GOULBURN
CITY COUNCIL

Wollondilly River and Mulwaree Chain of Ponds Floodplain Risk Management Study and Plan

Volume IV

Draft Native Vegetation Enhancement Strategy

March 2003



SMEC

GOULBURN CITY COUNCIL

WOLLONDILLY RIVER AND
MULWAREE PONDS
FLOODPLAIN RISK MANAGEMENT STUDY
and PLAN

VOLUME FOUR
DRAFT NATIVE VEGETATION
ENHANCMENT STRATEGY

March 2003

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Project Number: 31222

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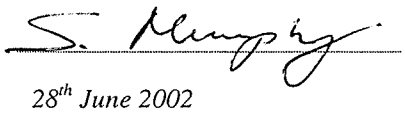
Prepared by:	*Shireen Murphy*	Signature:	
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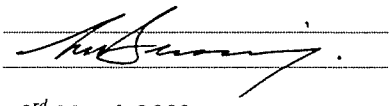
Reviewed by:	*Neil Benning*	Signature:	
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AAD	Average Annual Damages
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
DCP	Development Control Plan
DLWC	Department of Land and Water Conservation
EMA	Emergency Management Australia
EC	Environment Committee
FRMS	Floodplain Risk Management Study
FRMP	Floodplain Risk Management Plan
FWG	Floodplain Working Group
GCC	Goulburn City Council
LEP	Local Environmental Plan
LGA	Local Government Area
NPWS	National Parks and Wildlife Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
SEPP	State Environmental Planning Policy
SES	State Emergency Service
VES	Vegetation Enhancement Strategy

1 INTRODUCTION

1.1 AN INTRODUCTION TO THE VEGETATION ENHANCEMENT STRATEGY (VES)

SMEC Australia has been engaged by Goulburn City Council (GCC) to prepare a Floodplain Risk Management Study and Plan (FRMS & P). The FRMP provides recommendations for the management of flood prone land in the Goulburn region. Goulburn is located in the southern highlands of New South Wales (NSW), approximately 200km south-west of Sydney and lies on the confluence of the Wollondilly River and Mulwaree Ponds, in the upper reaches of Hawkesbury Nepean catchment (Figure 1).

A Vegetation Enhancement Strategy (VES) (this document) has been prepared as a component of the FRMP. The VES applies to the riparian[1] zone of the Wollondilly River and Mulwaree Ponds within the Goulburn Local Government Area (LGA) (Figure 1).

The primary objective of this VES is to increase the hydraulic capacity of the Wollondilly River and Mulwaree Ponds by removing exotic plant species that currently 'choke' the river systems. The VES also aims to provide a series of coordinated options to enhance the ecological value and aesthetic appeal of the riparian zone, without impeding flow.

The VES is not a step by step guide to revegetating the floodplain. Rather, it builds upon existing ecological initiatives within the region, and contains a series of strategic management alternatives for GCC to consider for development and implementation as vegetation management plans (VMPs). That is, the role of the VES was not to develop specific VMPs, rather it was to provide GCC with a range of management options so that suitable VMPs can be developed in the future.

The VES has a number of other objectives including:

- providing a description of the area and its conservation significance;
- developing an implementation timetable for management options; and
- providing an outline of opportunities for government funding and other sources of assistance.

1.2 POTENTIAL BENEFITS OF IMPLEMENTING THE VES

Enhancing the condition of native vegetation located within the riparian zone of the Wollondilly River and Mulwaree Ponds can potentially result in a number of important ecological, economic and social benefits to the local community. These benefits are illustrated in Table 1.1. The benefits can also be experienced at wider levels, including regional and catchment scales.

[1] Riparian zone is defined as a stream or river and the associated vegetation on the banks and floodplain.

It is understood that rehabilitation of the riparian zone back to the native (pre-European settlement) state is not economically or socially acceptable. The study area is too large, the works would be too expensive and constraints placed on surrounding development and use of the riparian zone would not be feasible. This VES aims to maximise the benefits listed in Table 1.1, without imposing unreasonable demands/constraints on the community or GCC.

Table 1.1 Potential Benefits of Implementing the Vegetation Enhancement Strategy

Ecological Benefits	Social Benefits	Economic Benefits
• Contributes to the return of the natural hydrological regime of the area. • Improves biodiversity and ecological integrity of the area. • Provides habitat for terrestrial and aquatic fauna, including important fish breeding and nursery grounds. • Reduces soil erosion and improves water quality.	• Reduces the severity of flooding. • Contributes to the conservation of indigenous heritage. • Preservation of areas of natural heritage. • Provides areas for tourism and recreational pursuits. • Provides areas for scientific study, education and research. • Improves the aesthetic quality of the area.	• Reduces the severity of flooding. • Reduces expenditure required to rectify environmental problems, such as algal blooms. • Enhances agricultural productivity in surrounding areas by providing shade and shelter; and reducing water and wind erosion. • Provides habitat for natural predators of insects and pests, meaning less pesticides need to be applied. • Enhances property values.

1.3 RELATIONSHIP BETWEEN THE FRMP AND THE VES

One of the main flood management options recommended in the FRMP is Floodplain Environmental Enhancement, including the removal of exotic species from the riparian zone to increase the hydraulic capacity of the rivers. This VES has been developed to recommend the most appropriate and effective methods of carrying out this work.

Prior to specific works being undertaken, VMPs need to be developed incorporating appropriate management principles which are detailed in this VES. A VMP should provide detailed information for the area being managed and it should list specific tasks and work methods that would achieve the relevant management objectives. Appendix A explains the steps involved in preparing a VMP.

Currently the presence of exotic species along the rivers acts to stabilise the banks, preventing erosion. The VES considers the need to maintain/regenerate/replant existing native vegetation to replace the exotic species, thereby maintaining bank stability. Careful planting and management (as recommended in this VES) will help ensure that 'choking' of the channel with vegetation does not reoccur.

1.4 DOCUMENT STRUCTURE

This document constitutes the VES for the Wollondilly River and Mulwaree Ponds riparian zone. The main aim of the document is to provide GCC with a range of possible management options. The possible management strategies are presented in Section 4. The remainder of the document provides important supporting information. Table 1.2 sets out document structure.

Table 1.2: Document Structure

Document Section	Description
Section 1	Introduces the aims and purpose of the VES and provides the project methodology.
Section 2	Description of the study area, with specific emphasis on the relevant local issues of flooding, ecology and water quality.
Section 3	Description of the existing ecological environment, in terms of flora and fauna.
Section 4	Provides seven possible management strategies with details on how they could be implemented.
Section 5	Identifies possible funding sources
Section 6	Provides a list of references. These should be consulted if additional information is required.
Appendix A	Provides details on how to prepare a Vegetation Management Plan (VMP).
Appendix B	Plant species list to be used when planning revegetation works.
Appendix C	Provides guidelines on how to collect native plant seeds so that revegetation can be with locally occurring native species.

1.5 PROJECT METHODOLOGY

1.5.1 Resource Review

A comprehensive review of relevant resources including literature, databases and guidelines, was undertaken to assist in the:

- description of the existing environment;
- identification of plant species and communities and fauna of conservation significance in the local area;
- existing pressures on the riparian environment; and
- identification of existing vegetation management initiatives in the region.

Material consulted is referred to throughout the report and summarised in Section 6, in particular the following guidelines and plans were consulted:

1. Riparian management Guidelines for the Wollondilly and Wingecarribee Rivers (Lewis, 2001);
2. Wollondilly River Rehabilitation Plan (GCC, 2000); and
3. Stonequarry Creek Vegetation Management Plan (Ian Perkins Consultancy Services, 1996).

1.5.2 Key Informant Interviews

Additional information was gained through interviews held with representatives from the following organisations:

- Goulburn City Council (GCC);
- Department of Land and Water Conservation (DLWC);
- Greening Australia;
- Landcare;
- National Parks and Wildlife Service (NPWS);
- NSW Fisheries; and
- Sydney Catchment Authority (SCA).

These interviews were particularly useful in the explanation of current and proposed ecological initiatives in the area; legislation; and local issues.

1.5.3 Field Survey

A field visit to the region was undertaken in April 2002. The purpose of the field survey was to familiarise the study team with the site, conduct the key informant interviews and identify site specific opportunities and constraints for the future vegetation management of the area. The potential for the presence of threatened species, populations, ecological communities or their habitats was also assessed.

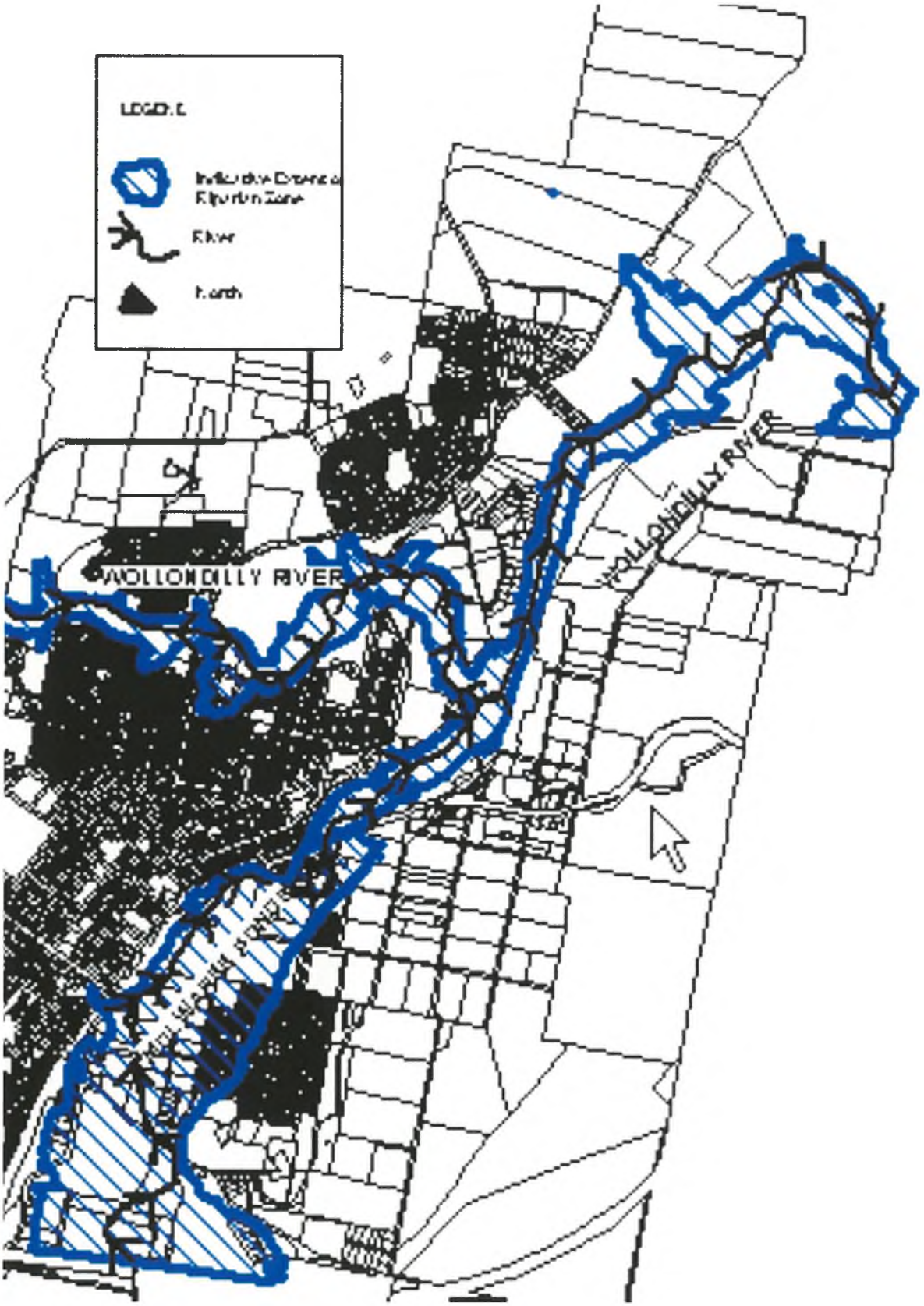

Figure 1: VES Study Area

2 DESCRIPTION OF THE STUDY AREA

2.1 STUDY AREA

Goulburn is located in the southern highlands of NSW, 200km from Sydney and 95 km from Canberra. Established in 1833, and proclaimed a city in 1859, Goulburn is Australia's oldest inland city with a population of 20884 (2001 census) with marginal decreases expected in the future.

The City lies at the confluence of the Wollondilly River and Mulwaree Ponds within the upper reaches of the Hawkesbury Nepean catchment (Figure 1).

The Wollondilly River rises in the Great Dividing Range east of Crookwell and drains the south-western section of the Hawkesbury River Basin. Its catchment area upstream of Goulburn is 720m^2. The catchment is hilly and the riverbanks have steep slopes. Typically the floodplain is well defined and narrow through Goulburn.

Mulwaree Ponds is one of the largest and southernmost tributaries of the Wollondilly River. It rises in the Great Dividing Range immediately south of the Tarago and flows north towards Goulburn. This catchment comprises an area of 750m^2, being bound to the west by steep slopes and to the east by undulating country.

2.2 RELEVANT LOCAL ENVIRONMENTAL ISSUES

2.2.1 Flooding

The areas adjacent to the Wollondilly River and Mulwaree Ponds have been repeatedly affected by flooding since European settlement, with two recent major floods (1974 and 1961) disrupting the City. The August 1974 flood has been estimated as having a 1 in 30 Annual Exceedence Probability (AEP)[2], and the November 1961 flood approximately a 1 in 100 AEP.

The FRMP, developed by SMEC, aims to manage flooding to reduce impacts on the local community. During the development of the plan, a number of flood mitigation options were considered. Broadly, these fell into three categories:

- flood modification measures, which modify the behaviour of the flood itself;
- property modification measures, which modify existing properties (e.g. house raising or purchasing) and/or by imposing controls on property and infrastructure development; and
- response modification measures, which modify the response of the population at risk to better cope with a flood event.

[2] Annual Exceedence Probability indicates the probability that a flood will be equalled or exceeded in any given year. So for example the 1 in 30 AEP flood has one chance in 30 of being equalled or exceeded in any given year.

Each measure was assessed using Multi-Criteria Analysis against social, economic and environmental criteria as well as considering its effectiveness in flood mitigation. Key initiatives, given a high score during the assessment were:

- Floodplain Environmental Enhancement, including removal of exotic species from the riparian zone, which currently 'choke' the river flow, causing upstream flooding.
- Land use management, including zoning and development controls. That is, development on flood prone land will be restricted to activities that can withstand periods of inundation, and that do not result in unreasonable risks to human safety; and
- Voluntary Purchase, House Raising and Flood Proofing, altering or purchasing properties to allow flood risks to be diminished;
- Flood Warning and Emergency Plans, to provide a sound basis for planning, preparation, response and recovery activities by SES and other emergency service providers during flood event ;
- Evacuation & Recovery Procedures, to enable and persuade the community to take the appropriate actions to increase safety and reduce the damages associated with flooding; and
- Community Awareness & Preparedness to ensure that the community is fully aware that floods are likely to interfere with normal activities in the floodplain.

These measures are discussed in detail in Volume I of the FRMS & P.

2.2.2 Ecology

The riparian zone along the Wollondilly River and Mulwaree Ponds within the Goulburn LGA has been significantly modified as a result of agricultural and urban development. Extensive clearing has been undertaken and invasion by exotic plant species has occurred. Most of the remnant vegetation is restricted to areas unsuitable for agriculture or urban development such as steep slopes and rock outcrops. The overall species diversity and coverage of riparian vegetation has been reduced to less than 10 percent (%) of the native state. Exotic species have invaded the riparian zone and now dominate in both species diversity and abundance.

2.2.3 Water Quality

Water quality within Wollondilly River and Mulwaree Ponds has been monitored by GCC since 1993. The monitoring results indicate that water quality ranges from poor to satisfactory, with samples often not satisfying the ANZECC Guidelines for Water Quality Criteria, particularly within Mulwaree Ponds.

The roots of vegetation act to hold soils together and stabilise river banks. Therefore, their removal promotes erosion and sedimentation of the waterways. Removal of native vegetation is a contributing factor to the poor water quality in the two rivers.

3 DESCRIPTION OF THE EXISTING ECOLOGICAL ENVIRONMENT

3.1 FLORA

3.1.1 Riparian Vegetation

The existing vegetation of the riparian zone is dominated by exotic species, primarily willows and occasional isolated groups of poplars and pines. Remnant stands of eucalypts are associated with rugged slopes adjoining the waterway especially along sections of the northern Wollondilly River. The riverine floodplains are mostly devoid of any significant stands of native vegetation away from the river channel.

Land Systems (1998) has classified the riparian vegetation into four vegetation associations as follows:

> **Riverine timbered areas:** predominantly willow trees and hawthorn, with occasional poplar trees and blackberry.
>
> **Introduced grassland areas:** containing some scattered exotic trees, pasture grasses and common weeds.
>
> **Native woodlands:** mainly along the hill ridges and occasional small remnants near the watercourses, especially adjacent to the north city reaches of the Wollondilly River such as Blakely's Gum/Yellow Box association, plus Broad-leaved Peppermint, Ribbon Gum and Scribbly Gum responding to local soil conditions.
>
> **Wetland areas:** indigenous water-based species (such as native Cumbungi, Common Reed and Water Ribbons) are associated with restricted localities along the Mulwaree River.

More recently Lewis (2001) identified two distinct sections[3] that occur within the riparian zone of the Wollondilly River. The sections relevant to this VES are: The Floodplain; and Floodplain and Hills. Details of these sections are summarised below.

> **Floodplain:** area of open floodplain surrounded by rolling hills, used for grazing, irrigated pastures and horticultural production. This section encompasses the township of Goulburn. Floodplain areas are dominated by pasture species such as Phalaris, with little tree cover on surrounding hills. Riparian vegetation is dominated by Willows (Crack and Weeping) and pasture grasses, with occasional remnant Eucalypt, mainly *E. viminalis and E. pauciflora*, and *Callistemon seberi* (River Bottle Brush). Native vegetation increases slightly as the river moves through town, but is still dominated by introduced species. Native instream vegetation through this section is more diverse and

[3] The river was dissected into sections of similar characteristics, based on vegetation composition, landform, riparian issues and river characteristics.

abundant, including species Water Milfoil, *Phragmites australis* (Common Reed), Paspalum (water couch), *Persicaria* (Slender Knotweed), and Azolla. It is considered by the guidelines (Lewis, 2001) that this section overall has poor habitat and native vegetation rating.

Floodplains and Hills: area including rolling to steep hills, which are well vegetated in some areas, with most floodplain areas used for grazing. Riparian vegetation is less dominated by exotic species, with more riparian vegetation found than in the Floodplain section. Remnant riparian vegetation consists mainly of River Bottlebrush, Common Reed, Cumbungi, various sedges and rushes, *Lomandra sp.*, and Eucalypts at the upper edge of this section, to *Casuarina cunninghamiana* (River she-oak), where the river moves towards the Gorge section boundary. It is considered by the guidelines (Lewis, 2001) that this section has moderate to good habitat and native vegetation rating.

3.1.2 Flora of Conservation Significance

A search of the NPWS Wildlife Atlas (licensed version) revealed that no threatened flora species are known to occur within the Goulburn LGA. However, some threatened flora species listed under the *Threatened Species Conservation Act 1995,* are known to occur within the greater Goulburn region as listed in Table 3.1.

Table 3.1 Threatened Flora Occurring in the Greater Goulburn Area

Species	Status
Diuris aequalis	Vulnerable
~~*Diuris aequalis*~~	~~Vulnerable~~
Diuris tricolor	Vulnerable

Vulnerable: the species is likely to become endangered if threats continue
Source: NSW NPWS Wildlife Atlas – Public Access version)

The riparian vegetation is considered to have moderate conservation significance, as it fulfils a number of important ecological functions, including:

- acting as a buffer zone between areas of urban and agricultural activity and the watercourses. This assists in maintaining water quality through filtering run-off from disturbed slopes in the watercourses;
- minimising river bank erosion because trees and shrubs protect the banks with their roots and reduce stream velocity; and
- providing habitat and movement/dispersal corridors for aquatic and terrestrial fauna and flora.

3.1.3 Noxious Weeds

Weeds are a major disturbance to the ecological environment. Weeds can rapidly colonise a site and have the ability to out-compete native flora species leading to changes in floristic and community structure. Consequently, habitat for fauna species is modified and often reduced.

Flooding of the study area promotes weed invasion by encouraging dispersal and colonisation. Due to the flood prone nature of the study area, the control of weeds (especially those listed as noxious – Table 3.2) should implemented on an ongoing basis.

Thirty-two noxious weed species (listed in Table 3.2) have been gazetted as occurring either within the Goulburn LGA or its vicinity.

Table 3.2 Noxious Weeds gazetted in the Goulburn LGA

Scientific Name	Common Name	Control Category
Alternanthera philoxeroides	Alligator Weed	W1
Cannabis sativa	Indian Hemp	W1
Carduus nutans	Nodding Thistle	W2
Cassinia nutans	Sifton Bush	W3
Cestrum parqui	Green Cestrum	W2
Conium maculatum	Hemlock	W2
Cortaderia spp	Pampas Grass	W2
Cuscuta spp.	Dodder	W2
Cystisus scoparius	Scotch/English broom	W2
Echium spp.	Paterson's Curse	W2
Eichhornia crassipes	Water Hyacinth	W1
Eqisetum arvense	Horsetail	W1
Eragrostis curvula	African Love Grass	W3
Erythroxylum coca	Coca Leaf	W1
Gymnocoronis spilanthoides	Senegal Tea Plant	W1
Hypericum peroratum	St. John's Wort	W2
Kochia scorparia	Kochia	W1
Lagarosiphon major	Lagarosiphon	W1
Lycium ferocissium	African Boxthorn	W2
Marrubiium Vulgare	Horehound	W3
Nasella trichotma	Serrated Tussock	W2
Onopordum spp	Scotch/Illyrian/Stemless Thistles	W2
Papaver somniferum	Opium Poppy	W2
Parthenium hysterophorus	Parthenium weed	W1
Pistia stratoites	Water Lettuce	W1
Rosa rubinosa	Sweet Briar	W2
Rubus fruticosis	Blackberry	W2
Salvinia molesta	Salvinia	W1
Sencio madagascariensis	Fireweed	W2
Toxicodendron succedaneum	Rhus Tree	W2
Ulex europaeus	Gorse	W2
Xanthium spp.	Cockle Burrs	W2

W1 Presence must be notified to the local control authority and they must be "fully and continuously suppressed and destroyed".
W2 Must be fully and continuously suppressed and destroyed".
W3 Must be prevented from spreading and their numbers and distribution reduced.

Source: Goulburn City Council (1996).

3.2 TERRESTRIAL FAUNA

The Goulburn district supports at least 22 native mammals and 179 bird species. Considering the limited number of habitats within the region and their relatively disturbed state, this number of species is relatively high.

3.2.1 Terrestrial Fauna of Conservation Significance

A search of the NPWS Wildlife Atlas (licensed version) revealed that no threatened fauna species are known to occur in the Goulburn LGA. Threatened flora species listed under the *Threatened Species Conservation Act 1995,* which are known to occur within the greater Goulburn region, are listed in Table 3.3.

Table 3.3 Threatened Fauna Occurring in the Greater Goulburn Area

Species	Status
Striped Legless Lizard (*Delma impar*)	Vulnerable
Blue-billed Duck (*Oxyura australis)*	Vulnerable
Australasian Bittern (*Botaurus poiciloptilus)*	Vulnerable
Regent Honeyeater (*Xanthomyza phrygia)*	Endangered
Spotted-tailed Quoll (*Dasyurus maculates)*	Vulnerable
Koala (*Phascolarctos cinereus)*	Vulnerable
Yellow-bellied Glider (*Petaurus australis)*	Vulnerable

Vulnerable the species is likely to become endangered if threats continue
Endangered the species is likely to become extinct if threats continue, its numbers are reduced to a critical level, or its habitat reduced.
Source: NSW NPWS Wildlife Atlas – Public Access version)

3.2.2 Terrestrial Fauna Habitat and Quality

The corridor of riparian vegetation provides an important habitat for local fauna species. It allows for the movement and dispersal of fauna and acts as a refuge for many species that may feed in the cleared areas but require riparian vegetation for protection and breeding purposes.

Most of the original riparian vegetation adjacent to the Wollondilly River and Mulwaree Ponds has been cleared and replaced by exotic species.

3.3 AQUATIC FAUNA

3.3.1 Aquatic Fauna of Conservation Significance

Macquarie Perch is listed as Vulnerable under Schedule 5 of the *Fisheries Management Act 1994*. This species has been recorded from south-eastern Australia, at moderate to high altitudes in rivers and reservoirs, and was once abundant in the upper sections of the Lachlan River (Fisheries Scientific Committee 2000). Macquarie Perch *(Macquaria australasica)* has been recorded in the Wollondilly River (J. Pursey NSW Fisheries, 11/9/01 *pers. comm.*).

3.3.2 Aquatic Habitat and Quality

Riparian vegetation provides important habitat for aquatic fauna as it offers shade and protection, an insect source, and fallen branches for snags (snags offer egg-laying sites).

The flow of water within the Wollondilly River and the Mulwaree Ponds is moderately impeded from siltation and growth of exotic plant species. Sediment and some nutrients (particularly phosphorous) are carried to the rivers in overland flow. Clearing, soil disturbance, agricultural activities and urban development promote substantial increases in erosion, sedimentation and the concentration of nutrients in the waterways. This can have negative impacts on aquatic fauna, especially fish species, as it alters in-stream habitat through reducing the depth of the water, increasing turbidity, congesting the flow and pollution.

3.4 LIKELY ORIGINAL VEGETATION AND HABITAT OF THE STUDY AREA

Given the highly modified state of the riparian zone (and surrounding land) of the Wollondilly River and Mulwaree Ponds, it is difficult to provide an accurate description of the former native vegetation and associated habitat. Nevertheless, it is important to understand the pre-European environment, as this represents a valuable source of information for the VES.

The former state of the riparian zone can act as a guide for future vegetation management, however restoring the region to its pre-European condition is not feasible, given the high level of disturbance, ongoing pressures from urban and agricultural development, and the high cost of restoring such a large area.

Records of remnant vegetation within the LGA, historic pictorial evidence, and vegetation studies of relatively undisturbed sections of the Wollondilly River, indicate it is likely that the pre-European riparian zone vegetation and habitat consisted of the following:

- Large pools lined with Cumbungi (*Typha orientalis*), Common Reeds (*Phragmites australis*) and a variety of other emergent graminoids, with these plants especially abundant on the downstream end in the form of a thick crescent.
- Narrow rocky faces and riffles lined with thickets of River Bottlebrush (*Callistemon sieberi*). Constrictions in the downstream portions may have been lined with herbaceous emergents such as Tall Spikerush (*Eleochais sphacelata*) and other locally indigenous rushes, sedges and reeds.

- Frost hollows in the river may have been lined with emergent aquatics such as *Cyperus spp., Eleocaharis spp.*, Common Reed and Cumbungi. The surrounding banks may have been lined with River Tussock (*Poa labillardieri*) on shallow slopes. Trees may have been absent over significant stretches of the river, especially in the low-lying plains.
- Shallow banks in less frosty areas could have been dominated by surrounding terrestrial vegetation, most commonly that of Box Woodland containing Yellow Box (*Eucalyptus melliodora*), Cabbage Gum (*E. amplifolia*), Apple Box (*E.* bridgesiana) and a variety of grasses and forbs with sparse shrub element.
- Steeper banks would probably have been lined with tall open forest dominated by Ribbon Gum (*E. viminalis*), Candlebark (*E.* rubida) and Cabbage Gum, with a tall understorey of Blackwood (*Acacia melanoxylon*), Black Wattle (*A. decurrens)*, Parramatta Wattle (*A. parramattensis*) and Silver Banksia (*Banksia marginata*). Medium shrubs, such as Yellow Tea-tree (*Leptospermum polygalifolium*) could have occurred either sparsely or as patchy thickets. Sub-shrubs may have been common but the most frequent element of this stratum would have been the Spiny Matrush (*Lomandra longifolia*).
- Perched banks could have been occupied either by the above mentioned tall open forest or by Snow Gum Woodland dominated by either Snow Gum (*E.* pauciflora) or Black Sallee (*E. stellulata*), with an understorey of mixed grasses including Kangaroo Grass (*Themeda triandra*), *Poa sieberana* and *P. labillardieri*, as well as a variety of dwarf shrubs including Epacrids and Guinea flowers.
- A variety of instream plant communities may have been common, including floating, emergent and sub-emergent forbs, many of which are aesthetically appealing and function as useful indicators of water quality and flow character.

If it is required to determine the original vegetation of the riparian zone and surrounding land, further studies would need to be undertaken. Such studies could include pollen analysis through core sampling of soils within the riparian zone and simple soil sampling trays in order to propagate what may be remaining in the soil.

4 MANAGEMENT STRATEGIES

4.1 MANAGEMENT STRATEGY PRINCIPLES

The main purpose of this VES is to present Council with a range of management strategies that could be implemented within the riparian zone of the Wollondilly River and Mulwaree Ponds. The aims of the suggested strategies are to:

- ***increase the hydraulic capacity of the rivers***; and
- ***enhance the ecological value and aesthetic appeal of the area.***

This chapter details a range of possible management strategies. The title of each strategy is provided in Table 4.1.

Table 4.1: Possible Management Strategies

Section Number (in this document)	Strategy Name
4.2	Removal of Exotic Species
4.3	Protection and Enhancement of Existing Native Vegetation
4.4	Revegetation
4.5	Fencing and Alternative Stock Watering
4.6	Habitat Creation and Management
4.7	Maintenance and Monitoring
4.8	Community Awareness

The management strategies presented in this chapter have been developed based on the following principles (Rutherfurd et al, 2000):

- activities offering value in terms of money and effort should be considered a priority;
- preservation of areas that remain in good condition should be prioritised over rehabilitation of areas that are already damaged;
- activities that stop river deterioration should be considered more important than activities that try to fix existing or future problems;
- critical problems should be treated prior to improving other areas; and
- priorities should be set within a regional framework.

4.2 REMOVAL OF EXOTIC SPECIES

Issue to be managed

Exotic species have been introduced and have flourished along the riparian zone. They are becoming dominant, replacing native species and are 'choking' the river channels and floodplains. Their presence has the potential to significantly elevate flood levels and increase periods of inundation.

Willows are the main problem species within the study area. They were traditionally used to stabilise the river banks and streams of the Goulburn Floodplain area. Willows have few insects pests or diseases in south-eastern Australia, and the decline in indigenous vegetation from grazing, clearing and erosion means there has been little competition. Willow species have therefore proliferated.

The abundance of willows and other exotic weeds has resulted in the following environmental issues:

- changes in watercourse behaviour;
- reduction in diversity of indigenous plants and animals; and
- displacement of indigenous plants.

Strategy

General Principles
Exotic species removal requires ongoing commitment and should be achieved through a repetitive three stage process:

- primary weeding;
- secondary treatment; and
- maintenance weeding.

If a site is too large or resources are too small to allow comprehensive weeding of an area, then particular dominant exotic species and weeds should be targeted.

A mosaic pattern of weeding should be used where no more than one third of the total area at any one time is cleared to minimise predation on moving wildlife. Weeding work should be completed outside peak fauna breeding times.

The strong root system of willows and other exotic species act to stabilise river banks, minimising erosion. Exotic species removal must occur in conjunction with plans of regeneration/revegetation of native species to ensure erosion within the riparian zone does not occur.

The following guidelines should be adopted when organising permission for removal/clearing of willows and other exotic plant species:

> *Exotic Plant Species Clearing Guidelines For Applicants: Best Management Principles for Exotic Plant Species clearing on Riparian State Protected Land[4] Under the Native Vegetation Conservation Act 1997.*

Removing Willows
There are three methods of willow removal, as explained in Table 4.2.

Table 4.2: Methods of Willow Removal

Method of removal	Details
Chemical Control	• foliar spraying • stem injection • cut stump and paint
Mechanical Control	• hand pulling • use of heavy machinery • felling
Organic Method	• cut down the tree leaving a stump approximately 1m high, to which vertical axe strokes are applied on several occasions

Effective management of willows requires regular maintenance of existing stands and removal of those trees that threaten stream stability, spread abundantly or do not control erosion.

The method(s) used to remove willows and other problematic introduced species will largely be determined by funding that is available.

The areas and the extent of degradation of the river channel and floodplain by willows and other exotic species was determined through data collected during site inspections, supplemented by aerial photography. This information was used assess the impacts on the flood regime within Goulburn, through estimates of 'n' values that reflected the willow growth within the various reaches of the river channels and floodplains and the impacts of the willows tested during hydraulic modelling completed as part of the FRMP. The areas that were identified as the worst affected were:

<u>*Mulwaree Ponds*</u>
- In the vicinity of the Landsdowne Bridge, both upstream and downstream; and
- Downstream of the Rail Bridge.

<u>*Wollondilly River*</u>
- Upstream of the Marsden Bridge; and
- From downstream of the Victoria Bridge by a couple hundred metres, to the confluence with the Mulwaree Ponds.

[4] Riparian State Protected Land is land that is situated within 40 metres of the bed or bank of any part of a prescribed stream or lake, including major watercourses. Both the Wollondilly River and Mulwaree Ponds are prescribed streams. The local Department of Land and Water Conservation (DLWC) office (contact Kathy Crawford 02 4828 6720) can help organise for permission to remove the weeds.

The **worst affected reach** noted was that from a couple hundred metres downstream of the Victoria Bridge, to several hundred metres downstream of the Taralga Bridge and Tully Park Golf Course (beside the treatment pond).

To assess which areas would produce the most benefit from the removal of willows, thus allowing priority for works to be determined, hydraulic analysis was undertaken. The above areas were defined as five different sections and changes were made in hydraulic roughness to reflect the presence or removal of the willows. These changes were modelled using the 1% AEP flood event in HEC-RAS, the software package used to model the hydraulic characteristics of flood events in the FRMS.

The sections were defined as:

- Section One: In the vicinity of the Landsdowne Bridge, both upstream and downstream;
- Section Two: Downstream of the Rail Bridge;
- Section Three: Upstream of the Marsden Bridge;
- Section Four: A couple hundred metres downstream of the Victoria Bridge, to several hundred metres downstream of the Taralga Bridge; and
- Section Five: From Section 4 to the confluence with the Mulwaree Ponds.

In the modelling, Case 1 was the benchmark, then Cases 2 to 5 considered each section separately, with changes being made to the values of hydraulic roughness, modelled and results compared to Case 1 to determine the effectiveness of willow removal. In Case 1, changes in flood levels are considered with respect to the total depth of flooding, and in Cases 2 to 5, changes in the rivers resulting from willow removal are considered against the increase in flooding recorded in Case 1.

The results of this analysis and the priorities set are presented in Table 4.3. Priorities are from 1 to 5, with 1 having the highest works priority.

Table 4.3: Results of Hydraulic Assessment of Willow Removal

Case #	Changes to Manning's 'n'	Average Change in Wollondilly	Average Change in Mulwaree Ponds	Work Priority
1	Increased in all sections to account for willow growth	+ 4% increase (in overall depth)	+ 8% increase (in overall depth)	N/a
2	Decreased within Section 1	0 %	- 0.1 %	5
3	Decreased within Section 2	0 %	-8 %	4
4	Decreased within Section 3	- 11 %	0 %	3
5	Decreased within Section 4	- 34 %	0 %	2
6	Decreased within Section 5	-58 %	-92 %	1

These results mean that with planned willow removal and vegetation enhancement in Section 5 on the Wollondilly River, there will be a significant reduction in flood levels throughout the entire system. This clearly indicates the priority order for implementing works will be from Section 5 through to Section 1, in that order.

As funds become available (refer Section 5 for sources of funding), the areas identified as the highest priority should be treated first. As further funding becomes available, sections of lesser priority, followed by areas other areas affected but not included in the above analysis should be treated. It should be noted however, that without a comprehensive removal program weed regrowth is more likely to occur. Ongoing monitoring and maintenance must also be incorporated to ensure the long-term viability of the strategy. This is discussed in Section 4.7 of this document.

Incorporating Off-Site Weed Control and Catchment Management Strategies
Sources of the problem weed species within the catchment should be considered. For example, weed management goals in the study area may be hindered by a lack of weed control in the LGA or the upstream catchment. Council should liase with relevant stakeholders to coordinate management plans and works. Integrating other ecological strategies established for the LGA is also beneficial as it could allow for the utilisation of available funding whilst providing a greater benefit to the environment.

Priority

The FRMP identified willow removal as a major solution to the flooding problems experienced in Goulbourn. This should therefore be implemented as a priority.

Benefits

- Increased hydraulic capacity
- Improved species variety

Sources of Additional Information

Relevant DLWC publications include guides complied by the Albury/Wodonga Willow Management Working Group (listed below), and are available on the DLWC website.

- Willow identification guide (Guide 1).
- Willows along watercourses: an introduction (Guide 2).
- Willows along watercourses: their impact compared to natives (Guide 3)
- Willows along watercourses: managing, removing and replacing (Guide 5)

Other information includes:

- DLWC. VegNotes. (Series 2) Managing Native Vegetation (2.3) Environmental Weeds. Available on the DLWC website.

- McNamara, P. Greening Australia – Technical Advice – Weeding Right. *The problems with traditional weeding techniques.* Available on the Greening Australia Website.

- Bradley, J. (1988) *Bringing back the bush: The Bradley method of bush regeneration.* Lansdowne Publishing Pty. Ltd. The Rocks, NSW.

- Buchanan, R. A. (1989) *Bush Regeneration: Recovering Australia Landscapes.* TAFE Student Learning Publications, NSW.

- Lewis, B (2001). *Riparian Management Guidelines for the Wollondilly and Wingecarribee Rivers. Draft Guidelines.* Wollondilly Catchment Committee.

4.3 PROTECTION AND ENHANCEMENT OF EXISTING NATIVE VEGETATION

Issue to be managed

Lack of remnant native vegetation.

Strategy

This strategy consists of three basic principles:

Retain Native Vegetation
Where possible existing areas of native vegetation, especially remnants should be retained. Retention of vegetation can be enforced by incorporating suitable provisions into Development Control Plans (DCPs) or other regulatory conditions as determined by GCC.

Retention of vegetation can be encouraged by increasing the community's awareness of how important native vegetation is and the benefits to be gained from its retention.

Protect Native Vegetation
Once the decision to retain native vegetation has been made, protection measures should be implemented to prevent further degradation. Possible options include:

- fencing off areas of native vegetation. This may not always be possible. In some cases, fencing may not be desirable, as it would restrict the community's enjoyment of the resource;
- provision of buffer zones or barriers. For example, GCC places log barriers in recreation areas, preventing vehicles being driven in and around native vegetation. The type of protection for implementation will largely be determined by the land use type.

Manage Native Vegetation.
Native vegetation should be actively managed to improve its condition (enhancement). Native vegetation should be encouraged to naturally regenerate, encouraging natural diversity, which will increase the long term viability of the vegetation. Natural regeneration is a cheaper and easier way to restore a landscape compared to active revegetation (i.e. tree planting). Furthermore the vegetation community will comprise of original, locally native species.

Priority

Vegetation retention is a cost effective management approach and can be implemented without delay.

Benefits

- Provision of shade and shelter
- Protection against land degradation by minimising soil and wind erosion
- Increased habitat diversity
- Improved aesthetic value
- Protection and enhancement of local genetic stock and diversity
- Cheaper than revegetation options

Sources of Additional Information

DLWC. VegNotes. (Series 2) Managing Native Vegetation (2.2) Three steps to better management. Available from the DLWC website. These notes are also available through DLWC offices.

DLWC. VegNotes. (Series 2) Managing Native Vegetation (2.3) Improving the condition of native vegetation.

4.4 REVEGETATION

Issue to be managed

Lack of biodiversity and aesthetic appeal of the riparian zone.

Strategy

There are several important factors to consider when implementing revegetation works:

- the need for revegetation as opposed to regeneration. If regeneration is feasible, it should be applied in preference to revegetation;
- site preparation works;
- species selection appropriate to site;
- genetic integrity[5];
- choose correct time to plant;
- choose most suitable planting method; and
- structural diversity and planting density.

This VES does not provide site specific revegetation plans for the study area, but discusses details that need to be considered when organising for revegetation works. Guidelines for the development of revegetation management plans are provided in Appendix A and should be used when site specific plans are being produced.

[5] Genetic Integrity of a plant species refers to the extent of genetic variation across its natural range of occurrence.

Site Preparation
The following issues must be considered when preparing the site for revegetation:

- protection of plants to be retained;
- installation of sediment and erosion control devices;
- completion of any site works (if any);
- weed control (techniques and sequences of removal);
- application of herbicides;
- topsoil/litter layer storage;
- soil remediation;
- surface preparation (levelling, deep ripping, scarifying, mulching etc.);
- surface stabilisation - (needs to be suitable for the site/vegetation - erosion matting, mulch, brushmatting, sterile cover crops, binding sprays, etc.); and
- site drainage.

Planting Program and Method
The following issues should be considered when developing the planting program and method:

- how the revegetation will be done;
- staging of works; and
- need for weed mats, mulch, stakes & ties, tree guards and the use of fertilizer types (justify their need), water-retaining crystals, etc.

Species Typing
Species used for revegetation should be those that are known to be native from the site or have been identified as once occurring naturally to the area. Native species diversity is particularly important in terms of resilience to weed infestation and overall survival rate because local native plant species are more likely to be genetically adapted (better suited) to the growing conditions of the area. By revegetating with native species important habitat will be provided for native flora and fauna. Revegetation using native species helps maintain and increase local genetic stocks.

Lewis, B (2001) identified four distinct zones along most watercourses that have different microclimates. These zones should be identified within the site, so the placement of species can be determined. The four zones are:

1. instream and along the waters edge;
2. waters edge;
3. temporarily inundated, moist but not wet; and
4. dry areas beyond high bank.

Appendix B provides a species list according to each zone type.

Vegetation Density and Patterning
Determining the appropriate density at which to plant trees and shrubs requires careful consideration in terms of ecological and hydraulic/flood control requirements. The density of existing vegetation within some sections of the waterway needs to be reduced (as indicated by the floodplain modelling completed as part of the FRMP). When areas are cleared of exotic species, the site needs to be stabilised. This should be achieved by using native species. In

some sections natural regeneration of species will be encouraged, however some sections will require revegetation (planting).

Additional studies need to be undertaken so site specific treatments can be determined such as minimum spacing of vegetation for each site. The spatial information for tree and shrub plantings is based on the mature stage of the tree and shrub components e.g. spacing of 15 metres represents the recommended spacing of mature trees. During the early revegetation stage of the works, planting densities can be at least two times the recommended density to allow for thinning as the plantings mature.

Ian Perkins Consulting Services (1996) identified a number of general rules to be applied to revegetation after flood mitigation works:

- *When revegetating a site following flood mitigation works (eg removal of willows), under-plant rather than over-plant.*
  Areas with higher flood prone ratings should be initially planted at lower densities. Density recommendations based upon flood modelling for each section should be developed. This will reduce competition between individuals and species.

  If the site suffers high losses, additional trees and shrubs should be planted to replace these losses. This staggering of plantings encourages important structural differences in vegetation to develop as a result of age variation. This approach is recommended especially in areas where the high flood prone ratings are due to adverse effects existing vegetation has on floodplain hydraulics.

  High flood prone area planting densities should remain low initially and increase over time if required. However, planting densities should always be sufficient to mitigate any adverse impacts upon the site e.g. erosion control.

- *Trees that seem reasonably spaced when initially planted may require removal/culling over time to reduce density to a level acceptable for flood purposes.*

- *Ongoing assessment of vegetation of the waterway should be conducted to ensure vegetation density and structure is not significantly beyond the recommended range used in hydraulic modelling.*

Stabilising banks of watercourses to minimise soil erosion and degradation
Erosion control measures may be required where there is extensive weed removal and potential soil erosion problems. Although a number of control measures are available, their use in the study area may conflict with the restoration of the vegetation. Depending on the site, appropriate measures may include the use of annual pasture grasses that quickly stabilise a site until the native vegetation begins to establish. Brush mulches are another alternative that act in a similar way and can also promote the regeneration of native plants by providing an additional seed source.

Priority

Revegetation should occur where regeneration is not feasible. A possible timetable for revegetation is provided in Table 4.4.

Table 4.4: Timetable of Tasks for a Revegetation Strategy

	TASK	TIMEFRAME	COMMENTS
1.	Determine appropriate species to be used in revegetation plan (species typing)	Complete prior to sourcing seed stock	
2.	Source seed stock	Completed prior to ground disturbance	Has been started already. Consider sites of proposed works in relation to species typing. Refer to procedures in Appendix C.
3.	Start propagation of native species	Completed prior to ground disturbance	Should be started at least 4 months prior to revegetation. Consider sites of proposed works in relation to species typing and pattering.
4.	Remove exotic species	Outside peak fauna breeding time	
5.	Prepare site for rehabilitation	First step after weed removal	
6.	Revegetate site	After exotic species removal	
7.	Conduct ongoing maintenance	Should be initiated during Task 6.	DLWC requires a minimum of **two** years maintenance after last plantings completed See section 4.7
8.	Conduct ongoing monitoring	Should be initiated prior to weeding, at site and landscape level	Monitoring should be conducted regularly and certainly during major changes. See section 4.7

Benefits

- Soil erosion protection

Sources of Additional Information

Additional information regarding species typing:

- Moran, K. & Falconer, R. (n/d). *Wollondilly River and Mulwaree Ponds Management Study and Plan.* Goulburn Field Naturalists Society's Submission to the Goulburn City Council's Environment Committee (Appendix 1).
- Lewis, B. (2001) *Riparian Management Guidelines for the Wollondilly and Wingecarribee Rivers. Draft Guidelines.* Wollondilly Catchment Committee (Appendix 1).
- Goulburn City Council (2000) *Wollondilly River Rehabilitation Plan* (Figure 2).

Additional information regarding vegetation density and patterning:

- Lewis, B (2001) *Riparian Management Guidelines for the Wollondilly and Wingecarribee Rivers. Draft Guidelines.* Wollondilly Catchment Committee.
- *Watercourse revegetation using indigenous plants (Guide 4).* Albury/Wodonga Willow Management Working Group. Available on the DLWC website.
- Ian Perkins Consultancy Services (1996) *Stonequarry Creek Vegetation Management Plan (Final)* Prepared for Wollondilly Shire Council.
- Rutherfurdet al. (2000). *A Rehabilitation Manual for Australian Streams Volume 1 and 2'.* Cooperative Research Center for Catchment Hydrology Land and Water Resources Research and Development Corporation.

4.5 FENCING AND ALTERNATIVE STOCK WATERING

Issue to be managed

Vegetation destruction and soil erosion generated by stock grazing and drinking within the riparian zone.

Strategy

Fencing the riparian zone is an important aspect of site maintenance and overall management of the river system. This is a particularly important in areas where stock graze within the riparian zone.

If the river is fenced off alternative watering points must be provided. Options include the use of farm dams, troughs or strategic stock watering points on the river. Landholders/graziers need to know which alternative watering option is best for them, based on cost, water supply volume and physical requirements. Rutherfurd et al. (2000) provides details of alternative offstream water options and costs.

Fencing off stock from the rivers does not necessarily mean the graziers/landholders must give up the land. They can retain the use of the riparian area for selective grazing. Selective grazing is an important form of weed control in the riparian zone. Once natural regrowth has occurred or revegetation is well established and protected, the fenced area can be crash grazed.

Priority

Restricted access to the riparian zone may be opposed by the graziers/landholders who currently graze the area. Relevant stakeholders should be consulted to verify the feasibility of this option.

A selection of highly stressed areas, in need of management, should be identified and fenced off, as a priority.

Benefits

Benefits to be obtained by fencing stock from the river include:

- reduced bank erosion and gullying;
- improved water quality;
- improved biological pest control;
- fewer cross-river fences; and
- better land stewardship.

Sources of Additional Information

Fence design, construction and implementation in flood prone areas, and alternative watering points for stock are described in detail in Section 5 of Lewis (2001). Volume 2 of Rutherfurd et al. (2000) provides fencing options and costs.

- Moran, K. & Falconer, R. (n/d). *Wollondilly River and Mulwaree Ponds Management Study and Plan*. Goulburn Field Naturalists Society's Submission to the Goulburn City Council's Environment Committee.
- Lewis, B. (2001). *Riparian Management Guidelines for the Wollondilly and Wingecarribee Rivers. Draft Guidelines.* Wollondilly Catchment Committee.
- Goulburn City Council (2000) *Wollondilly River Rehabilitation Plan.*
- Rutherfurd et al. (2000). *A Rehabilitation Manual for Australian Streams Volume 1 and 2'*. Cooperative Research Center for Catchment Hydrology Land and Water Resources Research and Development Corporation.

4.6 HABITAT CREATION AND MANAGEMENT

Issue to be managed

The riparian zone consists of small, isolated remnant native plants and extensive areas of exotic plants. The range of habitat types is therefore limited. If the riparian zone were rehabilitated to be a continuous vegetation corridor, it would link with more extensive vegetation located to the north and south of the study area.

Strategy

The rehabilitation of the riparian zone should be carefully planned to maximise its value as a fauna habitat by considering the following:

- regenerating cleared and partially cleared areas to form a continuous area of vegetation;
- encouraging plant species that provide important habitat for native fauna such as nectar producing species for food resources and thorny shrubs for protection from predators;
- linking significant areas of vegetation located on the higher slopes with the riparian corridors; and
- promoting the importance of the corridors to the local community so that private landholders can implement regeneration on their properties.

Assess Existing Habitat Value
The value of the existing habitat should be assessed before future management and use of the riparian zone is decided. It is important that habitat requirements for flora and fauna identified during the assessment are included in the initial planning stages of rehabilitation works and that habitats lost as a result of vegetation removal is adequately compensated for during rehabilitation. Rehabilitation will have the greatest benefit for wildlife when it is planned and undertaken in a way that meets the requirements of animal species.

Identify Habitat Requirements of Native Species
In order to identify these requirements a study should be undertaken to identify species that are typically found within the riparian zone on a permanent basis. Habitat should include both terrestrial and aquatic requirements and account for all forms of fauna.

A good vegetation structure with array of age classes, heights, a dense understorey and diverse range of species will provide the necessary components for good quality habitat for native species.

Habitat Enhancement at Different Levels of Land Management
Different kinds of actions need to be undertaken at different levels of land management. The following model has been adopted from Bennett et al. (2000). The model shows the different levels of land management and includes important components that should be carried out at each level.

Site Level

- revegetation/regeneration of the site
- consideration of vegetation structure and composition
- consideration of ground layer structure
- manage disturbances e.g. exotic species and weeds, erosion, cattle

Block/Patch of Habitat Level (Stretch of River)

- vegetation of a site forms a block/patch of habitat
- size shape, location and diversity of vegetation are features that influence the blocks habitat value
- land management at site and block/patch levels usually relates to single property

Landscape Level

- includes an area from several to tens of kilometres and includes numerous block/patches
- appropriate level at which planning for revegetation activities is usually undertaken as part of a management plan or sub-catchment plan
- important issues are addressed including the total amount of existing natural and revegetated habitat, planned revegetation works, spatial patterning and connectivity of habitats, and the representation of different vegetation types
- focus is on understanding interactions between multiple blocks/patches of habitat

Region Level (or Catchment)

- spans an area of tens to hundreds of kilometres and is the level at which strategic planning for the use of revegetation for nature conservation is most effectively undertaken
- coordination is needed by state and local government organizations, and community groups

Priority

Habitat creation and management can be incorporated into any of the other management strategies and would greatly increase the benefits of the strategies.

Benefits

- Increase in the range of habitat types
- Enhancement of existing habitats

Sources of Additional Information

- Lewis, B (2001) *Riparian Management Guidelines for the Wollondilly and Wingecarribee Rivers. Draft Guidelines.* Wollondilly Catchment Committee.
- Goulburn City Council (2000) *Wollondilly River Rehabilitation Plan.*
- Rutherfurdet al. (2000). *A Rehabilitation Manual for Australian Streams Volume 1 and 2.* Cooperative Research Center for Catchment Hydrology Land and Water Resources Research and Development Corporation.
- Bennett, A.F, Kimber, S. & Ryan, P. (2000). *Revegetation and Wildlife – A guide to enhancing revegetated habitats for wildlife conservation in rural environments.* Bushcare and National Research and Development Program Research Report 2/00.

4.7 MAINTENANCE AND MONITORING

Issue to be managed

Ensure the long term viability of the VES.

Strategy

Maintenance
Following any rehabilitation works **ongoing maintenance must be performed** to ensure the initial efforts are not wasted.

The area to be treated at any one time should be restricted to the extent that it can be both physically and financially maintained. Without appropriate ongoing support (physical and financial) a site may become degraded and revegetation lost. It is important that financial support is secured beyond the initial site stabilisation stage.

Ongoing maintenance works should include not just areas of new revegetation but also the protection of areas of existing revegetation and remnant vegetation. Ongoing maintenance of these areas will involve many activities including weeding, replacement planting, mulching, re-staking and monitoring.

An ongoing maintenance program should be developed for the VMPs. The maintenance program should include short, medium and long term goals starting from the initial site stabilisation process. It should comprise a checklist of maintenance procedures that need to be performed at specific times and places with an emphasis on weed control, including removal of willows. The monitoring of vegetation density and required management outcomes are also essential components of such a program.

The works program could be incorporated into a maintenance program currently being implemented by the GCC through the Parks division. Willow seedlings could be routinely removed as part of the GCC weed control program.

Monitoring

Monitoring enables the success of a rehabilitation project to be assessed. It is a relatively inexpensive form of gauging how successful the strategy is and provides a platform for changes in the future. The data gathered can be used to compare the success of various sites and various forms of management applied. Successful management methods can then be applied at other sites. Monitoring can encourage community participation and increase community awareness.

The main aspects to monitor are:

- density of seedlings;
- height of seedlings;
- health of trees and shrubs; and
- flowering and fruit of trees.

These measurements should also be combined with regular surveys of plant species composition and other aspects of structural diversity, including:

- rate of growth or regeneration of different plant types;
- presence of native species;
- invasion of exotic flora and introduced fauna;
- presence of native fauna; and
- build up of leaf litter and other changes to structural diversity.

Other forms of monitoring could include:

- biodiversity surveys – birds and aquatic fauna are useful indicators of biodiversity;
- water quality surveys – to compare water quality before and after;
- soil quality surveys – soil integrity and value
- fuel load surveys – in order to monitor fire hazards; and
- social study surveys – to gauge the community's opinion of the VES.

The information collected from monitoring can be used to guide future management of the site. The ongoing management of a particular site should be set in response to the changes at the site obtained by monitoring.

Monitoring should be conducted using a site assessment sheet to ensure the same set of measurements and conditions are monitored each time. Permanent photographic points could be established to gauge changes in vegetation over time and in response to management.

Community involvement in the long term collection of data during monitoring could play an important role in this process.

Priority

Monitoring should commence as soon as a particular site has been stabilised. From this point on it should occur on a regular basis i.e. bi-monthly or seasonally and certainly be conducted when changes in management to the site have been made.

Benefits

The cost and effort of maintenance and monitoring programs is only a proportion of the initial capital for the rehabilitation works. By maintaining the riparian zone in a healthy state, the need to carry out costly revegetation works can be avoided in the future.

Sources of Additional Information

- DLWC. VegNotes. (Series 1) Getting To Know Your Native Vegetation (1.6) Monitoring native vegetation. Available on the DLWC Website.
- Curtis, D. Greening Australia – Technical Advice – Monitoring Natural Regeneration. Available on the Greening Australia Website.

4.8 COMMUNITY AWARENESS

Issue to be managed

In general, the local community lacks an understanding and awareness of the nature, significance and possible benefits of the riparian zone. The level of community participation for the maintenance of the riparian zone is significantly less than what is potentially possible.

Strategy

The local community should be educated in the nature and significance of the riparian zone and to be made aware of Council's efforts to rehabilitate the area. Community education and involvement is a relatively inexpensive form of management, yet it has far reaching and long term benefits in terms of community ownership of projects, pride in the river appearance and uses, and a willingness to conserve and manage the riparian corridor.

Every effort should be made to have a program that is ongoing and involves all levels of the community from school children to land owners. As part of the education program, incentives for farmers to restore riparian areas could be provided. It is also recommended that a position at Council be created to ensure long-term education programs are conducted and a rapport is created with land owners.

Methods of raising community awareness include:

- articles in the local newspaper;
- interpretive signs along existing walking tracks;
- nature observation points or points of interest (bird hides);
- arboretum of locally native species; and
- community awareness programs.

Community awareness and interest can also be raised by providing recreational benefits to the people of Goulburn along the rivers. Recreational benefits could include:

- more recreation areas (i.e. picnic tables and barbeques); and
- improvements in and development of walking trails and nature spots along the rivers.

By increasing the recreational value of the riparian zone, the community will come to appreciate the area and be more willing to help in its preservation.

The expansion of the Waterwatch program within Goulburn would be an economical way to help raise awareness of the issues facing the riparian zone within the community. Waterwatch Australia is a national community water monitoring program that encourages all Australians to become involved and active in the protection and management of their waterways and catchments. The Waterwatch network is made up of individuals, community groups and school groups who undertake a variety of biological and habitat assessments and physical and chemical tests to build up a picture of the health of their waterways and catchments. By monitoring their local waterways over time community members can determine if the health of the waterway and surrounds are improving, declining or being maintained.

Funding for Waterwatch is provided by the Federal Government's Natural Heritage Trust and is administered by a team based in the Sustainable Water Section of Environment Australia.

It is expected that during the flood mitigation works there will be short term disinterest in the river due to the lack of aesthetic appeal (the landscape will be disturbed as vegetation is removed, fences constructed etc). It is possible that the community may disapprove of the works as it will involve the removal of the majority of the "green matter" i.e. willow tree cover. Sufficient eduction and awareness programs should help the community understand that the works will eventually result in a greatly improved aesthetic environment, with a range of additional benefits. As the aesthetic appeal of the river improves, it is expected people will find it attractive and will begin to utilise the rivers and their resources.

Priority

A range of community awareness activities has been suggested. Depending on available programming and funding, a selection or all of these activities can be implemented immediately. Most of these activities are inexpensive. The sooner this initiative begins, the larger the proportion of the community contacted. This will increase the effectiveness of the program.

Benefits

- Inexpensive
- Long-term affects

Sources of Additional Information

- Waterwatch (GCC) – ph: 02 4823 444

4.9 IMPLEMENTATION OF MANAGEMENT STRATEGIES

The components of the management strategies listed in Sections 4.2 – 4.8 that require minimal or no capital expenditure have the highest implementation priority because they can be implemented without delay. Some components that do require capital expenditure should also be implemented as soon as possible, as they represent the critical path for many of the management strategies. If these 'critical path' components are delayed, a significant proportion of the FRMP recommendations will be delayed. Hydraulic modelling has enabled areas for priority exotic species and weed removal to be nominated (Section 4.2). Some of the high priority components of the management strategies include:

- community awareness;
- sourcing of funding;
- protecting and enhancing existing remnants;
- commencing approval processes and obtaining licences; and
- monitoring.

Also, a detailed study of the existing environment should be prepared covering issues such as:

- flora and fauna (previous studies, endangered species & ecological communities/existing vegetation communities, etc.);
- habitat and corridor values; topsoil/litter layer quality;
- hydrology/hydraulics (flooding, surface water runoff/drainage, velocities, water table, etc.);
- frost areas;
- fire issues;
- contaminants;
- acid sulphate soils;
- salinity;
- infrastructure including roads and pathways, railways, airfields, service infrastructure (water, sewerage, gas, electricity, communications);
- stock and herbivore access (rabbits, hares, ducks, etc.);
- shadow zones;
- drainage;
- topography (slope, aspect, soils, geology, erosion, deposition);
- exotic species and their sources; and
- risk of vandalism and public safety issues.

Responsibility for tasks needs to be assigned. When assigning responsibility ensure there will be on-going commitment because the VES is a long-term initiative. A suitably qualified bush regenerator should coordinate the regeneration and revegetation activities. Bush regeneration (allowing native species to naturally regenerate) is the first priority. Where natural regeneration potential is unlikely (because the site is highly degraded or altered) replanting of native species will be required.

Other aspects to consider when selecting and developing the strategies to be implemented include:

- aim to ensure the strategy is successful in the long-term;
- ensure relationships between the river and the strategy are appropriate;
- minimise adverse changes to the river processes;
- identifying other factors within the catchment that may jeopardise the success of the works in the future; and
- identify and manage threats to the project.

5 SOURCES OF FUNDING

5.1 FUNDING FOR FLOODPLAIN MANAGEMENT MEASURES

The cost of implementing the VES will be off-set by a reduction in the costs incurred as a result of poor vegetation management (such as flood damages). Direct costs of the VES to GCC can be minimised by involving state agencies, local businesses, and community groups.

There is a State Government funding program that provides assistance to Councils to implement floodplain management measures. The measures outlined in the Vegetation Enhancement Strategy have significant potential for the mitigation of floods within the Goulburn LGA and therefore are expected to qualify for funding under this program. The current arrangements are that the funds are provided on a 2:1 (State:Council) basis.

The Council may seek other sources of funding or make arrangements with the residents or other interested parties regarding the costs for the Council share. This arrangement is usually a reflection of the merits of each case and no fixed formula can be applied in this document. Other sources of funding have been investigated during the preparation of this document and are listed below.

5.2 ALTERNATE ENVIRONMENTAL FUNDING SOURCES

Traditional sources of funding for the existing revegetation works along the two rivers have come from GCC and the Sydney Catchment Authority (SCA). However, there are many other sources of funding, which could be accessed for the VES, such as:

- State and Government environmental grant opportunities (eg the National Heritage Trust);
- transferable development rights - this involves placing areas of high conservation value under council ownership while allowing a higher degree of development on less significant land;
- voluntary conservation agreements which promote conservation of vegetation on land in private ownership; and
- exchanging land of low ecological significance with landowners for sites of high conservation significance.

5.2.1 COMMONWEALTH SUPPORT OPPORTUNITIES

i Bushcare (National Vegetation Initiative)

Bushcare is a major Commonwealth National Heritage Trust (NHT) program. The goal of Bushcare is to reverse the long-term decline in the quality and extent of Australia's native vegetation cover. The implementation of Bushcare within NSW is jointly managed by the DLWC and NSW NPWS. Activities funded by Bushcare include the protection of remnant

vegetation, strategic re-establishment of vegetation in priority areas, institutional change, planning and research.

Bushcare funding is available for projects which:

- address the Bushcare national goal and objectives;
- are strategic and address priority issues, ideally consistent with a regional strategy if one exists;
- show long-term commitment beyond Commonwealth funding;
- involve partnerships with the community, state agencies, and regional organisations;
- demonstrate practical on-ground achievements; and
- demonstrate that there is technical and financial ability to support the project.

Bushcare gives priority to projects at a regional or catchment scale which integrate management of remnant vegetation with extensive revegetation for a range of purposes, including:

- conserving biodiversity;
- rehabilitating degraded areas, on and off reserves;
- safeguarding and improving agricultural production;
- improving water quality and wetlands management; and/or
- conserving wildlife habitat.

a Application Process and Further Information

Information about Bushcare project funding, applying for Bushcare funding, and helpful hints about applying for funding can be found on the Bushcare website http://www.ea.gov.au/land/bushcare/index.html.

To apply for Bushcare funding you need to read the NHT Guide to New Applications and submit an application form. It is essential to read the NHT guide as it will give details about the application process, projects that are eligible, and projects that are not eligible for funding.

The Guide is available on the NHT website http://www.nht.gov.au/funding/index.html or electronic copies are available on disk by phoning 1800 065 823.

b Bushcare and Greening Australia

Under Bushcare Support, Greening Australia provides advice and technical support to land holders and community organizations. The advice and support offered includes:

- technical information and advice on managing remnant native vegetation;
- information and advice on revegetation;
- access to equipment and volunteer labour ;
- help with funding application processes under the Commonwealth's NHT;
- skills training for native vegetation management; and
- general education and awareness raising activities.

Further information about Bushcare support from Greening Australia is available from the Greening Australia website www.ga.org.au or contacting:

Acting CEO — Lorryn Williamson
Ph: (02) 9560 9144 Fax: (02) 9550 0576
Postal address: 142 Addison Road Marrickville NSW 2204.
Email: info@ga.org.au.

ii The Fencing Initiative Scheme (FIS)

The main aim of the Fencing Initiative Scheme (FIS) is to assist landholders to protect and enhance remnant vegetation. The FIS began in December 1996 and is administered by Greening Australia on behalf of Bushcare. The FIS is jointly funded by the Federal Government under the Natural Heritage Trust's Bushcare program and corporate sponsors Smorgons and BHP.

The FIS offers landholders a means of obtaining a subsidy (of $1 200 per kilometer) for fencing remnant vegetation. Under this scheme, Greening Australia provides advice on:

- types of sites which are suitable for fencing;
- types of fencing needed;
- site management (including weed management);
- fire and grazing regimes; and
- how to apply for funding.

The landholder can nominate a site by contacting the local Greening Australia representative, submitting an application form available from the local landcare group, or attending field days.

Once the site has been nominated by the landholder, Greening Australia staff visit and assess the site. Management options are usually discussed with the landholder during the site visit. It usually takes approximately one month for a site to be accepted into the program. If the site is accepted, the landholder buys fencing materials from their supplier of choice, and presents the receipts to Greening Australia to be reimbursed. After the fence is erected, a Greening Australia officer will check to see that the fence meets all requirements. On-going monitoring and management of the site is encouraged (Greening Australia will provide support and assistance for this, on request).

a Application Process

Landholders can contact the local Greening Australia office, or submit an application form available from the local landcare group.

iii National Heritage Trust (NHT) – The Australian Government Envirofund

The Australian Government Envirofund is a source of funding for individuals and community groups to undertake small projects aimed at conserving biodiversity and sustainable resource

use. Funding is only available for projects of up to $30, 000. The project must meet one or more of the NHT ten areas of activity, as listed here:

1. Protecting and restoring the habitat of threatened species, threatened ecological communities and migratory birds.
2. Reversing the long-term decline in the extent and quality of Australia's native vegetation.
3. Protecting and restoring significant freshwater, marine and estuarine ecosystems.
4. Preventing or controlling the introduction and spread of feral animals, aquatic pests, exotic species and other biological threats to biodiversity.
5. Establishing and effectively managing a comprehensive, adequate and representative system of protected areas.
6. Improving the condition of natural resources that underpins the sustainability and productivity of resource based industries.
7. Securing access to natural resources for productive purposes.
8. Encouraging the development of sustainable and profitable management systems for application by land-holders and other natural resource managers and users.
9. Providing land-holders, community groups and other natural resource managers with understanding and skills to contribute to biodiversity conservation and sustainable natural resource management.
10. Establishing institutional and organisational frameworks that promote conservation and ecologically sustainable use and management of natural resources.

Preference will be given to projects which take a systematic and coordinated approach to dealing with a problem.

a Application Process and Further Information

Information about the Australian Government Envirofund and application details can be found on the website http://www.nht.gov.au/envirofund/index.html.

To apply for Australian Government Envirofund support the NHT Guide to New Applications must be read and an application form must be submitted. It is essential to read the guide as it will give details about the application process, what projects are eligible, and what projects are not eligible for funding.

The NHT Guide is available on the NHT website http://www.nht.gov.au/funding/index.html or electronic copies are available on disk by phoning 1800 065 823. Applications for 2002 – 2003 funding close Wednesday 5 June 2002.

iv Conservation Volunteers Australia

Conservation Volunteers Australia has expertise in the management of volunteer involvement in conservation projects. Conservation Volunteers Australia involves the community in conservation projects in urban, regional and remote Australia including:

- tree planting;
- seed collection;
- endangered species protection;
- weed control;

- flora and fauna surveys;
- walking trail construction;
- fencing; and
- environmental monitoring.

Conservation Volunteers Australia work with major environment management agencies, non-government organisations, community groups, and individuals to identify environmental projects which are suitable for assistance.

Conservation Volunteers Australia seeks to undertake priority projects that have the support of the key stakeholders including the relevant State/Territory environment management agency and do not displace paid workers / volunteer groups.

a Application Process and Further Information

For information about assistance contact the National Head Office - Conservation Volunteers Australia – Ballarat 1800 032 501 or website http://www.atcv.com.au/index.asp or email the Conservation Volunteers Australia at info@conservationvolunteers.com.au.

v Green Corps

Green Corps is a youth initiative of the Commonwealth Government, administered by the Department of Education, Training and Youth Affairs in association with Environment Australia. The Green Corps program is managed nationally by the Conservation Volunteers Australia. Green Corps can provide labour assistance to land managers and community groups with priority environmental projects.

All environment management agencies, non-government organisations and community groups may apply for a Green Corps project. Conservation Volunteers Australia will work with the applicant to identify priority environmental projects that are suitable for Green Corps assistance. Projects should have broad based community support and be endorsed by the relevant State/Territory management agency and key stakeholders such as Landcare, Bushcare, Coastcare groups, local government and traditional owners.

a Application Process and Further Information

Further information about Greencorps can be found by:

- the website: http://www.greencorps.org.au/
- email: info@conservationvolunteers.com.au
- ringing Freecall 1800 633 844.

5.2.2 NSW GOVERNMENT SUPPORT AND INCENTIVES

i Property Agreements under the Native Vegetation Conservation Act

A Property Agreement is a voluntary agreement between a landholder and the DLWC to enhance the management of native vegetation on the property. A group of landholders may also develop a strategy for managing their vegetation and a partnership with government can be arranged through Property Agreements. There are many advantages for the landholder entering into a Property Agreement, including:

- eligibility for financial assistance for works on the ground;
- technical advice for the management of native vegetation; and
- providing greater certainty about the future management of native vegetation.

The methods and management practices that will be employed in the areas that are subject to the agreement determine the costs of implementing the agreement. Costs could include fencing, weed control, and costs associated with regenerating or re-establishing native vegetation. Landholders who have entered into a Property Agreement are eligible for financial assistance through the Native Vegetation Management Fund.

DLWC may also be able to provide technical advice to the landholder (eg how to survey and monitor vegetation on a property).

ii Farming for the Future

The Farming for the Future program helps farming families throughout New South Wales expand their skills to be prepared for the future highs and lows of climate, market and other risks. Farming for the Future delivers Property Management Planning through a series of workshops, informal lectures and field days.

The Property Management Planning Workshop Series runs for eight sessions and includes sessions on natural, financial and human resource planning. As a joint agency program, Farming for the Future uses the skills and experience within NSW Agriculture, DLWC, NSW NPWS and the NSW Farmers Association, to ensure a comprehensive and holistic approach to productive and sustainable farm and land management.

For more information, contact the Project Officer on (02) 6360 8251.

5.2.3 LOCAL GOVERNMENT SUPPORT AND INCENTIVES

Local government can support the VES through two main functions (Binning et al. 1999):

- core functions; and
- discretionary functions.

Core support functions are functions which council must undertake irrespective of whether or not local governments address issues such as native vegetation management. These core functions include:

- land use planning and development approvals;
- management of crown and council owned lands; and
- management of environmental risks.

Local government has the ability to offer a wide range of discretionary functions to help manage the rehabilitation process. These include:

- facilitating community involvement – supporting the work of community based groups, and undertake on ground works for native vegetation management;
- managing grant and incentive programs – councils can introduce grant and other incentive programs such as rate rebates to promote native vegetation conservation on private land; and
- providing financial and administrative support – councils act as revenue collectors and administrators of public funds and are therefore in a position to provide financial and administrative support to regional groups.

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PERSONAL COMMUNICATION

J. Pursey NSW Fisheries, 11/9/01

APPENDIX A

HOW TO PREPARE A VEGETATION MANAGEMENT PLAN

Appendix A – How to Prepare a Vegetation Management Plan (Draft)

How to Prepare a Vegetation Management Plan
(Draft)

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1. **Assess the site and determine constraints:** flora and fauna (previous studies, endangered species & ecological communities/existing vegetation communities, etc.); habitat and corridor values; topsoil/litter layer quality; hydrology/hydraulics (flooding, surface water runoff/drainage, velocities, water table, etc.); frost areas; fire issues; contaminants; acid sulphate soils; salinity, roads and pathways, railways, airfields, service infrastructure (water, sewerage, gas, electricity, communications); stock and herbivore access (rabbits, hares, ducks, etc.); shadow zones; drainage; topography (slope, aspect, soils, geology, erosion, deposition); weeds and weed sources, risk of vandalism, public safety issues, etc..
2. **Define project tasks:** describe each task necessary for the implementation of the plan, how each task will be done, the duration of each task, the priority order for each task and who will be responsible for undertaking each task.
3. **Prepare a time frame (eg Gannt chart):** address all tasks in the project.
4. **Liaise:** contact council Bushcare Officer, landcare or bushcare groups.
5. **Provide details on seed collection and propagation:** local native species only to be used - identify local native seed sources, check on any licences required - identify who will propagate.
6. **Prepare maps/diagrams and plant species lists:** describe existing vegetation, constraints, vegetation and natural features to be retained, proposed vegetation (species/communities, zonation from water to land, corridors/linkages, spacings, tubestock/virocells/long stems/direct seeding, etc.), sediment and erosion control, stabilisation works, etc..
7. **Provide details on site preparation:**
   - protection of plants to be retained
   - installation of sediment and erosion control devices
   - completion of any site works (if any)
   - weed control (techniques and sequences of removal)
   - application of herbicides
   - topsoil/litter layer storage
   - soil remediation
   - surface preparation (levelling, deep ripping, scarifying, mulching etc.)
   - surface stabilisation - (needs to be suitable for the site/vegetation - erosion matting, mulch, brushmatting, sterile cover crops, binding sprays, etc.)
   - site drainage
8. **Describe the planting program and method:** detail how it will be done, staging and also consider the installation of weed mats, mulch, stakes & ties, tree guards and the use of fertilizer types (justify their need), water-retaining crystals, etc..

9. **Describe site and vegetation maintenance:** sediment and erosion control, watering, replacement of plant losses, weed control, disease and insect control, mulch, etc. (Note: DLWC requires a minimum of **two** years maintenance after last plantings completed).

10. **Describe the monitoring and review process:** include a method of performance evaluation, assessing the need for replacing plant losses, addressing deficiencies and six-monthly reporting.

11. **Address other issues:** signage, relevant legislation, planning instruments/guidelines, OH&S, community involvement, liaison with DLWC and others, how other parts of the site and adjacent areas can be managed to compliment the vegetation strategy (weed control, drainage, etc.), etc.

12. **Prepare a costing:** for the implementation of all stages and all components of the work - show details on unit cost, materials, labour, monitoring/maintenance/reporting, etc.

Source: Guidelines have been supplied by the DLWC – Paul Bourne contact: (02) 47221111

APPENDIX B

PLANT SPECIES LIST

Appendix B – Plant Species List

Stream - aquatic species	
Juncus filicaulis	Fine Rush
Juncus gregiflorus	Rush spp.
Juncus remotiflorus	Rush spp.
Juncus usitatus	Common Rush
Phragmites australis	Common Reed
Schoenoplectus validus	River Clubrush
Typha domingensis	Cumbungi

Toe - low growing, multi-trunked plants and ground cover plants with matted roots to bind the toe of the bank.	
Acacia dealbata	Silver Wattle
Bursaria lasiophylla	Blackthorn
Callistemon sieberi	River Bottlebrush
Leptospermum myrtifolium	Myrtle Tea tree
Leptospermum phylicoides	Burgan
Leptospermum polygalifolium	Yellow Tea tree
Lomandra filiformis coriacea	Wattle mat-rush
Lomandra longifolia	Spiny mat-rush
Lomandra multiflora	Many-flowered Matrush
Phragmites australis	Common Reed
Poa labillardieri	Tall Tussock Grass
Schoenoplectus validus	River Clubrush
Typha domingensis	Cumbungi

Middle - generally medium sized trees with good root systems and large canopies which shade waterways, and a variety of ground cover plants.	
Acacia dealbata	Silver Wattle
Acacia decurrens	Green Wattle
Acacia melanoxylon	Blackwood
Acacia parramattensis	Parramatta Green Wattle
Banksia marginata	Silver Banksia
Bursaria lasiophylla	Blackthorn
Callistemon sieberi	River Bottlebrush
Eucalyptus amplifolia	Cabbage Gum
Eucalyptus melliodora	Yellow Box
Eucalyptus rubida	Candlebark
Eucalyptus viminalis	Ribbon Gum

Middle - generally medium sized trees with good root systems and large canopies which shade waterways, and a variety of ground cover plants	
Leptospermum myrtifolium	Myrtle Tea-tree
Leptospermum phylicoides	Burgan
Leptospermum polygalifolium	Yellow Tea-tree
Lomandra longifolia	Spiny Mat rush
Poa labillardieri	Tall Tussock Grass
Stipa bigeniculata	Tall Spear Grass
Themeda australis	Kangaroo Grass

Upper - larger trees with deep root systems, and some low growing ground covers.	
Allocasuarina luehmanii	Bull-oak
Acacia dealbata	Silver Wattle
Acacia decurrens	Green Wattle
Acacia melanoxylon	Blackwood
Acacia parramattensis	Parramatta Green Wattle
Banksia marginata	Silver Banksia
Banksia spinulosa	Hairpin Banksia
Bursaria lasiophylla	Blackthorn
Casuarina littoralis	Black She-Oak
Daviesia latifolia	Hop Bitter-pea
Eucalyptus amplifolia	Cabbage Gum
Eucalyptus bridgesiana	Apple Box
Eucalyptus cinerea	Argyle Apple
Eucalyptus melliodora	Yellow Box
Eucayptus pauciflora	Snow Gum
Eucalyptus rubida	Candlebark
Eucalyptus viminalis	Ribbon Gum
Leptospermum myrtifolium	Myrtle Tea-tree
Leptospermum phylicoides	Burgan
Leptospermum polygalifolium	Yellow Tea-tree
Lomandra longifolia	Spiny Mat rush
Poa labillardieri	Tall Tussock Grass
Stipa bigeniculata	Tall Spear Grass
Themeda australis	Kangaroo Grass

Source:

- *Moran, K. & Falconer, F. (n/d). Wollondilly River and Mulwaree Ponds Management Study and Plan: Submission to the GCC Environment Committee. Appendix 1 Species list; and*
- *Goulburn City Council (2000) Wollondilly River Rehabilitation Plan. Figure 2 Species list.*

APPENDIX C

HOW TO COLLECT NATIVE PLANT SEED RESPONSIBLY

Appendix C – How to Collect Native Plant Seed Responsibly

Note: These guidelines were produced by DLWC through consultation with Botanical Gardens, Greening Australia and National Parks and Wildlife Service (NPWS). These agencies should be consulted prior to collecting plant seeds. In some cases, a licence may be required from NPWS.

How to Collect Native Plant Seed Responsibly

To select seeds that will grow into plants that are best adapted to local conditions, collect seed from near the area where it is proposed to do the planting. If there are no suitable native species immediately nearby, then collect seed from as close as possible and from the same general habitat (same soil type, distance from watercourse, exposure etc.). Seedlings propagated from a similar habitat increases the likelihood of the seedlings being suitable for the planting site. As a guide, plants within about a 3 km radius can be considered satisfactory.

Seed collected from too far away may not be adapted to the local conditions and may introduce new genes to the site, thereby altering local genetic integrity.

There is one exception to the "local" rule. If the population of any of the native species has fallen to a very low level (eg. less than ten individuals of any species), then *for those species* it is advisable to supplement that seed with collections from elsewhere (but as close as possible) to ensure that there is sufficient genetic diversity to minimise the potential for inbreeding.

Where there are no native species left in the area, and no reasonable stands of native species within 3 km, then the site will probably be better treated as a garden and plants could be obtained from commercial sources. Even so, seed derived from closer to the site is preferred over seed collected further away.

Principles to follow when collecting native plant seed:

(a) Before collecting, obtain any necessary permit from National Parks &Wildlife Service and seek permission from the land owner (private, council, Crown Lands, etc.).

(b) Collect seed from as many different plants of the same species as possible (minimum of 5).

(c) Collect seed from plants of varying vigour, but not individuals with obvious disease symptoms.

(d) Collect seed from plants with different growth forms (straight, branching, straggly etc.).

(e) Try to maintain at least 100 m between each parent of the same species, but do not collect only from the edges of a population and always include the central areas in the collection.

(f) Do not strip plants of seed - collect no more than about 20 % of seed from any one tree.

(g) Collect from various parts of each plant and collect equal amounts of seed from each plant.

(h) If possible, avoid collecting from solitary plants and concentrate on stands or groups of plants (this is to minimise the risk of collecting self-pollinated seed).

(i) Label seed containers: *species name, location, date collected, collector's name, how many plants collected from* - and preferably: *position in the landscape (e.g. water's edge), % of ripe seed, soil/geology, plant associations, aspect/altitude/slope, weeds present.*

(j) Dry out seed and store in a cool and dry place (a refrigerator is ideal) in air-tight containers.

Source:

- *Guidelines have been supplied by the DLWC – Paul Bourne contact: (02) 47221111*
- *Royal Botanic Gardens Sydney, Greening Australia (NSW) & "Seed Collection of Australian Native Plants" (Ralph, M., 1994).*