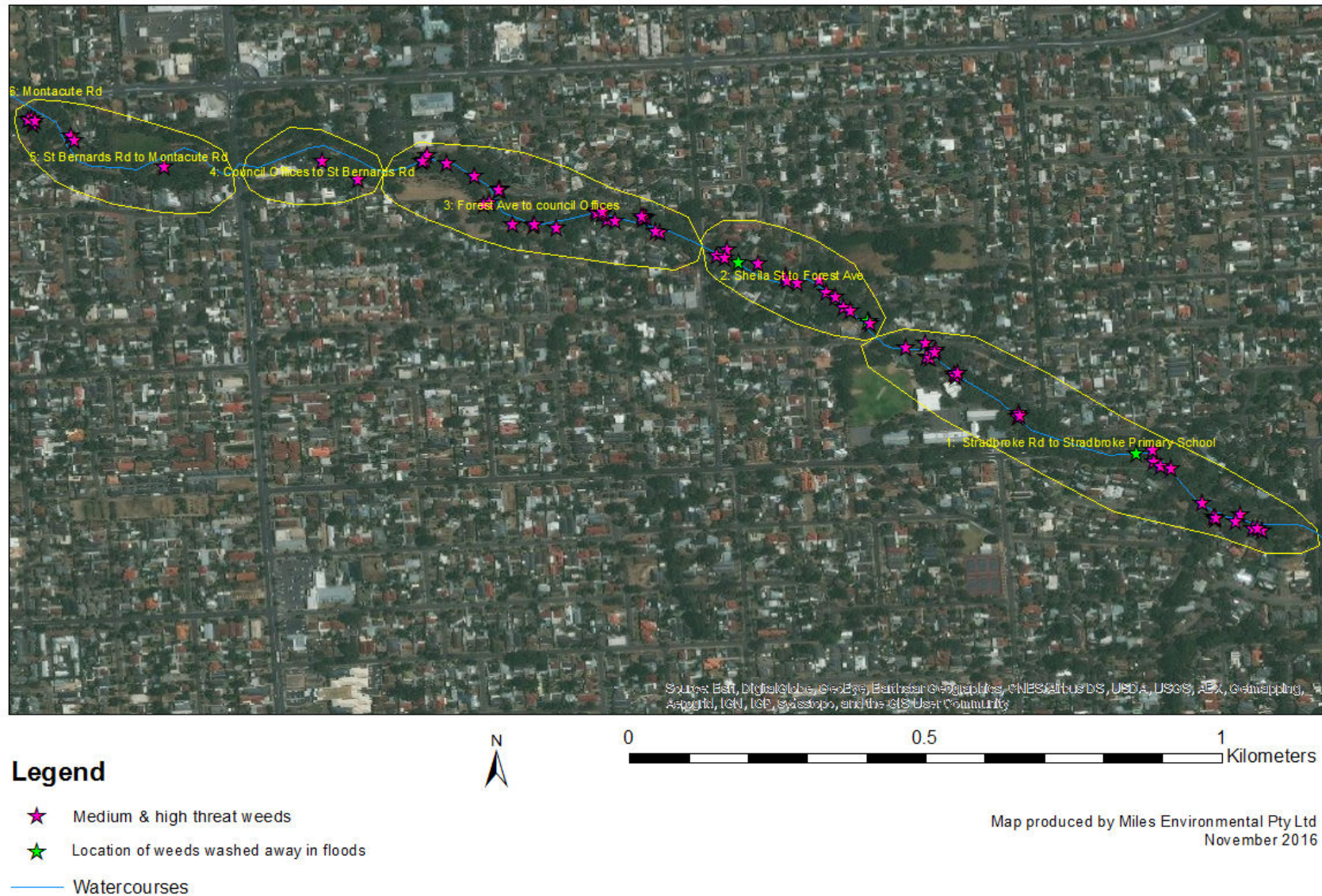
There are high threat woody weeds (trees and shrubs) throughout the section but in low abundance. Historically, the watercourse was dominated by Desert Ash trees, which have been removed, but Desert Ash seedlings are present throughout the length of the Creek. Periwinkle is a common groundlayer weed growing on the banks which, although it does not spread quickly, is difficult to control and forms dense mono-specific patches. See Table 6 for a full list of exotic species observed. Due to the scouring of the channel bed many of the weeds observed growing in the watercourse in May were not observed in November. It is recommended that remaining watercourse weeds are controlled as a priority whilst their numbers are low.

Flinders Ranges Wattle, Golden Wreath Wattle, Bracelet Honey-myrtle, Sweet Pittosporum and Swamp Oak are non-local native Australian species that have been commonly planted in the older revegetation areas and have potential to become weeds. Regeneration of Flinders Ranges Wattle, Golden Wreath Wattle and Swamp Oak were observed in the field survey.

There are several locations where adjacent property owners have established vegetation on the reserve area, as well as some instances of garden plants spreading into the reserve.

The Upper Section has been divided into five management sub-units (see Map 1).

Fourth Creek Management Plan



Map 1: Upper section showing extent of each of each subsection (yellow shapes), location of medium and high threat weeds

Note: due to the number of different weed species a separate shapefile has been supplied specifying the location of each weed species

5.5.2 Subsection 1. Stradbroke Road to Stradbroke Primary School

The vegetation is large remnant River Red Gums over a relatively diverse mix of revegetated shrub and small tree species but lacks native groundcover. Native groundlayer would be difficult to establish and maintain throughout due to the abundance of exotic groundlayer species (e.g. Periwinkle, Rice Millet, Nasturtiums and various grasses) but could be planted in small areas where intensive weed control can be maintained. Woody and non-woody weeds and non-local native species throughout need controlling. The riparian reserve is relatively wide although the watercourse is close to adjacent roads in some parts. Towards the upper end, large rocks on the floodplain close to the banks have prevented mowing, enabling some 'garden escapees' to establish.

Both Stradbroke Primary School and the Stradbroke Scouts use the Creek area. The Primary School have undertaken revegetation of mid-storey species (Figure 1) and the Scouts are interested to re-establish larger species that could be utilised in their activities (e.g. as supports for rope bridges).

Since 2016 floods there has been erosion damage to some sections, with one section of footpath washed away (Figure 2) and erosion very close to the adjacent roads. Older concrete bank protection structures have been undermined and broken up but gabions do not appear to be damaged. A dead tree has fallen near the upper end but is supported by another tree and a large tree has been undermined and slumped into the creek below the footbridge at the corner of Fairleys Road and Leabrook Drive. Both trees may need to be removed for safety reasons but the logs could be used in the adjacent reserves for habitat or play structures.

Floods have cleared the creek of most watercourse vegetation, including weeds such as an Arum Lily that was found in May but appears to have been washed away in the floods. Ash seedlings have been largely washed away but some persist on the banks and in gabions; removing small ash trees using cut-and swab method should be a priority.

Sub-section priority: High

Feature	Condition
Native vegetation condition	Moderate diversity: 18 native species. Large River Red Gums over revegetated shrubs and small trees.
Watercourse condition	Moderate: few weeds but only one native species
High threat weeds	Many larger woody species (incl. Palm, Olive, Caster Oil Plant, Peppercorn, Ash and Buckthorn) but in low abundance Non-local natives planted (Flinders Ranges Wattle, Golden Wreath Wattle and bracelet Honey Myrtle); Non-woody weeds: Wandering Jew, Rice Millet, Fennel, Climbing Asparagus and several patches of Periwinkle.
Habitat (terrestrial)	Hollows in most River Red Gums, overstorey, middlestorey, fallen timber
Habitat (watercourse)	Several deep pools have developed during the floods; rocks, riffles
Watercourse erosion	Bed deepening (less than 0.5 metre) through most of the section and channel widening, with banks up to 2m high, some old erosion control structures have been scoured around and/or undermined.
Channel modification	Erosion structures, channel concreting at banks

Feature	Condition
Other	Upper end has larger rocks on top of bank that prevent mowing close to the bank; Native Australian Hollyhock present in several areas as well as introduced Tree Mallow, needs flowers to identify. Scout Group would like to have large trees for use in activities.



Figure 1 Revegetation area adjacent to Stradbroke Primary School and Scout Hall at lower end of subsection 1, May 2016



Figure 2 Erosion of the banks leading to loss of the footpath. Note large rocks that have been placed here prior to the 2016 floods indicate the previous channel alignment.

4.5.3 Subsection 2. Sheila Street to Forest Avenue

River Red Gum canopy throughout. Sparse although moderately diverse middlestorey revegetation at the upper end but lower end lacks native understorey. The narrow riparian widths limit expansion of the revegetation area and groundlayer revegetation could be difficult to establish until the weed abundance is significantly reduced. Woody weeds (in higher abundance than adjacent sections), non-local natives and Periwinkle require control. Scouring of the channel has removed a Palm, an Arum Lily and many Ash seedlings and Dense Flat-sedges growing in the watercourse.

Channel bed deepening has occurred throughout, increasing in height from downstream to upstream end (Figure 3), and bank erosion in the order of one to two metres in height. Existing bank erosion control works have held but have been undermined and require works to ensure they are sound. The narrow riparian widths also make bank stabilisation works a priority here, however the channel deepening will need to be addressed for long term erosion minimisation.

Priority: Medium

Feature	Condition
Native vegetation condition	Poor to moderate diversity: 16 native species mainly in an area of older sparse revegetation at the upstream end; weedy. Large River Red Gums throughout.
Watercourse condition	Poor: 1 native species. Channel bed scoured out.
High threat weeds	Downstream end has a higher density of larger old Olives. Ash seedlings growing in the watercourse. Non-local natives Sweet Pittosporum and Flinders ranges Wattle planted on banks. Non-woody weeds include Rice Millet, several patches of Periwinkle and one patch of Galenia. Exotic sedges largely washed away in floods.
Habitat (terrestrial)	Hollows in most River Red Gum, overstorey, middlestorey
Habitat (watercourse)	Rocks, one pool below the upstream bridge.
Watercourse erosion	Channel bed deepening increases in depth towards the upstream end and erosion of banks in the order of 1-2 m. Existing erosion control structures require reinforcement.
Channel modification	Concreting around bridges and erosion control structures

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Figure 3 Upstream end of subsection 2 in May (top) and November (bottom).

The channel bed has dropped by almost approximately a metre with a deeper scour pool below the bridge concrete. Note the Ash saplings in observed in May photo that are no longer present following the floods. Note also the close proximity between the channel and the roads on either side.

4.5.4 Subsection 3. Forest Avenue to Council Offices

The vegetation consists of a continuous canopy of large River Red Gums over moderately diverse middlestorey revegetation. Control of woody weeds and Periwinkle is required and non-local natives in plantings should be removed. Native groundlayer would be difficult to establish due to the abundance of Kikuyu (Figure 4). Some instream weeds have been washed away in the floods including at least one Palm and many Ash seedlings and exotic sedges.

Erosion damage from the floods has been minor and the wider riparian reserve width reduces the risk to infrastructure from erosion (Figure 5). The most severe erosion is at the downstream end where the creek is narrowest and there has been some channel bed deepening and widening. Existing gabions have remained stable but some rock protection works require repair works.

Priority: High

Feature	Condition
Native vegetation condition	Moderate: 18 native species. Overstorey of large River Red Gums over older revegetation which includes some groundlayer species (although in low abundance)
Watercourse condition	Poor: 1 native species, low density of weeds. Most vegetation in channel bed removed in floods
High threat weeds	Woody weeds on banks (e.g. Olives, Broom) and Ash seedlings in watercourse (although many washed away). Non-local native species plantings of Wattles (Cootamundra, Flinders Ranges and Western Coastal, Golden Wreath), Sweet Pittosporum and Bracelet Honey-myrtle. Non-woody weeds abundant: Rice Millet, Kikuyu and several patches of Periwinkle
Habitat (terrestrial)	Hollows, overstorey, middlestorey, some groundcover, some litter
Habitat (watercourse)	Pebbles and cobbles
Watercourse erosion	Existing gabions have remained stable, minor erosion around rocks near Council offices, minor bank erosion and bed deepening at downstream end but wide riparian widths mean low risk
Channel modification	None other than erosion control works
Other	Frogs calling
Sub-section priority	High



Figure 4 Older local and non-local native revegetation in subsection 3, Ash seedlings and Kikuyu along watercourse edges, May 2016



Figure 5 Showing the channel bed scoured clear of sediment and vegetation in November 2016 but without bed deepening

4.5.5 Subsection 4. Council Offices to St Bernards Road

The channel has been concreted for the entire length (Figure 6) which limits the potential to restore any habitat. The upper end of the channel has eroded on both sides in the floods of 2016 and the concrete been undermined and pipework exposed (Figure 7). The erosion indicates the channel capacity is insufficient for the flows experienced in 2016 and, while infilling the eroded sections may provide a short term repair, it is likely that a similar level of erosion would occur again under high flows. Consideration should be given to removing the concrete lining and restoring a 'natural' channel bed which could incorporate rock cleared out from other sections of the creek. Engineering advice would be required if the concrete were to be removed.

Vegetation from adjacent gardens has spread into and been planted in the reserve (Figure 6).

Priority: Low

Feature	Condition
Native vegetation condition	Poor: 1 native species, mature River Red Gums, lack of understorey although very few weeds
Watercourse condition	Very poor: no native vegetation due to concrete lining
High threat weeds	Some Ash seedlings and regenerating Flinders Ranges Wattle as well as garden escapees
Habitat (terrestrial)	Few hollows (bees in some), overstorey, some litter
Habitat (watercourse)	Scour pool
Watercourse erosion	Erosion adjacent to channel on both sides
Channel modification	Channel concreted



Figure 6 Concreted channel with garden plantings by adjacent landholders, May 2016



Figure 7 Erosion either side of the concreted channel has undermined the concrete and exposed pipework, November 2016

4.5.6 Subsection 5. St Bernards Road to Montacute Road (Denis Morrissey Park)

This section has a canopy of large River Red Gums over a good cover of revegetated middlestorey species and has the highest native species diversity of all the subsections (Figure 8). The abundance and diversity of native groundcover species is low; given the low level of weed cover, revegetation with groundlayer species should be a focus for this area. Vegetation from adjacent gardens has spread into some parts of the reserve. The weed Dense Flat-sedge was previously abundant in this section but has been largely washed away, therefore control of any remaining plants should be a priority for short term action.

Feral pigeons are abundant at the downstream end and appear to be coming from an adjacent property.

There was major erosion from the 2016 floods which has resulted in damage to footpaths and loss of some revegetated trees and shrubs (Figure 9). Consideration should be given to following the new channel bank alignment when undertaking repair works and incorporating revegetation, with a focus on establishing small dense species to protect the toe of the bank. Scouring below the upstream footbridge has created an undercut pool of over 1 m depth which may be a safety concern.

The second footbridge has been by-passed due to becoming blocked; consideration should be given to increasing the channel capacity when undertaking repair works to the bridge. Alternatively the bridge could be removed and not replaced as there is access to the across the creek at the top and bottom of the reserve.

The northern bank towards the downstream end was eroded, and whilst the erosion is not as severe as in some other parts of the creek, the proximity to adjacent properties poses some risks. Council staff have identified that gabions are required, if this work is undertaken care should be taken to preserve as much of the native vegetation and other habitat elements (e.g. logs and pools) as possible and not reduce the channel capacity, while high threat weeds should be removed.

Priority: High

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Feature	Condition
Native vegetation condition	Moderate: mature River Red Gums with regeneration; diverse revegetation of middle storey (20 species), low weed threat and abundance
Watercourse condition	Moderate: few weeds but few (three) native species
High threat weeds	Non-local natives (Golden Wreath Wattle and Bracelet Honey Myrtle), Pine seedlings growing in revegetation, Ash seedlings and Dense Flat-sedge in watercourse, weedy species in adjacent gardens spreading and with potential to spread include Olives, Periwinkle, Watsonia and Buckthorn
Habitat (terrestrial)	Few hollows, overstorey, middlestorey, fallen timber, litter
Habitat (watercourse)	Deeper pools (most created by structures), rocks
Watercourse erosion	Minor erosion of banks, some rock reinforcing, scouring around trash racks and concrete
Channel modification	Upper end a concrete channel, erosion control works, trash racks



Figure 8 Old River Red Gums and diverse local native plantings in subsection 5, May 2016



Figure 9 Upstream end of subsection 5 in May 2016 (top) and November 2016 (bottom)

The channel bed has deepened, scouring below the concrete on the lower right foreground to create a pool over 1 m deep. The north (right) bank has eroded past the rock alignment, removing the revegetation on the northern bank seen in the top photo. Sand has been deposited on the floodplain on the south (left) side.

4.5.6 Management Priorities

See Section 5 for methods.

Priority	Management Action	Subsection				
		1	2	3	4	5
Very High	Asset protection erosion management works	✓	✓	✓	✓	✓
	Undertake engineering works to repair and reduce risk to assets and public safety, incorporating revegetation where feasible (see page 42).					
	Monitor for and remove watercourse weeds					
	Within twelve months undertake monitoring for and removal of re-growth of watercourse weeds using minimal disturbance methods to prevent off-target damage to the aquatic environment:					
	<ul style="list-style-type: none"> Exotic sedges* Palms* Desert Ash* Arum Lily* 		✓		✓	✓
High	Removal of high threat woody weeds (including non-local natives)					
	Control of exotic trees and woody weeds and follow-up every two to four years. Work from upstream to downstream. Use minimal disturbance techniques such as “cut and swab” for saplings and shrubs, “drill an fill” larger trees and small seedlings may be hand-pulled:					
	<ul style="list-style-type: none"> Olives Caster Oil Plant Peppercorn tree Buckthorn Broom Western Coastal Wattle Flinders Ranges Wattle Golden Wreath Wattle Swamp Oak 	✓	✓	✓		✓
		✓	✓	✓		
		✓				
		✓	✓			**
				✓		
				✓		
		✓	✓		✓	
		✓	✓	✓		✓
			✓	✓		
	Removal of high threat non-woody weeds					
	Control of non-woody weeds using minimal disturbance methods including spot spray and grubbing out					
	<ul style="list-style-type: none"> Periwinkle Fennel Galenia Rice Millet Climbing asparagus Wandering Jew Watsonia / African Cornflag 	✓	✓	✓		✓
		✓				
			✓			
		✓	✓	✓		
		✓			✓	
		✓				**
						**
Medium	Control of moderate threat weeds:					
	<ul style="list-style-type: none"> Tobacco bush African Daisy (purple) Cape Leeuwin Wattle Pine Cootamundra Wattle Bracelet Honey-myrtle 			✓		
		✓		✓		
		✓		✓		
						✓
				✓		
		✓		✓		✓

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Priority	Management Action	Subsection				
		1	2	3	4	5
	<ul style="list-style-type: none"> Sweet Pittosporum 		✓	✓		
	Spot weed around existing revegetation Spot spray or hand pull weeds around revegetation, particularly native groundcovers, to encourage natural regeneration	✓		✓		✓
	Erosion management Undertake a survey of bed levels and channel dimensions, asset risk assessment and develop and implement an erosion management plan, favouring 'soft' engineering options where assets are not at risk and/or there are sufficient riparian widths and focussing on addressing bed deepening	✓	✓	✓	✓	✓
	Revegetation Plant groundlayer species where sufficient weed control has been achieved.	✓	✓	✓		✓
Low	Engage with adjacent landholders to address 'garden creep'				✓	✓

*Indicates weeds growing in the watercourse that require great care to avoid off target damage

**Indicates weeds growing in adjacent gardens

4.6 LOWER SECTION: MONTACUTE ROAD TO GOLF COURSE

4.6.1 Description

The Lower Section of Fourth Creek begins at Montacute Road and extends downstream to the Lochiel Park Golf Course, just upstream of where Fourth Creek joins the Torrens River.

River Red Gums are scattered throughout this section, but at lower densities than the Upper Section and with fewer large trees with hollows. There are a few small areas of revegetation and occasional plantings of non-local native shrubs, but generally the Lower Section lacks native vegetation and has minimal terrestrial habitat features. The groundlayer is mostly mown exotic grasses and broadleaf weeds. In several locations adjacent landholders have planted on the reserve and there are also areas where garden plants are spreading into the reserve. No species of conservation significance were observed during the survey. See Table 5 for a full list of local native species observed.

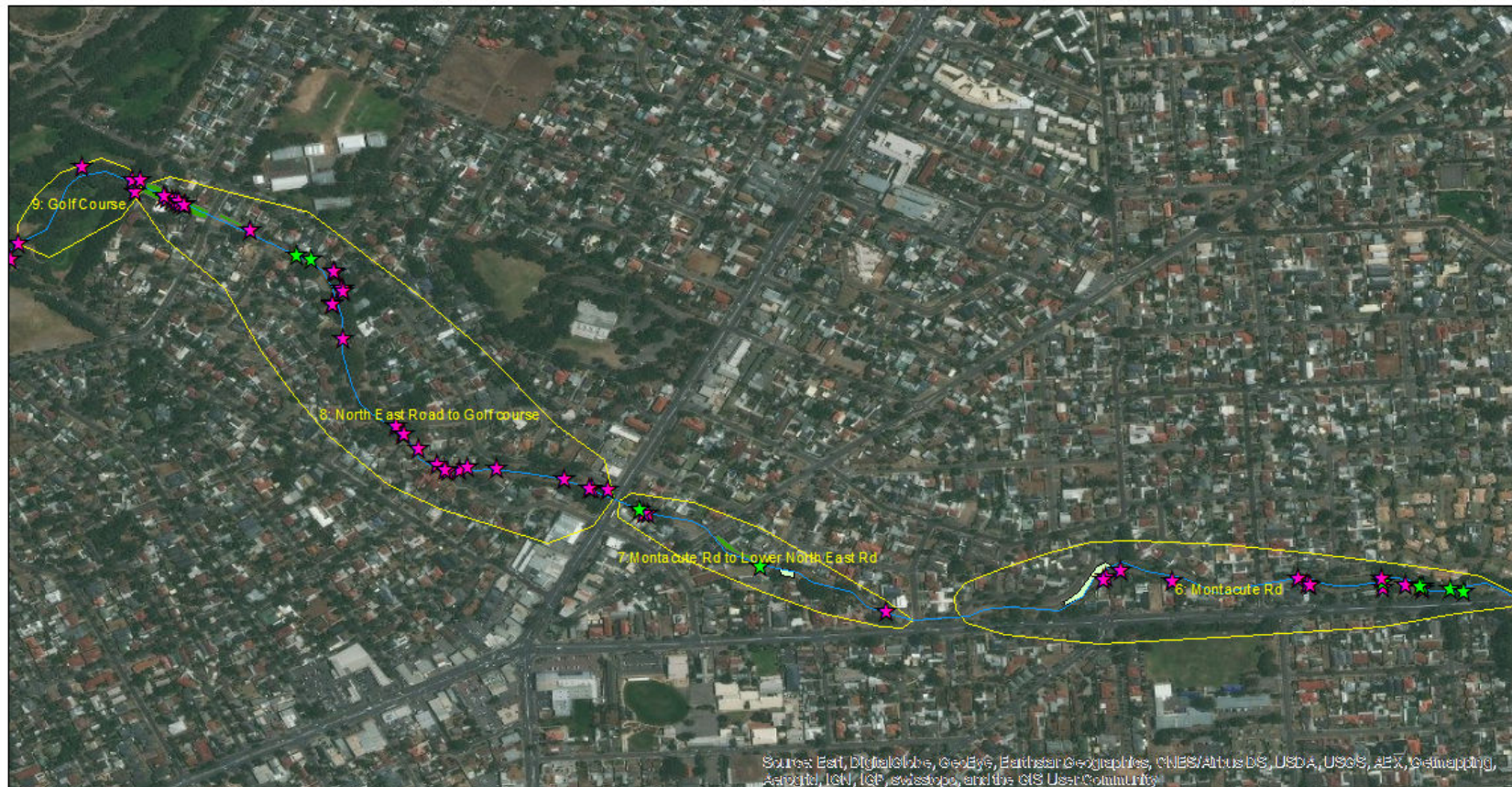
There have been issues in the lower section with adjacent landholders objecting to revegetation works, including actively removing revegetation, and lobbying for the removal of any natural regeneration, including reeds and rushes in the watercourse and River Red Gums on the bank.

Whilst the Lower Section is lacking in native vegetation, there is a low abundance of high threat weeds. The most abundant woody weeds are Desert Ash seedlings which occur throughout the watercourse. Palm seedlings were also common in the watercourse in May but appear to have been largely swept away or buried during the floods. The introduced exotic creeping grasses Couch, Water Couch and Kikuyu are prevalent throughout the Lower Section but were also reduced in the floods. These perennial grasses are difficult to control without causing off-target damage and leaving the channel and banks bare and at risk of erosion and colonisation by other weeds. The exotic Drain Flat-sedge is common along the watercourse and isolated occurrences of Umbrella Sedge were mapped in the first survey but not seen in November. See Table 6 for a full list of exotic species observed.





The banks have been battered throughout and there has been a considerable amount of works undertaken to control erosion before the May survey, including concreting the channel either side of all bridges, instream rock and concrete bed control structures, and rock, gabions and concreting of channel banks. Many areas of active erosion were observed in May, including undermining and scouring around older erosion control structures, bank erosion and bed deepening (up to two metres deep in the Lower subsection 8). However, rocks were deposited throughout much of the lower section during the floods and the level of erosion has generally remained similar or reduced.

The Lower Section has been divided into four management subsections (see Map 2).

Fourth Creek Management Plan



Legend

-  Medium & high threat weeds
-  Location of weeds washed away in floods
-  Watercourses
-  Existing revegetation
-  Proposed revegetation



Map produced by Miles Environmental Consulting
November 2016

Map 2: Lower section showing extent of each of each subsection (yellow shapes) and location of medium and high threat weeds

Note: due to the number of different weed species a separate shapefile has been supplied specifying the location of each weed species

4.6.2 Subsection 6. Montacute Road

This subsection is generally lacking in native vegetation with little habitat, however, an area of revegetation has been planted at the downstream end for National Tree Day 2016 (Figure 10). Fruit trees and garden shrubs have been planted on the reserve.

The watercourse was a zone for finer sediment deposition leading up to May 2016, with stands of Bulrush through which grew Blackberries. During the floods the sediment layer was scoured out at the upper end along with much of the Bulrush and Blackberry (Figure 11). Follow-up removal of the remaining small area of Blackberry is therefore a priority. It is likely that the Bulrush will spread back into the eroded channel and trap sediments in future small to medium flows. Previously installed rock and concrete weirs and gabions appear to have been effective at preventing bed deepening and bank erosion downstream, however there has been scouring around some of the structures and minor repair work is required to ensure their continued effectiveness. At the National Tree Day site (Figure 10), planting sedges, rushes and native grasses around the rock weir may assist to prevent this type of scouring in the future.

Priority: low

Feature	Condition
Native vegetation condition	Very poor: Sparse large River Red Gums, general absence of understorey, total of 13 native species mainly in one area of revegetation. Narrow riparian widths.
Watercourse condition	Poor: lack of native vegetation cover, although this section had the highest native watercourse species diversity (6 species)
High threat weeds	Woody weeds: Blackberries, Palms, Caster Oil Plant, Swamp Oak, Olive and Flinders Ranges Wattle. A Cactus is spreading from and adjacent garden and a mature Poplar is spreading. Non-woody weeds: Dense Flat-sedge in higher density than the Upper Section prior to floods; Umbrella Sedge and Fennel appear to have been washed away in the floods.
Habitat (terrestrial)	Sparse overstorey
Habitat (watercourse)	Deeper pool near pedestrian bridge, stands of bulrush
Watercourse erosion	Bed deepening at the upper end but deposition during the floods through most of this section has reduced the level of erosion (e.g. Figure 16).
Channel modification	Concrete around bridges, banks battered
Other	Several instances of planting in reserve adjacent to private properties



Figure 10 National Tree Day 2016 planting site to the left; the instream concrete weir has prevented bed deepening but minor scouring around the structure has occurred



Figure 11 Upstream end of subsection 6 following the 2016 floods; the top layer of sediment and rock has been removed upstream of a concrete weir, along with Bulrushes and Blackberries, but the weir has prevented bed deepening below this level.

4.6.3 Subsection 7. Montacute Road to north East Road

There is a lack of native vegetation cover on the banks and instream and little terrestrial or aquatic habitat, however there are few high threat weeds. Some weeds that were present in May have been washed away in the floods. One older revegetation area exists (Figure 12) and a new one was planned to be planted in 2016 but the planting was not undertaken.

Erosion (bed deepening) has occurred throughout as well as instances of bank erosion; however the severity of the erosion has largely been reduced as a result of rock deposited in the 2016 floods.

Priority: Low

Feature	Condition
Native vegetation condition	Very poor. Native species diversity of ten species recorded, with most of the diversity due to one small area of revegetation. Otherwise this section comprises sparse River Red Gums over mown exotic species. Low level of weed cover.
Watercourse condition	Poor: lack of native vegetation (1 species).
High threat weeds	Palms, Ash seedlings and Dense Flat-sedge in the watercourse, Caster Oil Plant, non-local natives Flinders Ranges Wattle and Swamp Oak.
Habitat (terrestrial)	Sparse overstorey, one patch of understorey
Habitat (watercourse)	Deeper pools (mainly due to erosion), rocks
Watercourse erosion	The degree of erosion has reduced following deposition of rocks during the 2016 floods. Existing rock and concrete structures require minor repair works. Edges of the watercourse are sprayed which is leaving soil vulnerable to erosion.
Channel modification	Banks battered, concreting of channel around bridges



Figure 12 Downstream end of subsection 7 in May 2016, revegetation area on right bank in background without spraying, rocks placed in creek to raise bed level in foreground and on left bank downstream to prevent channel widening

4.6.4 Subsection 8. North East Road to Golf Course

Sparse River Red Gums throughout in open 'park' setting, lacking understorey and watercourse vegetation; two patches of revegetation and plantings of non-local natives. Few high threat weeds except in the most downstream revegetation area. Gardens have been planted on the reserve in some areas and garden plants are spreading.

The length of eroded watercourse has reduced as a result of rock deposition during the 2016 floods (Figure 13). Desert Ash seedlings and Dense Flat-sedges have been reduced in abundance since the floods.

Priority: Low

Feature	Condition
Native vegetation condition	Very poor: 8 native species, with only two occurring naturally. Medium-sized River Red Gums throughout. Lack of understorey except two small patches of revegetation at the downstream end.
Watercourse condition	Poor: lack of native vegetation but wider riparian widths than immediate upstream sections
High threat weeds	Scattered high threat weeds throughout and abundant in downstream revegetation area. Planted Lombardy Poplar spreading. Woody weeds (Buckthorn, Olives, Caster Oil Plant, Peppercorn Tree) and non-local natives (Golden wreath Wattle and Flinders Ranges Wattle) on the banks. Palms, Ash seedlings and Dense Flat-sedge in the watercourse (although reduced in abundance since the floods). Non-woody weeds: Ivy, Periwinkle and Galenia.
Habitat (terrestrial)	Sparse overstorey, two patches of understorey revegetation
Habitat (watercourse)	Deeper pools (mainly due to erosion), rocks
Watercourse erosion	Bed deepening up to 2 m although the length affected has been reduced by rock deposited during the floods. Instream and bank protection works have been carried out using rocks, gabions and concrete; some require repair works. Battered banks have eroded in some areas and matting has been used to stabilise these areas. Level of erosion reduced from just upstream of the footbridge
Channel modification	Banks battered. Concreting of channel around bridges. Old erosion control works.



Figure 13 Example of instream rock structure in subsection 8 that was beginning to fail at the downstream end in May 2016 (top), however this was covered in rocks during the floods, reducing the erosion at this site (bottom).

4.6.5 Subsection 9. Golf Course

Short section of creek through the Lochiel Park Golf Course. The creek is wide and shallow and not eroding and received large deposits of rock and sand during the 2016 floods. There is little native vegetation but also few weeds.

Priority: Low

Feature	Condition
Native vegetation condition	Poor: only four native species; good cover of River Red Gums but no old large trees. The groundcover is mown exotic grasses and broadleaf weeds. Few high threat weeds.
Watercourse condition	Lack of native vegetation (two species) but few weeds.
High threat weeds	Plantings of non-local native Australian Swamp Oak throughout the Golf course as well as some Aleppo Pines have the potential to spread into the creek but the grounds maintenance may limit their spread. Ash seedlings in creek
Habitat (terrestrial)	Overstorey (no hollows)
Habitat (watercourse)	Rocks
Watercourse erosion	Very minor (< 20 cm high) bank erosion prior to floods has been infilled by deposited rock
Channel modification	Banks battered.



Figure 14 Subsection 9 through the golf course in November 2016 showing rock deposits

4.6.6 Management Priorities

See Section 5 for management methods.

Priority	Management Action	Subsection			
		6	7	8	9
Very High	Monitor for and remove watercourse weeds				
	Within twelve months undertake monitoring for and removal of re-growth of watercourse weeds using minimal disturbance methods to prevent off-target damage to the aquatic environment:				
	• Exotic sedges*	✓	✓	✓	✓
	• Caster Oil Plant		✓		
	• Palms*	✓	✓	✓	✓
	• Blackberry*	✓			
High	Removal of high threat woody weeds (including non-local natives)				
	Control exotic trees and woody weeds and follow-up every two to four years. Work from upstream to downstream. Use minimal disturbance techniques such as “cut and swab” for saplings and shrubs, “drill an fill” larger trees and small seedlings may be hand-pulled:				
	• Olives	✓		✓	
	• Caster Oil Plant			✓	
	• Peppercorn tree			✓	
	• Lombardy Poplar**	✓		✓	
	• Buckthorn			✓	
	• Prickly Pear**	✓			
	• Flinders Ranges Wattle	✓	✓	✓	
	• Golden Wreath Wattle			✓	
	• Swamp Oak**	✓	✓		✓
	Removal of high threat non-woody weeds				
	Control of non-woody weeds using minimal disturbance methods including spot spray and grubbing out				
	• Periwinkle			✓	
	• Fennel	✓			
	• Galenia			✓	
	• English Ivy			✓	
	Erosion management works	✓	✓	✓	
	Undertake repair works to existing erosion control structures where required, incorporating revegetation where feasible (see page 42).				
	Erosion management	✓	✓	✓	
	Undertake a survey of bed levels and channel dimensions, asset risk assessment and management plan for erosion, favouring ‘soft’ engineering options where assets are not at risk and/or there are sufficient riparian widths. Implement recommendations.				
Medium	Control of moderate threat weeds:				
	• Palm	✓		✓	
	• Exotic sedges*	✓	✓	✓	
	• Oleander	✓		✓	

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Priority	Management Action	Subsection			
		6	7	8	9
	<ul style="list-style-type: none"> • Prunus • Elm** • Bracelet Honey-myrtle 			✓	
		✓		✓	
		✓			
	Undertake revegetation on banks	✓	✓	✓	
	Engage with adjacent landholders to undertake revegetation and establish demonstration sites on upper bank levels				
	Management of River Red Gums in channel	✓	✓	✓	
	Identify River Red Gums not likely to obstruct flow and mark for retention. Remove others.				
Low	Control regeneration from potential weed plantings				✓
	Monitor for regeneration from plantings of Swamp Oak and Aleppo Pine and control				
	Spot weed around existing revegetation		✓	✓	
	Control woody weeds and spot weed around plants to improve aesthetic				
	Engage with adjacent landholders regarding 'garden creep'	✓	✓	✓	

* Indicates species growing in the watercourse. ** Indicates species planted in the reserve.

5. MANAGEMENT METHODS

5.1 WEED MANAGEMENT

This study has mapped isolated occurrences of high threat weeds (see Map 1 and 2) that require control, in addition to weeds that occur throughout (Desert Ash and Drain Flat-sedge).

5.1.1 Woody weeds and exotic trees

Council staff currently undertake an annual to biannual program of woody weed control using cut and swab methods to remove instream and bank woody weeds, particularly Desert Ash and Olives. This has been highly successful in achieving a riparian corridor with a low abundance of woody weeds. This program will need to be on-going as the urban setting of the creek means that weeds are constantly being replaced, however, with regular maintenance, the task is kept to a minimum.

Isolated occurrences of high threat weeds were mapped as part of the field survey, some of which may have been missed as part of the regular weed control program. The field survey component also identified a number of non-local native species considered a weed threat that have been planted and are either regenerating or have the potential to do so (Virtue & Melland 2003). These species should also be included in the regular woody weed control program and similar control methods can be used. Several exotic tree species (e.g. Buckthorn, Peppercorn Tree) were also mapped that should be removed due to their weed threat. These should be killed using drill and fill method and subsequently cut down if they are considered likely to pose a risk.

The control methods used must be consistent with current best practice (AMLR NRMB 2014) to ensure no off-target damage, including undertaking control work when the watercourse is dry and no rain is expected and using approved herbicides.

5.1.2 Non-woody weeds

A range of non-woody weeds were also identified in the field survey (see Maps 1 and 2) that should be controlled to reduce the threat of these becoming dominant. Control methods are outlined below, based on Robertson (2005) and Shepard (2013). Recommended herbicides and application rates for most species are given in Shepard (2013). As for woody weeds, control methods must be consistent with current best practice (AMLR NRMB 2014).

Weed	Control methods	Timing	Other
Periwinkle, Wandering Jew	Spray from the outer edges, can be slashed and actively growing re-growth sprayed	Winter – spring	Monitor and control regrowth annually
Sedges (Umbrella and Dense/Drain Flat-sedge)	Grub out small plants, ensuring all roots are removed or wipe herbicide onto leaves	Early summer (before seed set)	See below for identification tips. Work from upstream to downstream.
Arum Lily	Grub out small plants before they grow, spot spray or cut and swab	Spring	Remove while still small
Watsonia	Grub out in Winter or wipe leaves in early Spring before flowering with a non-selective herbicide	Winter / Spring	

Galenia	Grub out/hand-pull before flowering	Winter	Follow-up required
Rice Millet	Apply non-selective herbicide when actively growing	Spring to early Summer	Slashing and spraying re-growth may be most effective
Fennel	Dig out or slash and spray re-growth before seed set	Spring to early Summer	
Climbing Asparagus	Spot spray with a non-selective herbicide with wetter added	Winter to Spring	Follow-up required
English Ivy	Work inwards from outer edges, grub out or spray	Spring	Herbicide may not be highly effective

Exotic Sedge (*Cyperus* spp.) identification

Two exotic sedges were observed during the field surveys. The larger and less abundant of the exotic sedges is Umbrella Sedge (*C. scariosus*), while the smaller more abundant species is most likely Dense Flat-sedge (*C. congestus*), however it did not have any seed heads and could also have been another common exotic species, Drain Flat-sedge (*C. eragrostis*). Native Flat-sedge (*C. vaginatus*) was also found while another native species (*C. gymnocaulos*) may also occur in Fourth Creek. The exotic sedges can be most easily distinguished from the native species by the following features:

- Umbrella Sedge is almost twice the height of the other sedges and has much longer and more numerous bracts than the local native species
- Dense (/Drain) Flat-sedge has leaves of similar length to the stems and is bright green while the two native species have no obvious leaves (they are reduced to short bracts around the base of the stem) and are a darker green colour.

The locations of Umbrella Sedge were mapped (see Maps 1 and 2) in the first survey but were not seen during the second survey. The Drain Flat-sedge was noted as occurring throughout all the subsections in low density in the first survey but only a few occurrences were noted in the second survey.

Herbaceous and grassy weeds

Herbaceous and grassy weed species were recorded throughout most of Fourth Creek, particularly Kikuyu, Nasturtiums, Three-corner Garlic, Couch and Water Couch. Attempting to remove these weeds on a broadscale is not recommended as they are already so abundant that effective removal would be difficult to achieve, would leave large areas bare and may result in off-target damage. However, in existing and proposed revegetation areas, herbaceous and grassy weeds should be controlled as part of the revegetation preparation and management. Non-selective herbicides approved for use near a watercourse should be effective, however, non-herbicide methods that could also be effective are steam weeding and flame torch. Experienced contractors should be engaged to trial these non-herbicide methods.

5.1.3 Weed sources

Locate upstream seed sources for Desert Ash, exotic Sedge and Caster Oil Plant and remove seed sources where possible.

5.1.4 Garden encroachment

There are many instances along the riparian corridor where adjacent landholders have planted garden vegetation on the reserve, as well as areas where more invasive species are spreading from the gardens into the reserve. Landholders in some areas have also removed revegetation, natural regeneration and spray out the grass. As per the recommendations of the Trails Master Plan, the Council should work and communicate with residents to deliver a collective vision for the Chain of Trails. Properties with high threat species should be a priority and proactively engaging with new landholders when there is a change of ownership may also assist.

5.1.5 Flood follow-up weed control

During the floods of 2016 much of the channel bed was washed away, which resulted in the removal of many weeds growing in the watercourse, particularly isolated occurrences of Palms, Arum Lilies and Umbrella Sedges, while numbers of both Desert Ash seedlings and Dense Flat-sedges were much reduced. Weeds are most efficiently controlled whilst they are in low numbers and therefore it is strongly recommended that a program of removing in-stream weeds be undertaken in 2017, before any remaining weeds set seed.

5.2 NATIVE VEGETATION MANAGEMENT

5.2.1 Establishing New Areas of Native Vegetation

While the Upper section is effectively revegetated throughout most of the available areas, the Lower section is almost devoid of native vegetation. The opportunity exists to undertake revegetation in the Lower section to improve the biodiversity values of the riparian corridor, amenity of the area and manage erosion. However there has been significant opposition by adjacent landholders to revegetation of the Creek corridor that will need to be addressed before any revegetation works are undertaken.

Strategies to assist to improve the community support for bank revegetation are:

- Establish small areas of 'demonstration revegetation' in the wider sections where private properties are not directly adjacent to the creek (e.g. the lower part of subsection 8, the Trails Master Plan identifies potential locations)
- Make revegetation areas small so that a high level of weed control can be achieved, minimise the density of shrubby species to maintain an 'open park' feel (see Table 3) and increase the number of groundcover species (see Table 2) compared with Upper section plantings, align the revegetation parallel to the creek,
- Continue to work with and support local schools to undertake revegetation works in locations where adjacent landholders are supportive,
- Promote benefits of revegetation through signage and Council communication tools,
- Involve local landholders in the selection of species and layout of revegetation works, the Trails Masterplan includes photographs of many local native species that could be included in the plantings,
- Undertake an expression of interest for property owners to identify if they would like revegetation adjacent to their property and focus on these areas.

As can be seen from the existing revegetation in the Upper section, the Council has a good understanding of appropriate methods and species for revegetation. New areas of revegetation should use a similar mix of species with a reduction in the density of shrubby species and addition of more groundlayer species (see Table 2 and Table 3). A good example of understorey revegetation is on the corner of Montacute and Newton Roads (Figure 15).

Local seed sources should be used for propagation and a records system should be developed to document the source of seed used in projects. This will enable revegetation sites to become a source for propagation for future revegetation.

Any new areas of revegetation should have regard to the Trails Master Plan, including the proposed widths and location of trails.



Figure 15 Example of good understorey revegetation in City of Campbelltown Reserve, corner of Newton and Montacute Roads

Revegetation species list and plant numbers

The following tables are recommended species for plantings (Table 2) and relative numbers of plant life forms per 10 x 10 metres (0.01 hectares) of revegetation area designed to achieve an 'open park' appearance (Table 3).

The groundlayer of any area of undisturbed remnant vegetation generally contains the greatest diversity of species but many of these species are difficult to propagate. Some groundlayer species are often accidentally mistaken for weeds by those not familiar in plant identification, which results in them being removed as part of site maintenance. The groundlayer revegetation species are therefore divided into two groups:

- Group A: species that are reasonably hardy and readily identifiable as being planted natives
- Group B: species that are less hardy and more likely to be confused with weeds.

Group B species should only be planted in areas where a high level of weed maintenance by experienced staff or contractors can be undertaken. Council staff that

are likely to undertake maintenance should be involved in the plantings so that they are aware of what has been planted, and plant identification resources and/or training will assist them to maintain the areas without causing accidental off-target damage. Bamboo stakes placed next to each plant may also assist to identify planted species.

Table 2 Revegetation species (see Table 3 for plant numbers)

Scientific Name	Common Name	Watercourse	Bank	Large tree	Small tree	Shrub	Groundlayer A ¹	Groundlayer B ¹	Section ²
<i>Acacia acinacea</i>	Wreath Wattle		✓			✓			
<i>Acacia melanoxylon</i>	Blackwood		✓		✓				U
<i>Acacia pycnantha</i>	Golden Wattle		✓		✓				
<i>Acacia retinodes</i>	Wirilda ('hill form')		✓		✓				
<i>Allocasuarina verticillata</i>	Drooping Sheoak		✓		✓				
<i>Aristida behriana</i>	Brush Wire-grass		✓					✓	
<i>Arthropodium strictum</i> , <i>A. fimbriatum</i>	Chocolate lilies		✓					✓	
<i>Atriplex semibaccata</i>	Berry Saltbush		✓				✓		L
<i>Austrostipa elegantissima</i>	Elegant Spear-grass		✓					✓	
<i>Austrostipa</i> spp.	Spear Grass		✓					✓	
<i>Banksia marginata</i>	Silver Banksia		✓		✓				
<i>Bulbine bulbosa</i>	Bulbine Lily		✓					✓	
<i>Bursaria spinosa</i>	Christmas Bush		✓			✓			
<i>Callistemon sieberi</i>	River Bottlebrush	✓				✓			
<i>Callitris gracilis</i>	Native Pine		✓		✓				
<i>Calocephalus citreus</i>	Lemon Beauty-heads		✓					✓	✓
<i>Calostemma purpureum</i>	Pink Garland Lily		✓					✓	
<i>Carex tereticaulis</i>	Rush Sedge	✓					✓		
<i>Chloris truncata</i>	Windmill Grass		✓					✓	
<i>Chrysocephalum apiculatum</i>	Common Everlasting		✓					✓	
<i>Correa glabra</i>	Rock Correa		✓			✓			U
<i>Cullen parvifolium</i>	Native Scurf-pea		✓			✓			
<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge	✓	✓				✓		L
<i>Cyperus vaginatus</i>	Flat-sedge	✓					✓		
<i>Dianella revoluta</i>	Black-anther Flax-lily		✓				✓		
<i>Dodonaea viscosa</i> ssp. <i>spatulata</i>	Sticky Hop-bush		✓			✓			
<i>Einadia nutans</i>	Climbing Saltbush		✓				✓		
<i>Enchylaena tomentosa</i>	Ruby Saltbush		✓				✓		L
<i>Enneopogon nigricans</i>	Blackhead		✓				✓		
<i>Eucalyptus camaldulensis</i> ssp. <i>camaldulensis</i>	River Red Gum		✓	✓					
<i>Ficinia nodosa</i>	Knobby Club-rush	✓	✓				✓		L
<i>Goodenia amplexicans</i>	Clasping Goodenia		✓				✓		U
<i>Grevillea lavandulacea</i> var. <i>lavandulacea</i>	Lavender Grevillea		✓				✓		U
<i>Hakea rostrata</i>	Beaked Hakea		✓			✓			U
<i>Hardenbergia violacea</i>	Native Lilac		✓			✓			
<i>Hibbertia exutiacies</i>	Prickly Guinea-flower		✓				✓		U
<i>Juncus</i> spp. (e.g. <i>J. sarophorus</i> , <i>J. subsecundus</i> , <i>J. pallidus</i>)	Rushes	✓	✓				✓		
<i>Kennedia prostrata</i>	Running Post-man		✓				✓		
<i>Lavatera plebia</i>	Native Hollyhock		✓						

Scientific Name	Common Name	Watercourse	Bank	Large tree	Small tree	Shrub	Groundlayer A ¹	Groundlayer B ¹	Section ²
<i>Leptospermum continentale</i>	Prickly tea-tree	✓	✓			✓			U
<i>Lomandra multiflora ssp. dura</i>	Hard Mat-rush		✓				✓		
<i>Myoporum viscosum</i>	Sticky Boobialla		✓			✓			U
<i>Olearia ramulosa</i>	Twiggy Daisy-bush		✓			✓			
<i>Pelargonium australe</i>	Australian Pelargonium		✓					✓	
<i>Pittosporum angustifolium</i>	Native Apricot		✓		✓				
<i>Poa labillardieri</i>	Tussock Grass		✓				✓		
<i>Rytidosperma spp.</i>	Wallaby Grass		✓					✓	
<i>Scaevola albidia</i>	White Fanflower		✓					✓	U
<i>Senecio quadridentatus</i>	Cotton Groundsel		✓					✓	U
<i>Teucrium racemosum</i>	Grey Germander		✓				✓		
<i>Themeda triandra</i>	Kangaroo Grass		✓				✓		
<i>Vittadinia spp.</i>	New Holland Daisy		✓					✓	

¹Groundlayer A are hardier and easier to grow species that can be planted into most sites and are readily distinguishable from weeds, Groundlayer B species are species that require good weed control and may not be readily identified as planted by person's not experienced in plant identification

²U for Upper section, L for Lower section, otherwise suitable for planting throughout if no section specified

Table 3 Number of plants per 10 x 10 metres of revegetation

Plant life form	Number
Large tree	1
Small tree	2
Shrub	5
Groundlayer A	25 to 100
Groundlayer B	50 to 200

5.2.2 Management of existing revegetation

The existing revegetation areas include a good diversity of local native shrubs and small trees but only a small proportion of groundlayer species (e.g. groundcovers, native grasses, tussocks and herbaceous species, although the timing of the survey was not ideal for identifying grasses). The revegetation areas will provide habitat and biodiversity benefits without further plantings, but could provide greater benefits with the establishment of native groundlayer species. Native groundlayer plants provide food and habitat for a greater range of fauna, particularly insects and ground foraging birds (Munro et al., 2007; Kazemi et al., 2009). Groundlayer species are, however, relatively difficult to establish in existing revegetation where there is competition for soil moisture and light and also require more complex on-going weed management. Therefore groundlayer species should be included in new and existing plantings where there has been good weed control. Groundlayer species are included in the revegetation list (Table 2).

Encouraging natural regeneration

Spot spraying and hand-pulling weeds around existing plantings can assist to encourage natural regeneration but requires good plant identification and care to ensure no accidental damage to the revegetation. Brush-cutting annual weeds amongst revegetation can also be used to reduce the weed seed set.

Mulching is a useful method to control weed regeneration in new plantings but generally prevents natural regeneration. Therefore it is recommended that mulching should not continue to be applied once revegetation is well established (i.e. after three years) unless weed control is a priority (i.e. in 'demonstration revegetation' areas).

5.2.3 In-Stream Vegetation

River Red Gum Regeneration

River Red Gums seedlings and saplings were observed throughout Fourth Creek growing in the watercourse, particularly in the Lower section. In a 'natural' system this would be considered a positive outcome, however, in the highly urbanised setting of Fourth Creek, where the creek provides an important stormwater transport system, such regeneration may contribute to flooding (by restricting and slowing flow) and erosion (by diverting flow into new flow paths). Therefore the current practice of removing River Red Gums growing in the watercourse can continue except:

- Those growing on the outer bends where they may provide protection of the banks from erosion and
- Potentially in areas where the reserve is wider and there is room for flows to spread out, however this should be considered as part of the erosion management planning recommended in the following section.

Where River Red Gums regenerate on the banks they should be clearly marked (so as not to be mown) and retained.

Revegetation of Sedges and Rushes

Little instream native vegetation was observed during the field survey, however these types of fast flowing, cobbled watercourses are commonly not densely vegetated. Flat-sedge (*Cyperus vaginatus*) was observed growing sparsely throughout the watercourse and Bulrush grew almost exclusively in Lower subsection 6. Additional sedges and rushes could be planted on the lower banks of the creek in areas with low weed cover. Due to the issues noted previously with landholders in the Lower section, it is only recommended to undertake such revegetation in the Upper section except in conjunction with erosion control works.

5.3 EROSION MANAGEMENT

As noted in the previous sections, since the 2016 floods, much of Fourth Creek is now impacted by erosion. Only minor erosion issues were noted in the Upper Section during the first (May) survey, with more severe erosion primarily observed in the Lower section. In the second (November) survey, the Upper Section was found to have undergone significant erosion (e.g. Figure 3 and Figure 9) while in the Lower Section the level of erosion was generally not much worse than was observed in May. The Lower section appears to have been a zone for deposition of bed materials from the upper section (Figure 16) during the floods; this and the existing erosion control works may have contributed to the lower level of impact in the Lower Section.

There is now an immediate short term priority to undertake bank and infrastructure protection and repair works in the Upper Section. Council staff have undertaken a preliminary survey and identified the works that are required. The following are some issues to be considered in relation to these works:

- Where large trees are being removed the logs should be utilised in the adjacent riparian reserve, either for habitat (e.g. as natural fallen logs) or natural play areas (e.g. stumps and balance logs)
- Where new gabions are used to protect banks, incorporate methods or structures to prevent channel deepening and undermining of gabions in future flood events
- Rocks naturally deposited in channel will help prevent bed deepening in the future
- Where bank erosion has occurred but no assets are at risk, consider working with the new bank alignment
- Incorporate planting of native sedges, rushes and grasses around structures and infill to trap sediments.

Some issues noted in the field that should also be addressed as part of the short term erosion repair works are:

- In some instances large trees have had much of their roots exposed; these should have soil replaced around the roots covered with protective matting or rocks and planted with native grasses to stabilise the trees
- There are some locations where the rock gabions appear to have held together but have been undercut and are beginning to slump or at risk of slumping; these will need to be assessed by an engineer.

Following these immediate works, it is recommended that an erosion management plan for Fourth Creek be undertaken, including a survey of the bed levels and identification of high risk areas. Hard engineering options may be required in some sections, such as a single large drop structure installed between each control point (concreted bridge) or multiple smaller drop structures. If bed deepening can be addressed then the need for bank protection should be significantly reduced as most instances of bank erosion are caused by bed deepening (e.g. see left bank in Figure 16).

Management of erosion to date has involved gabions, rock and concrete to protect the banks, as well as instream rock (Figure 16) and concrete weir structures intended to trap sediments and prevent bed deepening. At all road bridges the channel has been concreted up and downstream to protect the bridges. These areas provide control points on the channel depth and at some locations there have been erosion control measures to protect the channel immediately downstream to prevent undermining.

Due to the close proximity of infrastructure and private properties along much of the watercourse, management of even quite minor erosion (e.g. Figure 17) is a priority where there are risks to properties. Whilst it is desirable to implement 'soft' engineering options

to maintain and restore the riparian habitats, 'hard' engineering options (e.g. drop structures) may be required in high risk areas.

Erosion control works may require a Water Affecting Activities permit under the Natural Resources Management Act (2004) and should utilise the AMLR NRMB Best Practice Operating Procedures (AMLR NRMB 2014).

Soft engineering options that could be considered to reduce erosion of the watercourse are:

- Not spraying the banks so that grass is retained to protect the soil, particularly around bed control structures (e.g. see Figure 18)
- Establishing local native sedges and rushes (see Table 2) around existing and new instream rock structures to assist in binding the soil and trapping sediments, this may prevent erosion such as that shown in Figure 10; the planting purpose may need to be communicated to adjacent landholders who have concerns about instream vegetation as well as maintenance staff;
- Planting low growing woody shrubs and sedges and rushes (see Table 2) at the toe of outer bank erosion points to protect the banks and trap debris without obstructing the flow (it is important that only small species are used and this method is only used on outer bends so that flood risk is not exacerbated); this can be done in conjunction with the constriction of alignment fences however these would need to be biodegradable and/or strongly constructed to minimise the impact if the fence is damaged in major floods.

In addition to bed deepening and widening, there are locations where the battered banks lack cover and there has been surface erosion of the soil. In some of these areas matting has been placed to protect the soil. Establishing and retaining groundcover vegetation on these slopes is the simplest method to control this erosion, however it appears many of these areas are sprayed with herbicide, which may be at the request of, or by, adjacent landholders. Therefore any efforts to establish cover will need to be undertaken in consultation with adjacent landholders and Council staff and revegetation should not be undertaken without their support. Native groundcover species that could be used include:

- Ruby Saltbush (*Enchylaena tomentosa*)
- Running Postman (*Kennedia prostrata*)
- Berry Saltbush (*Atriplex semibaccata*)
- Native grasses such as Windmill Grass (*Chloris truncata*), Blackhead Grass (*Einneapogon nigricans*), Elegant Spear- grass (*Austrostipa elegantissima*), Brush Wiregrass (*Aristida behriana*) and Wallaby Grasses (*Austradanthonia* spp.).



Figure 16 Showing an area in lower subsection 7 impacted by bed deepening and erosion around the rock weir in May 2016 (top) where bed materials from upstream were deposited during the floods (bottom)



Figure 17 Bank erosion in subsection 2; because of the narrow width, controlling this erosion is important for protecting the road



Figure 18 Small area of revegetation in Lower subsection 8 where watercourse edges are not sprayed and grasses provide protection against erosion

5.4 MONITORING RECOMMENDATIONS

There are two types of monitoring that should be undertaken as part of the implementation of this plan. Firstly there is monitoring that informs day to day management activities, this can include monitoring the survival of revegetation, weeds that require control and the success of watercourse erosion control works. The second type of monitoring is evaluating if the objectives outlined in this plan are being achieved.

The first type of monitoring ('action monitoring') should be undertaken at least annually and is probably already undertaken to some extent at least informally by Council staff. This could be formalised to at least a biannual survey of medium and high threat weeds using GPS and plant counts

The second type of monitoring ('objective monitoring') can be undertaken less frequently (e.g. every five years) and will require more careful planning to ensure progress towards the objectives is evaluated. Table 4 presents some options for monitoring progress towards the objectives which could be developed into a more formalised monitoring program.

Table 4 Options for monitoring objectives

Objective	Method	Performance indicator
To prevent any further decline in condition of the watercourse and riparian habitats	Re-survey the creek using the method used for this project	No section declines in condition in overall or individual attributes
	Establish Bushland Condition Monitoring (Croft et al. 2005) sites in each section	No decline in Bushland Condition Monitoring score
	Fauna (e.g. birds, macroinvertebrates) monitoring	No decline in fauna diversity
To restore the condition of the watercourse and riparian habitats	Re-survey the creek using the method used for this project	Sections improve in watercourse attribute indicators (e.g. watercourse condition, weed threat, erosion)
	Establish BCM sites in each section	Improved BCM score
	Fauna (e.g. birds, macroinvertebrates) monitoring	Improved fauna diversity
Maintain and enhance the amenity and recreational values of the creek corridor	Survey adjacent residents	Resident satisfaction is maintained or improved
	Survey number of people using	Number of people using the creek corridor is maintained or improved
Coordinated management across Council to achieve multiple objectives.	Actions are implemented and maintained by staff	Qualitative evaluation

6. REFERENCE LIST

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7. APPENDIX: PLANT SPECIES OBSERVED

Table 5 Local native species

N = naturally occurring (banks)

W = watercourse (naturally occurring)

P = planted (banks)

* indicates South Australian native species that may be outside their natural range

Species Name	Common Name	1999-2000	Upper 1	Upper 2	Upper 3	Upper 4	Upper 5	Lower 6	Lower 7	Lower 8	Lower 9
<i>Acacia acinacea</i>	Round-leaf Wattle		P	P			P	P	P	P	
<i>Acacia melanoxylon</i>	Blackwood		P	P	P						
<i>Acacia paradoxa</i>	Kangaroo Thorn		P				P				
<i>Acacia provincialis</i>	Wirilda		P		P		P				
<i>Acacia pycnantha</i>	Golden Wattle		P	P	P		P	P	P	P	
<i>Acacia retinodes</i>	Silver Wattle	N	P		P		P	P		P	
<i>Acacia rupicola</i>	Rock Wattle	N	P	P			P				
<i>Acacia salicina</i> *	Broughton Willow									P	
<i>Acacia sp. (?ligulata)</i>	Wattle (?Umbrella Bush)			P							
<i>Acacia verniciflua</i>	Varnish Wattle		P								
<i>Allocasuarina sp. (striata / muelleriana)</i>	Sheoak		P								
<i>Allocasuarina verticillata</i>	Drooping Sheoak			P	P		P		P		
<i>Atriplex semibaccata</i>	Berry Saltbush										
<i>Banksia marginata</i>	Silver Banksia				P		P				
<i>Bursaria spinosa var. spinosa</i>	Christmas Bush		P				P				
<i>Callistemon sieberi</i>	River Bottlebrush		P								
<i>Callistemon sp.*</i>	Bottlebrush							W		W, P	
<i>Callitris gracilis</i>	Southern Cypress-pine		P	P	P		P		P		
<i>Carex tereticaulis</i>	Sedge						P				
<i>Correa sp.</i>	Correa		P		P						
<i>Correa glabra ssp.</i>	Rock Correa						P			P	
<i>Correa sp. (?reflexa)</i>	Correa						P				
<i>Cullen australasicum</i>	Native scurf-pea				P						
<i>Cyperus vaginatus</i>	Flat-sedge	N	W	W	W		W	W, P		W	
<i>Dianella revoluta var. revoluta</i>	Black-anther Flax-lily				P						

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Species Name	Common Name	1999-2000	Upper 1	Upper 2	Upper 3	Upper 4	Upper 5	Lower 6	Lower 7	Lower 8	Lower 9
<i>Dianella brevicaulis</i>	Short-stem Flax-lily									P	
<i>Dianella sp.**</i>	Non-local species										
<i>Dichondra repens</i>	Tom Thumb										T
<i>Dodonaea viscosa ssp. spatulata</i>	Sticky Hopbush			P	P		P	P	P	P	
<i>Epilobium hirtigenum</i>	Hairy Willow-herb	N									
<i>Eucalyptus camaldulensis ssp. camaldulensis</i>	River Red Gum	N	T	B	T	T	T	T	T	T	T
<i>Eucalyptus leucoxylon ssp. leucoxylon</i>	SA Blue Gum	N		P	P		P		P		
<i>Geranium retrorsum</i>	Grassland Geranium	N									
<i>Goodenia albiflora</i>	White Goodenia				P						
<i>Goodenia amplexans</i>	Clasping Goodenia				P						
<i>Hakea carinata</i>	Erect Hakea			P			P				
<i>Hakea rostrata</i>	Beaked Hakea			P							
<i>Juncus caespiticus</i>	Grassy Rush							W			
<i>Juncus sp.</i>	Rush						W				
<i>Juncus usitatus</i>	Common Rush	N									
<i>Kennedia prostrata</i>	Running Postman				P						
<i>Leptospermum continentale</i>	Prickly Tea-tree			p			P	W			
<i>Lomandra multiflora ssp. dura</i>	Irongrass				P						
<i>Lythrum hyssopifolia</i>	Lesser loosestrife	N					W	W			
<i>Malva preissiana</i>	Australian Hollyhock		T	T						W	
<i>Melaleuca decussata</i>	Totem Poles			P			P				
<i>Melaleuca sp. (?lanceolata?)*</i>	Melaleuca						P				
<i>Olearia ramulosa</i>	Twiggy Daisy-bush		P	P	P		P	P	P		
<i>Persicaria decipiens</i>	Slender Knotweed							W	W		W
<i>Pittosporum angustifolium</i>	Native apricot				P						
<i>Rhagodia spinescens</i>	Thorny Rhagodia								P		
<i>Typha sp.</i>	Bulrush	N						W			W
<i>Urtica incisa</i>	Scrub Nettle	N									
<i>Xanthorrhoea quadrangulata</i>	Grass Tree		P								
Total		11	18	16	20	1	24	13	10	10	4

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Table 6 Introduced species

P = Planted T = Throughout W = Watercourse only Banks = isolated occurrences, mapped NO = not observed in November survey but observed in May

High threat	WoNS ¹	SA declared ²	Species Name	Common Name	Upper 1	Upper 2	Upper 3	Upper 4	Upper 5	Lower 6	Lower 7	Lower 8	Lower 9
			<i>Acacia baileyana</i>	Cootamundra Wattle			B						
*			<i>Acacia cyclops</i>	Western Coastal Wattle			P						
*			<i>Acacia iteaphylla</i>	Flinders Ranges Wattle	P	B		P		B	W	B	
*			<i>Acacia saligna</i>	Golden Wreath Wattle	P	B	P		P			B	
			<i>Acanthus mollis</i>	Oyster Plant		B							
		C	<i>Allium triquetrum</i>	Three-corner Garlic	T				W			W	
*			<i>Arecaceae sp.</i>	Palm			W			W		W	
*		Cn	<i>Asparagus plumosus</i>	Asparagus fern	B			B					
			<i>Callistemon sp.</i>	Bottlebrush			P				P	P	B
*		C	<i>Casuarina sp. (? glauca)</i>	(?Swamp) Oak		B	B			W	B		B
			<i>Centranthus ruber</i>	Valerian		B	B						
			<i>Ceratonia siliqua</i>	Carob Tree	P	P							
			<i>Coniferae sp.</i>	Conifer	P								
		C	<i>Coprosma repens</i>	New Zealand Mirror-bush					P				
			<i>Corymbia ficifolia</i>	Flowering Gum							P		
			<i>Corymbia maculata</i>	Spotted Gum	P	P		P					
			<i>Cucurbita sp.</i>	Pumpkin						W			

¹WoNS = Weeds of national significance

²SA Declared = Declared plants in South Australia, January 2015, C = Control required in part of the State only, Cn = Control not required (but sale prohibited)

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High threat	WoNS ¹	SA declared ²	Species Name	Common Name	Upper 1	Upper 2	Upper 3	Upper 4	Upper 5	Lower 6	Lower 7	Lower 8	Lower 9
			<i>Cynodon dactylon</i>	Couch	T		W		W	W	W	T	T
*			<i>Cyperus congestus</i> (/C. <i>eragrostis</i>)	Dense (/Drain) Flat-sedge		W	W		NO	NO	NO	W	NO
*			<i>Cyperus involucratus</i>	Umbrella Sedge		NO				NO	NO		
			<i>Eucalyptus cladocalyx</i>	Sugar Gum			P						
*			<i>Foeniculum vulgare</i>	Fennel	W					W			
*		C	<i>Fraxinus angustifolia</i> ssp. <i>angustifolia</i>	Desert Ash		W	W	B	W	W	W	W	W
			<i>Fumaria</i> sp.	Fumitory	W	B	B	B	B	B	B	B	B
*			<i>Galenia</i> sp.	Galenia		B						B	
*	*	C	<i>Genista monspessulana</i>	Broom			B						
			<i>Geranium</i> sp.	Geranium	P	P							
			<i>Graminae</i>	Exotic Grasses	T	T	T	T	T	T	T	T	T
			<i>Grevillea robusta</i>	Silky Oak			P	P					
*			<i>Hedera helix</i>	English Ivy								B	
			<i>Hypericum perforatum</i>	St Johns Wort	B								
			<i>Lathyrus tingitanus</i>	Tangier Pea	B	B							
			<i>Malva parviflora</i>	Small-flowered Marshmallow	T				T		T	T	T
			<i>Malva arborea</i>	Tree Mallow									
			<i>Melaleuca armilaris</i>	Bracelet Honey-myrtle	P		P		P	B			
			<i>Melaleuca</i> sp. (could be <i>L. cont</i>)	Paperbark		P	P						
			<i>Nerium oleander</i>	Oleander						B		W	
			<i>Nicotania glauca</i>	Tobacco Bush			B						
*		*	<i>Olea europaea</i> ssp <i>europaea</i>	Olive	B	B	B		P	B		P	
*	*	*	<i>Opuntia</i> sp.	Prickly Pear						B			
*			<i>Osteospermum ecklonis</i>	African Daisy (purple)	B		B						
			<i>Oxalis pres-caprae</i>	Soursobs	T	W	T		T	B		T	T

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High threat	WoNS ¹	SA declared ²	Species Name	Common Name	Upper 1	Upper 2	Upper 3	Upper 4	Upper 5	Lower 6	Lower 7	Lower 8	Lower 9
			<i>Paraserianthes lophantha</i> ssp. <i>lophantha</i>	Cape Leeuwin Wattle	B		B						
			<i>Paspalum distichum</i>	Water Couch						W	W		
			<i>Pennisetum clandestinum</i>	Kikuyu	T	T	T	T	W	T	T	T	T
*		C	<i>Pinus halapensis</i>	Aleppo Pine					B				P
*			<i>Piptatherum miliaceum</i>	Rice Millet	T	W	B						
		*	<i>Pittosporum undulatum</i>	Sweet Pittosporum		B	B						
*			<i>Populus nigra</i> var. <i>italica</i>	Lombardy Poplar						B,W		B	
			<i>Prunus</i> sp.	Plum								B	
*		C	<i>Rhamnus alaternus</i>	Italian Buckthorn	B	B			P			B	
*			<i>Ricinus communis</i>	Caster Oil Plant	B						W	W	
			<i>Rorippa nasturtium-aquaticum</i>	Watercress						W			
*	*	C	<i>Rubus fruticosus</i>	Blackberry						W			
			<i>Rumex</i> sp.	Dock	W	W	W			W	W		
*			<i>Schoenus molle</i>	Peppercorn	B							P	
			<i>Tradescantia fluminensis</i>	Wandering Jew	B				B				
			<i>Tropaeolum majus</i>	Nasturtium	W	W	W	T	W		W	T	B
			<i>Ulmus</i> sp.	Elm						B		B	
			<i>Verbena</i> sp.	Verbena						B	B		
*			<i>Vinca major</i>	Periwinkle	B	B	B		P			B	
*		C	<i>Watsonia</i> sp.	Watsonia					P				
*		C	<i>Zantedeschia aethiopica</i>	Arum Lily	B	B							
				Unknown exotic tree with bipinnate leaves								W	
				Various non-local natives	P				B			P	

