Greening Australia

Prepared for

CSR
Erskine Park Biodiversity Corridor Restoration VMP

Greening Australia

Transforming our landscapes

Our Mission

To engage the community in vegetation management to protect and restore the health, diversity and productivity of our unique Australian landscapes.

Our Vision

A healthy, diverse environment, treasured by the whole community.

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CSR
EPBC Vegetation Management Plan

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1. Project Context

1.1 Project Context

This Vegetation Management Plan (VMP) has been prepared for CSR Limited (CSR). It outlines the restoration strategy for a high profile section of the Erskine Park Biodiversity Corridor.

The aim of the VMP is to provide a framework for the restoration of the relocated creekline, to establish clear targets to measure the effectiveness of restoration and provide indicative project delivery costs.

The VMP will achieve this by using the following core objectives and outcomes:

- Achieve sound naturalised watercourse and long term riparian area stabilisation and management by the emulation of the native communities of the subject area
- Protect remnant local native riparian vegetation
- Demonstrate naturalised bed and bank stability of the affected watercourse
- Restore riparian areas disturbed or otherwise affected to a state that is reasonably representative of the appropriate vegetation communities

This VMP will be included in the Development Application submission to Penrith City Council and the NSW Office of Water.

Brown Consulting (Pty Ltd) prepared the Civil and Creek Works Design for Development Application and the Stormwater Concept Plan Report for the industrial subdivision. WetlandCare Australia prepared a Wetland Management Plan for the creek reinstatement.

These documents have been consulted during the compilation of this VMP and will be submitted as part of the Development Application for Lot 22, Tyrone Place, Erskine Park.

1.2 Relevant Legislation

1.2.1 Water Management Act 2000

This VMP takes into consideration the general principles of the Water Management Act 2000. Restoration will be undertaken to provide in-stream features, a vegetation structure that provides a functional system and creates a stable soil profile.

It is anticipated that controlled activity approval provisions will be established to guide the civil and creek earthworks. The implementation of vegetation community restoration will also be guided by these provisions.

1.2.2 Threatened Species Conservation Act 1995

River Flat Eucalypt Forest is found within the site and is listed under Part 3 of Schedule 1 in the Threatened Species Conservation (TSC) Act. As such the objects of the TSC Act will be followed to ensure the protection of the endangered ecological community.

A Section 132c licence maybe required for this project.

The objects of the Threatened Species Conservation Act (TSC Act) aim to:

- conserve biological diversity and promote ecologically sustainable development, prevent the extinction
- promote the recovery of threatened species, populations and ecological communities,
- protect the critical habitat of those threatened species, populations and ecological communities that are endangered
- eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities, and
- ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed, and
- encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

1.2.3 Environment Protection and Biodiversity Conservation Act 1999

There are a number of aims under the Environment Protection and Biodiversity Conservation Act of which the most relevant to the site includes the conservation of Australia's biodiversity and the promotion of ecological sustainable development. Part of conserving biodiversity includes dealing with invasive species.

On the site Blackberry is evident and has been listed as a weed of National significance, and will therefore be treated and monitored.

1.2.4 Noxious Weeds Act 1993 (NSW)

A number of noxious weed species have been indentified on site listed under the Noxious Weeds Act. These species will be removed during bulk earthworks. The restoration maintenance program will control the potential for reinfestation.

Noxious weeds located on site are described more fully in table 1 within Section 2.

1.3 Conservation Values

The site is situated within the Erskine Park Biodiversity Corridor (EPBC) which is a 211ha vegetation corridor established to achieve greater sustainability outcomes for the Erskine Park Industrial Estate and to compensate for losses of vegetation during construction. The EPBC links 2 major Western Sydney creeks, South and Ropes Creek which flow into the Hawkesbury-Nepean River.

The EPBC provides a significant east-west linkage and therefore plays an important role in the movement of flora and fauna between these major creek corridors. The mature canopy species that run along the edge of the creek provide habitat for a variety of native fauna and vegetation restoration during this p[project will enhance habitat diversity and increase the overall biodiversity value of the site and the EPBC.

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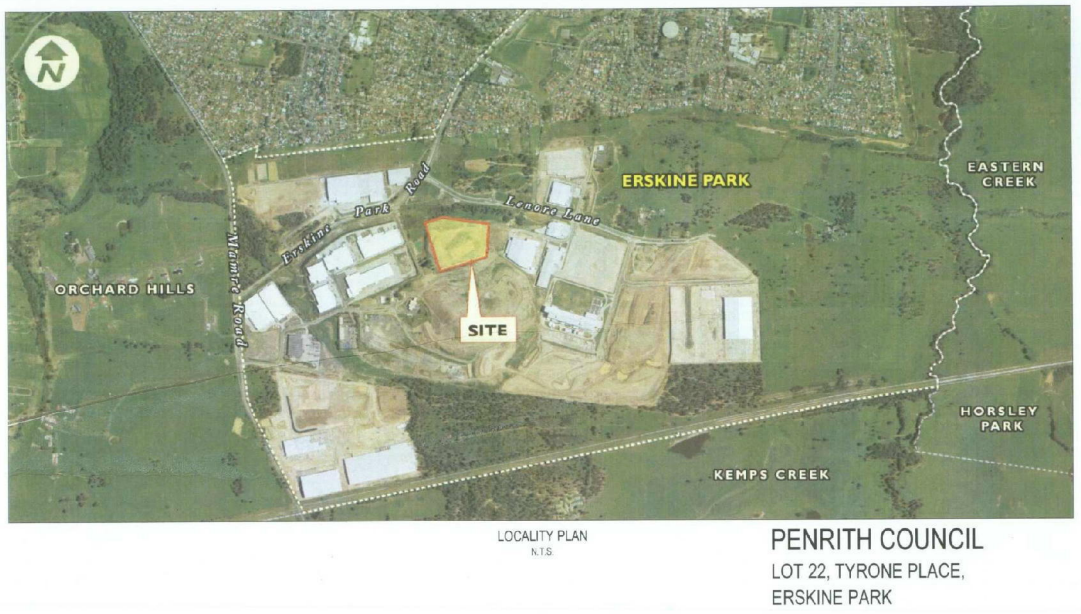
General Site Description

2. General Site Description

2.1 Site Location

The site is located at Erskine Park, within the Penrith City Council (LGA), 40km west of the Sydney CBD. The site sits in the southern corner of Erskine Park Road and Lenore Lane in the Erskine Park Industrial Estate.

Figure 1 Site location



2.2 Site description - current

This VMP relates to the 5.72 hectare restoration area which includes an unnamed creekline that flows into South Creek via a degraded wetland.

Land either side of the creekline is relatively flat, with some areas being ephemeral in nature, remaining wet for extended periods after rain. The western portion of the site is largely an open space incorporating the degraded wetland and a small stand of woody weeds along the western edge. Along the southern end of the restoration area a steep batter of groundlayer weeds extends to the industrial development zone.

Some revegetation and bush regeneration activities have been conducted over the past 6 years along the eastern edge of the site to supplement the remnant vegetation along the creekline. This adjacent area is of high conservation value within the EPBC.

There are no built structures on site. A constructed basin containing provenance wetland and terrestrial plants is located at the northern boundary of the site.

2.3 Topography

A steep batter has been created on the south-eastern corner of the site adjacent to the development area. In general, the site is level with a slight gradient from the base of the wetland to the batter and adjoining access tracks.

2.4 Soils and Geology

Soil types of the Cumberland Plain can generally be identified by vegetation communities that exist on the site in lieu of detailed soil analysis. The site contains remnants of River Flat Eucalypt Forest in which its soils are generally rich in silt, lack deep humic layers and have little or no saline influence.

River-Flat Eucalypt Forest on Coastal Floodplains generally occurs below 50m elevation, but may occur on localised river flats up to 250 m above sea level in the NSW North Coast, Sydney Basin and South East Corner bioregions. Floodplains are level landform patterns on which there may be active erosion and degradation by channelled and overbank stream flow.

2.5 Climate and Rainfall

Based on meteorological data collected at St Clair, the mean average annual rainfall for the area is 702mm. The highest average monthly rainfalls are recorded in January. July has the lowest average rainfalls.

Based on Data collected from Penrith Lakes AWS, January is the hottest month with a mean maximum temperature of 30.8℃ and July is the coolest month with a mean maximum temperature of 17.7℃. The mean minimum temperature is also experienced in July with the temperature falling to 5.5℃.

The minimum temperature may fall below 2℃ (potential frost days) from June to August with July experiencing an average of 3.5 days under 2℃.

2.6 Existing Vegetation

The vegetation is associated with the Endangered Ecological Communities, River Flat Eucalypt Forest on Coastal Floodplains (RFEF) and Freshwater Wetlands on Coastal Floodplains (FWCF).

In the eastern portion of the site remnant native species dominate the canopy layer, mature *Eucalypt* and *Melaleuca* species have restricted weed invasion in this area, however in areas where little native canopyv exists the mid and ground layers are dominated by weed species due to clearing or degradation. On the western side, the open space/wetland has scattered woody and aquatic weeds, however it also contains significant stands of native wetland plants.

2.6.1 Remnant

Little native diversity remains in remnant areas.

Identified species in the eastern riparian zone;

- Canopy - *Eucalyptus amplifolia, Casuarina glauca and Melaleuca linariifolia.*

- Groundcover - *Microlaena stipoides* and *Dianella longifolia*
- Wetland - *Carex appressa* and *Persicaria dicipiens*

None of the original mid-storey species remain.

In the wetland/open space area there is a large stand of the wetland species *Bolboschoenus fluviatilis*, scattered *Casuarina glauca* trees and some *Baumea articulate*.

Despite the lack of diversity in remnant vegetation on-site, remnant vegetation adjacent to the site demonstrates a relatively high level of species richness and restoration works should continue this trend. The adjacent site consists of 5 canopy species, 4 mid-storey species and at least 15 groundcover species.

2.6.2 Existing Revegetation

Revegetation was carried out on this site approximately three years ago.

Species installed are consistent with those commonly found in River-Flat Eucalypt Forest, Freshwater Wetlands and Cumberland Plain Woodland which the area would have originally graded into before clearing.

Revegetation increased the biodiversity of the site and included a range of species from all strata including:

- Canopy – *Eucalyptus tereticornis, Melaleuca styphelioides, Melaleuca decora*
- Mid-storey – *Bursaria spinosa, Ozothamnus diosmifolius*, *Acacia decurrens*
- Ground layer – *Lomandra longifolia*, *Capillipedium parviflorum*
- Wetland – *Carex appressa, Juncus usitatus*

2.6.3 Weed Species

There's a significant weed infestation in the ground layer of the site with some mid-storey weeds also present.

The ground layer consists of many exotic species, including significant amounts of Rhodes grass (*Chloris gayana*), moth vine (*Araujia sericifera*), and blackberry (*Rubus.fruticosus*).

Mid-storey weed species include large leaf privet (*Ligustrum lucidum*), small leaf privet (*Ligustrum sinense*), African boxthorn (*Lycium ferocissimum*) and African olive (*Olea europaea var africana*), however bush regeneration activities and the sites natural resilience to woody weeds has resulted in their low abundance.

On the western side of the site the woody weeds willow (Salix sp.) and poplar (Populus sp.) are present. The wetland weed African juncus (*Juncus acutus*) is prevalent in the area, much of which has been mechanically treated by mulching down to crown level. Pampas grass (Cortaderia sp.) is also scattered throughout.

2.6.3.1 Noxious Weeds

The following Noxious weeds have been identified on the project site.

Table 1 Noxious weeds identified on site

Common name	Scientific name	Class (see table below)
African olive	*Olea europaea var africana*	4
blackberry	*Rubus fruticosus*	4
African boxthorn	*Lycium ferocissimum*	4
bridal creeper	*Asparagus asparagoides*	4
pampas grass	*Cortaderia sp*	3
privet (small-leaved)	*Ligustrum sinense*	4
privet (large-leaved)	*Ligustrum lucidum*	4
willow	*Salix sp.*	5

Throughout the restoration and maintenance period, monitoring will determine the requirements for noxious weed control. It is anticipated that the earthworks will control the existing noxious weeds and minimal regrowth will occur as a result.

A list of all declared noxious weeds within the Hawkesbury River County Council, of which the Penrith LGA is included can be found in Appendix 1 - Declared Noxious Weeds, Hawkesbury River County Council.

2.7 Fauna

2.7.1 Threatened Flora and Fauna

The NPWS Atlas of NSW Wildlife lists 13 flora and 39 fauna species as threatened within the Penrith LGA (See Appendix 3). None of these species were observed on site; however a fauna survey has not been conducted.

Some larger trees may be used by bird or bat species while transiting across the site from adjacent areas.

The wetland flora species located on the edges of the creek and the wetland provide habitat for water birds and other wetland fauna including frogs and lizards.

A variety of fauna were observed while conducting the site assessment including an individual Wallaby (unknown species) and the Common Eastern Froglet (*Crinia signifera*), demonstrating the habitat value of the site.

2.7.2 Endangered Ecological Communities

National Parks and Wildlife Service, Native Vegetation of the Cumberland Plain Map 12 identifies River-Flat Eucalypt Forest on Coastal Floodplains (RFEF) on the VMP site. An on-ground vegetation assessment also showed that the EEC, Freshwater Wetlands on Coastal Floodplains is present.

Earthworks will modify the site topography and growing conditions for native plant specie, as a result a vegetative transition zone will be created. The vegetation will transition from River Flat Eucalypt Forest in the riparian zone to Cumberland Plain Woodland on the upper section of the structural batter. Species installed during revegetation will reflect this transition.

A description of the vegetation communities are provided below. A list of plant species associated with these communities is included in Appendix 2

2.7.2.1 River Flat Eucalypt Forest

An Endangered Ecological Community (EEC) under the Threatened Species Conservation Act 1995 (TSC Act) (NSW Scientific Committee), River Flat Eucalypt Forest includes and replaces the EEC known as Sydney Coastal River Flat Forest. Due to its topography and soil structure, these communities play an important role in maintaining river ecosystems and riverbank stability.

The structure of the community may vary from tall open forests to woodlands. Therefore there are two communities that fall under the definition of River Flat Eucalypt Forest and have been mapped by the NPWS as Alluvial woodland (Map unit 11) and Riparian Forest (Map unit 12).

Alluvial woodland occurs exclusively along or in close proximity to minor watercourses draining soils derived from Wianamatta Shale. It is the most common community found on soil of recent alluvial deposition.

Alluvial Woodland is also found on the floodplains of the major watercourse the Hawkesbury-Nepean but grades into Riparian Forest on the terraces immediately adjacent to the river. It commonly includes trees such as *Eucalyptus amplifolia* (cabbage gum), *Eucalyptus tereticornis* (forest red gum) and dense stands of *Casuarina glauca* (swamp oak).

A layer of small trees may be present, including *Melaleuca decora*, *Melaleuca styphelioides* and *Backhousia myrtifolia*. Scattered shrubs include *Bursaria spinosa*, *Rubus parvifolius*, *Breynia oblongifolia* and *Ozothamnus diosmifolius*. The groundcover is composed of abundant forbs, scramblers and grasses including *Microlaena stipoides*, *Dichondra repens* and *Oplismenus aemulus*.

Riparian Forest is a tall open forest community on alluvial soils adjacent to main river channels, with emergent trees such as *Angophora subvelutina* (broad leaf apple) *Eucalyptus amplifolia* (cabbage gum), *Eucalyptus botryoides* (bangalay) and *Eucalyptus elata* (river peppermint).

2.7.2.2 Cumberland Plain Woodland - Shale Plains Woodland

Cumberland Plain Woodland occurs throughout the driest part of the Sydney Basin and is well adapted to drought and fire. NPWS identifies 2 sub-communities of CPW – Shale Plains Woodland (SPW) and Shale Hills Woodland (SHW). The SPW sub-community is the most

common of the 2, occurring on flat to undulating terrain throughout the Cumberland Plain on shale derived soils.

Understorey plants often rely on underground tubers or profuse annual seed production to survive adverse conditions. The general percentage structural composition of canopy to mid-storey to groundcover for SPW is 25%: 15%: 60%.

Floristically the canopy is represented by a mixture of *E. tereticornis* (forest red gum), *E. moluccana* (grey box), *E. fibrosa* (broad leaved ironbark), *E. crebra* (narrow leaved ironbark), *E. eugenioides* (thin leaved stringybark) and *Angophora floribunda* (rough-barked apple). However, *E. crebra* more commonly occurs in the sub-community, SHW.

The mid-storey ranges to a height of approximately 15m with forest red gum being the most common species with white-feather honey myrtle (*Melaleuca decora*) and occasional broad-leaved ironbark also found in this layer. The understorey consists of *Acacia parramattensis* (Parramatta green wattle), *Acacia decurrens* (Sydney green wattle), *Bursaria spinosa* (blackthorn) and *Acacia falcata* (hickory wattle).

The ground layer is usually dominated by native species to a height of 1m, including *Themeda australis* (kangaroo grass), *Austrodanthonia tenuior* (wallaby grass), *Microlaena stipoides* (Weeping grass), *Oplismenus aemulus* (basket grass), *Dichondra repens* (Kidney Weed) and a variety of native herbs.

2.7.2.3 Freshwater Wetlands on Coastal Floodplains

This ecological community, also known as Freshwater Wetlands, is associated with periodic, semi-permanent or permanent inundation by freshwater. It occurs in areas that are generally less than 20 metres in elevation.

The community is dominated by herbaceous plants. The wetlands that regularly lack standing water are generally dominated by grassland and sedgeland species including Paspalum distichum (water couch), Leersia hexandra (swamp rice-grass), Pseudoraphis spinescens (mud grass) and Carex appressa (tussock sedge). While those that subjected to interchanging conditions include larger, emergent sedges such as Baumea articulata, Eleocharis equisetina and Lepironia articulata, as well as emergent or floating herbs such as Hydrocharis dubia (frogbit), Philydrum lanuginosum (frogsmouth), Ludwigia peploides subsp. montevidensis (water primrose), Marsilea mutica (nardoo) and Myriophyllum spp. (milfoils).

In areas where standing water becomes deeper, floating and submerged aquatic herbs such as Azolla filiculoides var. rubra, Ceratophyllum demersum (hornwort), Hydrilla verticillata (water thyme), Lemna spp. (duckweeds), Nymphaea gigantea (giant waterlily), Nymphoides indica (water snowflake), Ottelia ovalifolia (swamp lily) and Potamageton spp. (pondweeds) become more abundant.

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Site Restoration

3. Site Restoration Techniques

This section describes of the techniques that will be employed to restore the site.

3.1 Germination testing

Germination testing is to be undertaken to assist in the efficient production of tube stock. Production time can be significantly longer if testing is not undertaken prior to propagation due to low rates of germination and the subsequent requirement to re-sow.

Testing should be undertaken by an appropriately qualified company and the results supplied to the principle contractor.

3.2 Hydromulching

Hydro-mulching will provide additional erosion control to the earth worked areas, as well as spreading delivering native seed to the restoration area. In-situ germination will increase the density of native grasses and shrubs across the site without the propagation and installation cost of tubestock planting. By taking this approach, we estimate a reduction of 125,000 tubestock propagation and installation, reducing the overall project cost by $187,500.

This technique will incorporate sterile mulch, tackifier, a sterile cover crop and provenance seed. The majority of the native grass seed to be included are from the following species *Themeda australis*, *Microlaena stipoides* and *Capillipedium spicigerum*.
Additional grass species are to be included for increased diversity as the opportunity presents and may include *Sorghum leiocladum*, *Poa labillardieri*, *Austrostipa ramosissima*, *Bothriochloa macra*, *Dicanthium sericeum*, *Austrodanthonia tenuior*, *Chloris truncata* and *Chloris ventricosa.*
Mid-storey species recommended for inclusion in the mulch mix include pioneer *Acacia* species such as *Acacia falcata*, *Davesia spp.*, *Dilwynia seiberi*, *Dodonaea viscose var. cuneata*, *Hardenbergia violocea*, *Lomandra longifolia*, *Bursaria spinosa, Plectanthrus parviflorus* and *Wahlenbergia gracilis*. This will assist in increasing the density of shrubs across the site.
It is anticipated that hydromulching will take place in Autumn 2012. The addition of a sterile cover crop is recommended, Rye corn is suitable for this time of year and should be applied at 7.5kg per hectare.

3.3 Plant Propagation and Supply

All plants are to be propagated by a nursery specialising in native plant supply using appropriate provenance material. Plants should be supplied in ‘hiko’ cells; these plants are an ideal size for planting, requiring a significantly smaller planting hole than a forestry tube.

Plants in this size container also have a high root to stem ratio, thereby requiring lower resource levels to maintain plant health and vigour, and are ready for rapidly establishment.

Plants supplied must be consistent with the following characteristics:

- Large healthy root systems, with no evidence of root curl, restriction, damage or compaction
- The overall habit, leaf form and colour of the plants shall be characteristic of the species and shall show consistent growth with canopies of uniform density
- All plants shall be fresh and exhibit new growth with fibrous root system and capable of holding potting mix together without restriction or damage
- Vigorous, well established, free from disease and pests, of good form consistent with the species.
- Hardened off in their final contains, not soft or forced, and suitable for planting in the natural climatic conditions prevailing at the site.

It is recommended that the threatened species *Grevillea juniperina* be propagated and installed as part of the patch connection planting. Approval for the collection, propagation and installation of this species must be gained from the Office of Environment and Heritage. If approval is not achieved, alternative species from the Cumberland Plain Woodland community can be substituted and installed.

3.4 Shrub and Groundcover Patches

An appropriate mix of River Flat Eucalypt Forest on Coastal Floodplain canopy, shrub and understorey species will be used to ensure that the mature vegetation community will be well structured. The installation methodology was developed in line with the Recovering Bushland on the Cumberland Plain: Best practice guidelines for the management and restoration of bushland (DEC 2005).

Shrubs and groundcovers will be installed in a mosaic of patches. Patches will be ~100m^2 in area with 100 shrubs and 200 groundcovers per patch. Species composition within the patches will consist of one shrub and multiple groundcovers, patches will increase the habitat diversity across the site. Patches aim to mimic natural shrub populations within the Cumberland Plain Woodland vegetation community. As the shrubs establish, the patch microclimate will favour the establishment of groundcovers.

Groundcovers have proven difficult to establish across large areas of Western Sydney restoration sites. Patch plantings enable the establishment of plant communities that have a high level of resilience. Once established and maturing, the shrubs will set and drop seed. This will reinforce the seedbank of the restoration area.

3.5 Grass, Shrub and Groundcover Connectors

Grass and shrub connectors will be installed between one third of the shrub and groundcover patches. Each connector will be one metre wide and up to thirty metres long. Plant densities within the patches will be 6/m^2 for grasses, 2/m^2 groundcovers and 1/m^2 for shrubs.

Connectors will provide an immediate grass population across the restoration site, accelerating habitat provision and reducing erosion potential.

Multiple shrub and groundcover species will be installed into the connectors, this diversity will provide perches for small native birds and transient habitat niches for other native fauna. The

connector populations will expand as plants mature, set seed and drop seed in adjacent areas. The seed will germinate when conditions are favourable and the native plant community will evolve.

3.6 Installation Method

There will be a total of 99,000 grasses, shrubs and groundcovers installed without tree guards.

This equates to a substantial reduction in revegetation cost and planting materials, without tree guards, resources can be focused on increasing plant density and habitat diversity.

Plant holes will be dug with a mechanical auger to a width of 75-100mm. The base of the hole will be excavated to a depth of 150mm and the sides of the hole loosened to prevent confinement of root growth. Plants are to be pre-watered and then removed from containers ensuring minimal disturbance to the root ball.

Each plant will have a small quantity of soil conditioner added to the hole before placing the plant in and backfilling. This will help with plant establishment by supplying slow release nutrients and water crystals for the retention of moisture around the root zone.

Once inserted the top soil level of the plant root ball should be level with (in moist locations), and slightly depressed (in dry locations) the finished surface of the surrounding soil. Backfill with topsoil mixture, lightly tamp and water to eliminate air pockets, ensuring minimal topsoil is placed over the top of the root ball. The plant stem remains the same height above ground as it was in the container, no potting mix should be showing.

3.7 Canopy Installation in Core Riparian Zone

Canopy species will be installed in the woodland and riparian areas of zones 1, 3 and 5.

The woodland area of the batters will cover ten metres upslope from the base of the batter. Tree guards will be utilized and there will be a total of 2,300 plants installed. Tree guards will identify the location of canopy species and provide a supportive microclimate during establishment. During maintenance, up to 10% of the canopy species will be replaced to ensure survival at the appropriate plant density.

Plant installation will adopt the same technique as for shrubs, grasses and groundcovers. In addition, one jute weed mat (370mm*370mm) will be placed around each canopy species. Three bamboo stakes will be rammed through slits in the mat and into the soil. One green plastic tree guard will be placed around the stakes and the plant. Tree guards must be removed at the end of the maintenance period and disposed of at an appropriate waste management facility.

3.8 Harvest, Storage and Reinstatement of *Bulboschoenus fluviatilis*

As part of the earthworks, a 1,200m2 area of remnant wetland plants will be excavated and stockpiled on site. The bulbs will be removed along with the top 300mm of wetland soil. This bulb and soil mix will be reinstated during the final shaping and topsoil application between the two endemic water bodies; coir netting will be installed to hold the mix in place.

3.9 Wetland and Ephemeral plant Installation

A total of 66,000 wetland and 33,000 ephemeral plants installed in Zones 2 and 4.

Coir netting will be installed and fastened over the entire 0.79 hectares of Zone 2 and the 0.22 hectares of Zone 4. This netting will reduce erosive potential and will be installed at the completion of earthworks and reinstatement of the *Bulboschoenus fluviatilis* population.

Plant translocation is recommended for *Imperata cylindrica* in ephemeral areas. Colonies of this species can be found within the Erskine Park Biodiversity Corridor (EPBC). This species utilises rhizomes and is ideal for translocation, which involves digging up material from a donor site and transplanting at the restoration site. Care must be taken to ensure that the donor site is not made susceptible to weed infestation as a consequence of the removal of plant material.

Wetland and ephemeral plants will be installed with the same technique as for shrubs, grasses and groundcovers with the exclusion of the soil conditioner. Field staff will spread the net to 100mm squares at each plant location to enable the use of an earth drill/auger to prepare the planting hole. Plant densities for wetland and ephemeral species will be 6/m^2.

3.10 Establishment Watering

It is essential that revegetation is watered on installation and throughout the establishment phase. Irrigation frequency and timing will vary throughout the establishment of the seedlings and will be based around the occurrence of natural rainfall.

Strict monitoring of site conditions and plant health is required to make sure irrigation frequency is adequate. An example of a watering regime would be one watering per week for the first month, reducing to one watering every two weeks for the next two months, however this is dependant upon prevailing conditions.

Hand watering will utilise a trailer mounted water cart and roadside hydrants where accessible.

3.11 Maintenance

Restoration practical completion will be achieved at the completion of the revegetation activities outlined in this VMP. Maintenance, monitoring and reporting will continue for 24 months following practical completion. This is to account for any controlled activity approval provisions required by the NSW Office of Water. Provisions will be determined once the NSW Office of Water and Penrith City Council assess the development application for the industrial sub-division and creek realignment.

During the maintenance period, weeds will be controlled by brushcutting, spot spraying with herbicide and herbicide wiping. Tree guards will be maintained and replacement planting will be undertaken to ensure 80-85% survival of installed plants.

4. Zone Specific Restoration Strategy

The restoration site has been divided into five zones, with a total area of approximately 5.72 hectares. Each zone has unique characteristics that dictate their restoration strategies.

Appendix six contains a site plan with zone allocation.

Zone 1

Area – 2.88 hectares

Vegetation Community – River Flat Eucalypt Forest grading to Cumberland Plain Woodland

Zone 1 encompasses the batter supporting the industrial subdivision,the gradient of the batter will be one in three and its length will range from 30 to 50 metres.

Bulk earthworks will establish the adjoining industrial subdivision and shape the batter. Erosion controls measures will be installed as part of the earthworks. Coir logs are to be installed along the contours of this zone at 10 metre intervals.

Each log is 150mm in diameter and 3m long. Approximately 400 logs will be required. The material is completely biodegradable and will not be removed. The batter is approximately 50m long at its maximum and four lines of erosion prevention will be required.

Restoration activities will involve hydro-mulching with native seed, revegetation and vegetation maintenance. The native hydro-mulch mix will be applied first. The 135 patches and 45 connectors will then be installed.

Canopy species such as *Melaleuca spp., Callistemon spp.* and *Casuarina spp.* will be located close to the boundary of Zone 2. The core riparian zone plantings will reflect the River Flat Eucalypt Forest (RFEF) Vegetation community. From the base of the batter to top, the species composition will transition from the RFEF community to the Cumberland Plain Woodland Community (CPW).

Zone 2

Area – 0.79 hectares

Vegetation Community – Fresh Water Wetlands on Coastal Floodplains

Zone 2 covers the wetland and ephemeral area associated with the redirected creek and drainage swale. The area is approximately 0.79 hectares. Development earthworks will be undertaken in this zone to remove noxious and environmental weeds.

One particular wetland species, *Bolboschoenus fluviatilis,* will be harvested from an existing population on site. A native plant specialist must be onsite to direct the removal and stockpiling of the material to be harvested. Endemic wetland species will be reinstated and a new creek-line created to meet the hydrological specifications for the site.

Harvested native wetland plants will be re-planted in the wetland area between the two water bodies. Erosion controls will be installed at earthwork completion. This will consist of 400g/m^2 coir netting with 20mm squares. This netting is completely biodegradable and will remain onsite.

Restoration activities in this zone will involve wetland and ephemeral plant installation followed by vegetation maintenance. In the central stream of the creek and at the foot of the embankments, 51,200 wetland plants will be installed. Large macrophytes will be installed in the endemic water bodies. In the remainder of the embankments and within 5m of the top of the

bank, 25,600 ephemeral plants will be installed. The installed species will reflect the Fresh Water Wetlands on Coastal Floodplains vegetation community.

Zone 3

Area – 0.88 hectares

Vegetation Community – River Flat Eucalypt Forest on Coastal Floodplains

Zone 3 is divided into two sections, encompassing the level area on the northern and western boundary of the site.

This zone is relatively level and will be formed in conjunction with the water body reinstatement. Its slope will rise from the top of the creek bank to the site boundary. There is a row of Poplar trees and suckers adjacent to the western boundary of Zone 3, that will be removed prior to the commencement of earthworks. As part of the earthworks, the trees will be felled and removed by qualified arborists. Suckers will be removed by earthworking machinery and any re shooting plants will be controlled during the maintenance period. Re-shooting poplars will be sprayed with a broadleaf selective herbicide and non-ionic surfactant.

Restoration activities will involve hydromulching with native seed, revegetation and vegetation maintenance. The native hydromulch mix will be applied first, followed by the creation of 40 patches and 15 connectors. Canopy species such as *Melaleuca spp., Callistemon spp.* and *Casuarina spp.* will be located close to the boundary of zone 2. The core riparian zone plantings will reflect the River Flat Eucalypt Forest (RFEF) Vegetation community.

Zone 4

Area – 0.22 hectares

Vegetation Community – Fresh Water Wetlands on Coastal Floodplains

Zone 4 is the re-instated water quality basin in the north-eastern corner of the site, this basin will process stormwater from neighbouring areas prior to entering the waterway. The existing basin will be re-shaped during earthworks and erosion controls will be installed at earthwork completion. This will consist of 400g/m^2 coir netting with 20mm squares. This netting is completely biodegradable and will remain onsite. Restoration activities will involve wetland and ephemeral plant installation followed by vegetation maintenance. In the central section of the basin and the lower section of the embankment 8,800 wetland plants will be installed. For the remainder of the embankment and the outer edges of the basin, 4,400 ephemeral plants will be installed. The installed species will reflect the Fresh Water Wetlands on Coastal Floodplains vegetation community.

Zone 5

Area – 0.95 hectares

Vegetation Community – Cumberland Plain Woodland

Zone 5 is the existing north facing batter at the eastern end of the site,this area will function as a stockpile for mulch and topsoil during bulk earthworks. At the completion of earthworks, erosion control will be undertaken in the form of coir logs being installed along the contours of this zone

at 10 metre intervals. Each log is 150mm in diameter and 3m long. Approximately 100 logs will be required. The material will be completely biodegradable and will not be removed.

Restoration activities will involve site preparation, hydromulching with native seed, revegetation and vegetation maintenance.

Site preparation will be undertaken to control existing grass weeds, this will involve a blanket spray application of glyphosate herbicide and surfactant one month after the completion of earthworks. The area will then be slashed one month after the application of the herbicide.

Two months after the slashing, the zone will be blanket sprayed with the same herbicide mix. One week after the application of the herbicide, the zone will be hydromulched with the native seed mix.

50 patches and 20 connectors will then be installed and watered, to complete the restoration, 300 canopy species will be installed and guarded. The installed species composition will reflect the Cumberland Plain Woodland Community.

Table 2 Planting specifications

Zone	Installed Plants	Replacement Plants	Planting Technique
1 2.88ha	13,500 shrubs 27000 groundcovers 8600grasses 1550 canopy Total 50650	1350 shrubs 2700 groundcovers 860 grasses 155 canopy Total 5065	135 patches 45 connectors Guarded Canopy
2 0.79ha	25,600 ephemeral 51200 wetland 76,800 total	2560 ephemeral 5120 wetland Total 7680	Mass Planting
3 0.88ha	4000 shrubs 8000 groundcovers 2650 grasses 450 canopy Total 15,100	400 shrubs 800 groundcovers 265 grasses 45 canopy Total 1510	40 patches 15 connectors Guarded Canopy
4 0.22ha	4400 ephemeral 8800 wetland Total 13200	440 ephemeral 880 wetland Total 1320	Mass Planting
5 0.95ha	5000 shrubs 10000 groundcovers 3750 grasses 300 canopy Total 19050	500 shrubs 1000 groundcovers 375 grasses 30 canopy Total 1,905	50 patches 20 connectors Guarded Canopy
Total plants	174,800	17,480	

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Monitoring and Evaluation

5. Monitoring and Evaluation

Monitoring is critical to the success of any project, regular monitoring can quickly highlight and avert negative influences upon the site and allows tracking of objectives. A number of methods are to be utilised to monitor the success of this project and are discussed below.

An example of a monitoring form can be found in Appendix 4 – Monitoring Form Example.

5.1 Photo point monitoring

It is recommended that six permanent photographic monitoring sites be set up on site prior to restoration work commencing. Photo points should be established permanently which can be achieved through the use of star pickets. Photos will be taken prior to any works commencing and thereafter will coincide with each 6 monthly progress report to the client. These photos will be included in the progress report.

Photo point monitoring is an inexpensive and quick method that can highlight the impacts of management decisions and their coinciding on-ground activities. Photo points are useful in providing a visual image of a site/ works at any given point in time. When done properly photo point monitoring can be used to evaluate the outcome of a management action/decision.

5.2 Vegetation survey quadrats

Monitoring changes in vegetation over time can be achieved through the establishment of permanent quadrats on site. Quadrats are revisited at regular intervals over the life of the project and beyond. Project sites are often too large to monitor as a whole so the establishment of known sized quadrats allows manageable 'snapshots' of the site to be observed.

The measurements recorded from the quadrat can then be scaled up to provide a description of the whole site in a per hectare amount. To determine the size and number of quadrats required the overall size of the site should be considered.

A minimum number of three quadrats is required to achieve a good representation of an area/zone. However the number of quadrats in any given area and their location will be determined by the size of the study area, the work being undertaken, the diversity of the environment and the reason for establishing the quadrats.

It is recommend that four quadrats are established within the terrestrial zones of the site and four quadrats be established within the wetland zone.

The quadrats should be permanently marked with star pickets and all relevant information regarding its location should be recorded on the monitoring sheet. Appendix 4 has an example quadrat based field monitoring sheet that outlines the information that needs to be recorded within the terrestrial zones. This can be modified depending on the information required from the monitoring process. The original monitoring of the quadrat becomes the baseline data and all future measurements can be compared against this data.

Due to the variation within vegetation structure of wetland zones it is recommended that monitoring be conducted in a separate manner to terrestrial vegetation. Monitoring of quadrats within the wetland zone should be monitored following the Wetland Assessment Techniques Manual for Australian Wetlands (Price et al, 2007). Such monitoring will also consider habitat potential along side vegetation changes.

Monitoring requirements may change throughout the project or some types of monitoring may only need to be carried out at certain time intervals. Table 6 gives an example of a monitoring plan.

Table 3 Example monitoring plan

Monitoring requirement	Monitoring frequency			
	Opportunistic	Monthly	6 monthly	Completion
Survival rates	X	X	X	X
Weed cover	X	X	X	X
Weed species present	X		X	X
Plant densities			X	X
Native species abundance			X	X
Native vegetation cover			X	X
Native species present			X	X
Vegetation structure			X	X
Herbivory	X	X		

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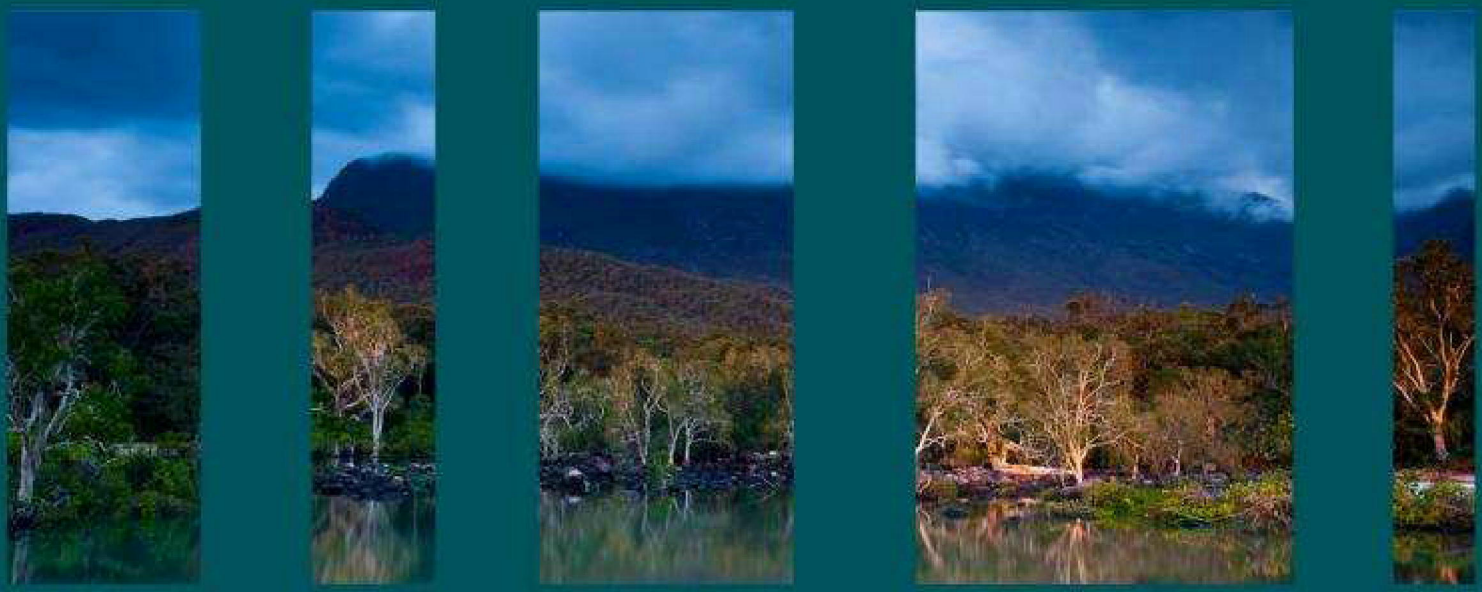


Reporting

6. Reporting

6.1 Monthly Progress Reporting to Practical Completion

Monthly progress reports should include the following information. The final progress report will summarise the restoration work undertaken to achieve practical completion.

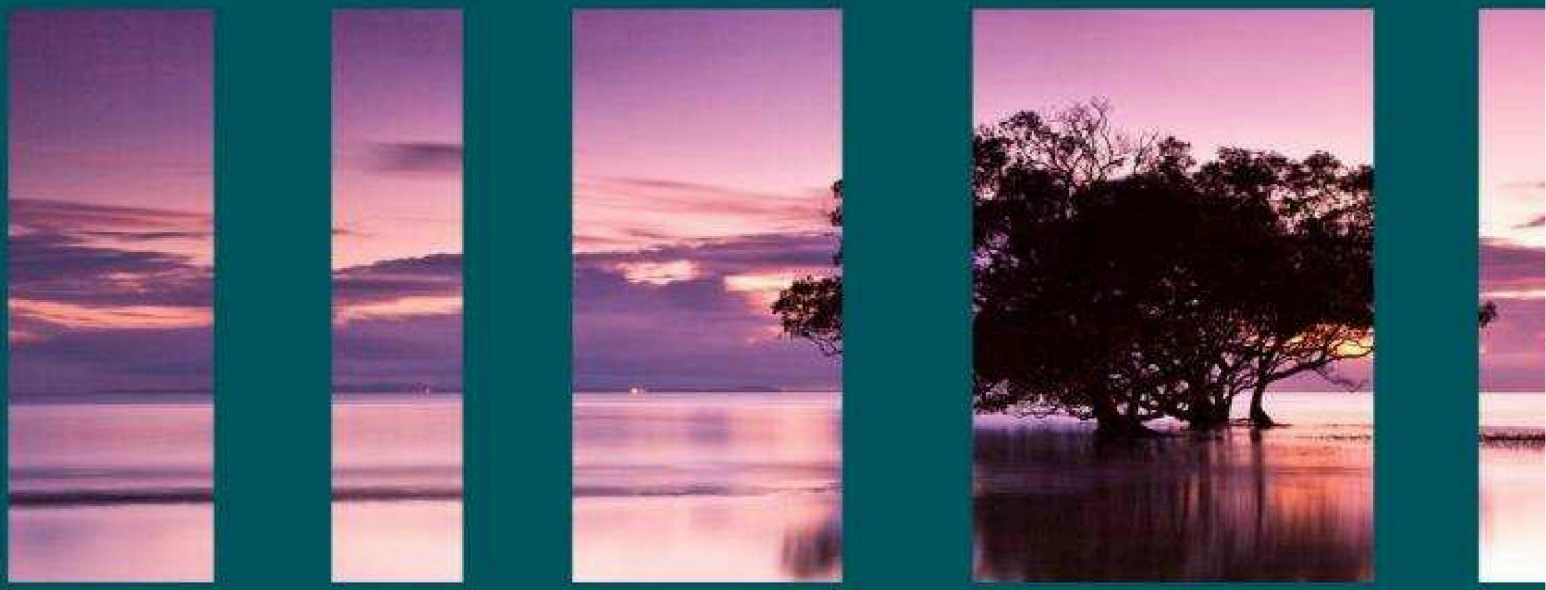
- General information including the reporting month, contact name and number, site name and location;
- A summary of the months activities e.g. site preparation
- Issues that may have presented themselves and how they were resolved
- An assessment of status against success indicators for each area and actions required to maintain/ realign program to meet indicator targets
- Completed monitoring sheets
- Analysis of monitoring data

6.2 Six Monthly Progress Report

A detailed progress report will be prepared for the client and the Office of Water at the end of each 6 month maintenance period following practical completion. Submission of the fourth maintenance report will signify project completion. Each report will include the following information:

- An assessment of the site and constraints as documented in the VMP and their impact on the actual tasks completed;
- A description of each task completed noting where deviations from the VMP have occurred and the commencement and completion date of each task.
- Colour coded maps of areas where tasks have been completed and photographic monologue from established photo points;
- Costing to date showing details on unit cost, materials, labour, watering, monitoring/maintenance/reporting etc;
- Details of any new threatened biodiversity or archaeological or heritage management requirements not documented in the VMP and how these will impact upon planting location and densities;
- Details on the progress of the planting program and methodologies used including any deviations from the VMP
- Details of any maintenance tasks completed including, but not limited to tasks related to sediment and erosion control, watering, replacement of plant losses, weed, disease and insect control as well as mulching;
- An evaluation appraisal of the completed tasks and an evaluation of the sufficiency of the monitoring and review process;
- Details of climatic conditions and where appropriate assess their impact on the progress/completion of the tasks for example increased watering required due to low rainfall and high evaporation rates; and
- Details of any other issues and/or actions such as installation of signage, relevant legislation and licences required, community involvement and liaison with stakeholders.
- An assessment of status against success indicators for each area and actions required to maintain/ realign program to meet indicator targets
- Completed monitoring sheets

- Analysis of monitoring data



Proposed On-ground Works Program

7. Proposed On-Ground Works Program

Table 1 Proposed On-ground Works Program

Indicative Workplan - Erskine Park Biodiversity Corridor - Lot 22

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Jan-12 Feb-12 Mar-12 Apr-12 May-12 Jun-12 Jul-12 Aug-12 Sep-12 Oct-12 Nov-12 Dec-12 Jan-13 Feb-13 Mar-13 Apr-13 May-13 Jun-13 Jul-14 Aug-13 Sep-13 Oct-13 Nov-13 Dec-13 Jan-14 Feb-14 Mar-14 Apr-14 May-14 Jun-14 Jul-14 Aug-14 Sep-14 Oct-14 Nov-14

Earthworks Zone

- Plant Supply
- Hydro-mulching
- Shrub & Ground Layer
- Canopy
- Establishment Watering
- Maintenance

Stockpile Zone

- Plant Supply
- Hydro-mulching
- Shrub & Ground Layer
- Canopy
- Establishment Watering
- Maintenance

Wetland/Ephemeral Zone

- Plant supply
- Installation
- Watering
- Maintenance

Management/Reporting

- Management and Reporting

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Indicative Project Costs

8. Indicative Project Costs

Below is a table showing the indicative costs for each zone. They are reported in lump sum amounts. These costs are only a guide and are subject to change. The project is currently costed to run over a period of 2.5 years.

Table 2 Indicative total costing

Zone	Activity	Cost
1	• Hydromulch	• 42,896.00
	• Plant Supply	• 49,917.50
	• Patch and Connector Installation	• 37,074.40
	• Canopy Installation	• 6,511.00
	• Watering	• 12,256.00
	• Maintenance (24 months)	• 23,937.50
	• **Sub total**	• **$172,592.40**
2	• Plant Supply	• 60,231.60
	• Plant Installation	• 35,380.80
	• Watering	• 11,973.00
	• Maintenance	• 16,029.00
	• **Sub Total**	• **$123,614.40**
3	• Hydromulch	• 13,104.00
	• Plant Supply	• 14,332.50
	• Patch and Connector Installation	• 11,325.60
	• Canopy Installation	• 1,989.00
	• Watering	• 3,744.00
	• Maintenance (24 months)	• 7,312.50
	• **Sub total**	• **$51,807.60**
4	• Plant Supply	• 16,988.40
	• Plant Installation	• 9,979.20
	• Watering	• 3,377.00
	• Maintenance	• 4,521.00
	• **Sub Total**	• **$34,865.60**
5	• Hydromulch	• 16,000.00
	• Plant Supply	• 17,963.40
	• Patch and Connector Installation	• 19,650.00
	• Canopy Installation	• 1,475.00
	• Watering	• 6,450.00
	• Maintenance (24 months)	• 18,575.00
	• **Sub total**	• **$80,113.40**
All Zones	• **Project Management**	• **$25,425.00**
	• **TOTAL**	• **$488,418.40**

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Appendices

10. Appendix 1 Declared Noxious Weeds, Hawkesbury River County Council

Weed	Class	Legal requirements
African boxthorn [Lycium ferocissimum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
African feathergrass [Pennisetum macrourum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
African olive [Olea europaea subspecies cuspidata]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
African turnipweed [Sisymbrium runcinatum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
African turnipweed [Sisymbrium thellungii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Alligator weed [Alternanthera philoxeroides]	3	The plant must be fully and continuously suppressed and destroyed
Anchored water hyacinth [Eichhornia azurea]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Annual ragweed [Ambrosia artemisiifolia]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Arrowhead [Sagittaria montevidensis]	4	The plant may not be sold, propagated or knowingly distributed.
Artichoke thistle [Cynara cardunculus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Athel pine [Tamarix aphylla]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Bathurst/Noogoora/Hunter/South American/Californian/cockle burr [Xanthium species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Bear-skin fescue [Festuca gautieri]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Black knapweed [Centaurea nigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Blackberry [Rubus fruticosus aggregate species] except cultivars Black satin, Chehalem, Chester Thornless,	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed

Dirksen Thornless, Loch Ness, Murrindindi, Silvan, Smoothstem, Thornfree		
Bridal creeper [Asparagus asparagoides]	4	The plant may not be sold, propagated or knowingly distributed.
Broomrapes [Orobanche species] Includes all Orobanche species except the native O. cernua variety australiana and O. minor	1	The plant must be eradicated from the land and the land must be kept free of the plant
Burr ragweed [Ambrosia confertiflora]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Cabomba [All Cabomba species except C. furcata]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Cayenne snakeweed [Stachytarpheta cayennensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Chilean needle grass [Nassella neesiana]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Chinese violet [Asystasia gangetica subspecies micrantha]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Clockweed [Gaura parviflora]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Columbus grass [Sorghum x almum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Corn sowthistle [Sonchus arvensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Crofton weed [Ageratina adenophora]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Dodder [Cuscuta species] Includes All Cuscuta species except the native species C. australis, C. tasmanica and C. victoriana	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
East Indian hygrophila [Hygrophila polysperma]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Espartillo [Amelichloa brachychaeta, Amelichloa caudata]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Eurasian water milfoil [Myriophyllum spicatum]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Fine-bristled burr grass [Cenchrus brownii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with

Fountain grass [Pennisetum setaceum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Gallon's curse [Cenchrus biflorus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Giant Parramatta grass [Sporobolus fertilis]	3	The plant must be fully and continuously suppressed and destroyed
Glaucous starthistle [Carthamus glaucus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Golden dodder [Cuscuta campestris]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Golden thistle [Scolymus hispanicus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Green cestrum [Cestrum parqui]	3	The plant must be fully and continuously suppressed and destroyed
Harrisia cactus [Harrisia species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Hawkweed [Hieracium species]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Horsetail [Equisetum species]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Hygrophila [Hygrophila costata]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Hymenachne [Hymenachne amplexicaulis]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Italian bugloss [Echium species]		See Paterson's curse, Vipers bugloss, Italian bugloss
Johnson grass [Sorghum halepense]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Karoo thorn [Acacia karroo]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Kochia [Bassia scoparia] except Bassia scoparia subspecies trichophylla	1	except B.scoparia subspecies trichophylla The plant must be eradicated from the land and the land must be kept free of the plant
Lagarosiphon [Lagarosiphon major]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Lantana [Lantana species]	4	The plant may not be sold or knowingly distributed.

Leafy elodea [Egeria densa]	4	The plant may not be sold, propagated or knowingly distributed.
Lippia [Phyla canescens]	4	The plant must not be sold, propagated or knowingly distributed by any person other than a person involved in hay or lucerne production. The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
Long-leaf willow primrose [Ludwigia longifolia]	3	The plant must be fully and continuously suppressed and destroyed and the plant may not be sold, propagated or knowingly distributed
Ludwigia [Ludwigia peruviana]	3	The plant must be fully and continuously suppressed and destroyed
Mexican feather grass [Nassella tenuissima]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Mexican poppy [Argemone mexicana]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Miconia [Miconia species]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Mimosa [Mimosa pigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Mossman River grass [Cenchrus echinatus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Mother-of-millions [Bryophyllum species and hybrids]	3	The plant must be fully and continuously suppressed and destroyed and the plant may not be sold, propagated or knowingly distributed
Noogoora burr [Xanthium species]		See Bathurst/Noogoora/Hunter/South American/Californian/cockle burr
Pampas grass [Cortaderia species]	3	The plant must be fully and continuously suppressed and destroyed
Parthenium weed [Parthenium hysterophorus]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Paterson's curse, Vipers bugloss, Italian bugloss [Echium species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Pellitory [Parietaria judaica]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Pond apple [Annona glabra]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Prickly acacia [Acacia nilotica]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Prickly pear [Cylindropuntia species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or

		knowingly distributed
Prickly pear [Opuntia species except O. ficus-indica]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Privet (Broad-leaf) [Ligustrum lucidum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Privet (Narrow-leaf/Chinese) [Ligustrum sinense]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Red rice [Oryza rufipogon]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Rhus tree [Toxicodendron succedaneum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Rubbervine [Cryptostegia grandiflora]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Sagittaria [Sagittaria platyphylla]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Salvinia [Salvinia molesta]	3	The plant must be fully and continuously suppressed and destroyed
Senegal tea plant [Gymnocoronis spilanthoides]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Serrated tussock [Nassella trichotoma]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Siam weed [Chromolaena odorata]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Smooth-stemmed turnip [Brassica barrelieri subspecies oxyrrhina]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Soldier thistle [Picnomon acarna]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Spiny burrgrass [Cenchrus incertus]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Spiny burrgrass [Cenchrus longispinus]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed

Spotted knapweed [Centaurea stoebe subspecies micranthos]	1	The plant must be eradicated from the land and the land must be kept free of the plant
St. John's wort [Hypericum perforatum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Texas blueweed [Helianthus ciliaris]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Tropical soda apple [Solanum viarum]	2	All of NSW except the local control authorities listed as a class 3 noxious weed The plant must be eradicated from the land and the land must be kept free of the plant
Water caltrop [Trapa species]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Water hyacinth [Eichhornia crassipes]	3	The plant must be fully and continuously suppressed and destroyed
Water lettuce [Pistia stratiotes]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Water soldier [Stratiotes aloides]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Willows [Salix species] Includes all Salix species except S. babylonica, S. x reichardtii, S. x calodendron	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Witchweed [Striga species] Striga species except the native Striga parviflora	1	The plant must be eradicated from the land and the land must be kept free of the plant
Yellow burrhead [Limnocharis flava]	1	The plant must be eradicated from the land and the land must be kept free of the plant
Yellow nutgrass [Cyperus esculentus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with

Description of noxious weed classes

CLASS 1 – STATE PROHIBITED WEEDS	
Class characteristics:	Class 1 noxious weeds are plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.
Control objective:	To prevent the introduction and establishment of those plants in NSW.
Control measures:	The plant must be eradicated from the land and the land must be kept free of the plant. The plant must not be sold, propagated or knowingly distributed.
CLASS 2 – REGIONALLY PROHIBITED WEEDS	
Class characteristics:	Class 2 noxious weeds are plants that pose a potentially serious threat to primary production or the environment of a region and are not present in the region or are present only to a limited extent.
Control objective:	To prevent the introduction and establishment of those plants in parts of NSW.
Control measures:	The plant must be eradicated from the land and the land must be kept free on the plant. The plant must not be sold, propagated or knowingly distributed.
CLASS 3 – REGIONALLY CONTROLLED WEEDS	
Class characteristics:	Class 3 noxious weeds are plants that pose a serious threat to primary production or the environment of an area to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.
Control objective:	To reduce the area and the impact of those plants in parts of NSW.
Control measures:	The plant must be fully and continuously suppressed and destroyed AND for some specific weeds, the plant must not be sold, propagated or knowingly distributed.
CLASS 4 – LOCALLY CONTROLLED WEEDS	
Class characteristics:	Class 4 noxious weeds are plant that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.
Control objective:	to minimize the negative impact of those plants on the economy, community or environment of NSW.
Control measures:	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority AND for some specific weeds, the plant must not be sold, propagated or knowingly distributed.
CLASS 5 – RESTRICTED PLANTS	
Class	Class 5 noxious weeds and plants that are likely, by their sale or the sale of

characteristics:	their seeds or movement within the State or an area of the State, to spread in the State or outside the State.
Control objective:	To prevent the introduction of those plants into NSW, the spread of those plants within NSW or from NSW to another jurisdiction.
Control measures:	The requirements of the Noxious Weeds Act 1993 for a notifiable weed must be complied with. The plant must not be sold, propagated or knowingly distributed.

11. Appendix 2 Vegetation Communities – Plant Species

11.1 River-Flat Eucalypt Forest on Coastal Floodplains Species List

Botanical Name	Common Name
Canopy – Alluvial Woodland	
Angophora floribunda	rough-barked apple
Angophora subvelutina	broad-leaved apple
Casuarina glauca	she-oak
Eucalyptus amplifolia	cabbage gum
Eucalyptus bauerana	blue-box
Eucalyptus tereticornis	forest red gum
Canopy – Riparian Forest	
Angophora subvelutina	broad-leaved apple
Casuarina glauca	she-oak
Eucalyptus amplifolia	cabbage gum
Eucalyptus botyroides	bangalay
Eucalyptus elata	river peppermint
Middle Storey:	
Acacia decurrens	Sydney green wattle
Acacia parramattensis	Parramatta green wattle
Breynia oblongifolia	coffee bush
Bursaria spinosa	black thorn
Callistemon salignus	willow bottlebrush
Leptospermum polygalifolium	lemon-scented tea-tree
Melaleuca linarifolia	snow-in-summer
Melaleuca stypheloides	prickly-leaved paperbark
Ozothamnus diosmifolium	pill flower
Groundcovers:	
Centella asiatica	swamp pennywort
Commelina cyanea	scurvy weed
Dichondra repens	kidney weed
Einadia hastata	saloop
Geranium solanderi	Australian cranesbill
Oplismenus aemulus	basket grass
Pandorea pandorana	wonga wonga vine
Pratia purperescens	white root
Rubus parvifolius	native rasberry
Wahlenbergia gracilis	native bluebell

Grasses:	
Austrostipa ramosissima	
Capillipedium parviflorum	Scented top
Danthonia tenuior	wallaby grass
Dichelachne micrantha	Shorthair plume grass
Echinopogon caespitosus var. caespitsus	hedgehog grass
Imperata cylindrical var. major	bladey grass
Lomandra filiformis	wattle mat-rush
Lomandra longifolia	mat rush
Microlaena stipiodes	weeping meadow grass
Stipa verticillata	spear grass
Themeda triandra	kangaroo grass
Sedges/ rushes:	
Bolboschoenus fluviatilis	marsh club rush
Carex apressa	
Eleocharis cylindrostachys	
Juncus usitatus	common rush
Schoenoplectus mucronatus	

11.2 Cumberland Plain Woodland Species List

Species	
Acacia decurrens	Eucalyptus fibrosa
Acacia falcata	Eucalyptus moluccana
Acacia implexa	Eucalyptus tereticornis
Acacia parramattensis	Exocarpos cupressiformis
Aristida ramosa	Glycine clandestina
Aristida vagans	Glycine tabacina
Arthropodium milleflorum	Goodenia hederacea
Asperula conferta	Hardenbergia violacea
Brunoniella australis	Hibbertia diffusa
Bursaria spinosa	Hypericum gramineum
Cheilanthes sieberi	Hypoxis hygrometrica
Chloris truncata	Indigofera australis
Chloris ventricosa	Lepidosperma laterale
Commelina cyanea	Lissanthe strigosa
Corymbia maculata	Lomandra filiformis
Cyperus gracilis	Lomandra multiflora
Daviesia ulicifolia	Melaleuca decora
Dianella longifolia	Microlaena stipoides
Dianella revoluta	Oplismenus aemulus
Dichelachne micrantha	Oxalis exilis
Dichondra repens	Panicum simile
Dillwynia sieberi	Phyllanthus filicaulis
Echinopogon caespitosus	Pratia purpurascens
Echinopogon ovatus	Solanum pungetium
Entolasia marginata	Themeda australis
Eragrostis leptostachya	Tricoryne elatior
Eremophila debilis	Vernonia cinerea
Eucalyptus crebra	Wahlenbergia gracilis
Eucalyptus eugenioides	

11.3 Freshwater Wetlands on Coastal Floodplains Species List

Scientific Name	
Alisma plantago-aquatica	*Myriophyllum propinquum*
Azolla filiculoides var. rubra	*Myriophyllum variifolium*
Azolla pinnata	*Najas marina*
Baumea articulata	*Najas tenuifolia*
Baumea rubiginosa	*Nymphaea gigantea*
Bolboschoenus caldwellii	*Nymphoides geminata*
Bolboschoenus fluviatilis	*Nymphoides indica*
Brasenia schreiberi	*Ottelia ovalifolia*
Carex appressa	*Panicum obseptum*
Centipeda minima	*Panicum vaginatum*
Ceratophyllum demersum	*Paspalum distichum*
Cyperus lucidus	*Persicaria attenuata*
Eclipta platyglossa	*Persicaria decipiens*
Eclipta prostrata	*Persicaria hydropiper*
Eleocharis acuta	*Persicaria lapathifolia*
Eleocharis equisetina	*Persicaria strigosa*
Eleocharis minuta	*Philydrum lanuginosum*
Eleocharis sphacelata	*Phragmites australis*
Fimbristylis dichotoma	*Potamogeton crispus*
Gratiola pedunculata	*Potamogeton ochreatus*
Hemarthria uncinata	*Potamogeton perfoliatus*
Hydrilla verticillata	*Potamogeton tricarinatus*
Hydrocharis dubia	*Pseudoraphis spinescens*

Juncus polyanthemos	*Ranunculus inundatus*
Juncus usitatus	*Schoenoplectus litoralis*
Leersia hexandra	*Schoenoplectus mucronatus*
Lemna spp.	*Schoenoplectus validus*
Lepironia articulata	*Spirodella spp.*
Ludwigia peploides subsp. montevidensis	*Triglochin procera sensu lato*
Marsilea mutica	*Typha orientalis*
Maundia triglochinoides	*Utricularia australis*
Myriophyllum crispatum	*Vallisneria spp.*
Myriophyllum latifolium	*Wolffia spp.*

12. Appendix 3 Threatened Flora and Fauna of the Penrith LGA

Legal Status Types:	
E1	- Endangered (Threatened Species Conservation Act, 1995)
E2	- Endangered Population (Threatened Species Conservation Act, 1995)
E4	- Presumed Extinct (Threatened Species Conservation Act, 1995)
E4A	- Critically Endangered (Threatened Species Conservation Act, 1995)
V	- Vulnerable (Threatened Species Conservation Act, 1995)
FE	- Endangered (Fisheries Management Act, 1994)
FEP	- Endangered Population (Fisheries Management Act, 1994)
FV	- Vulnerable (Fisheries Management Act, 1994)
FX	- Presumed Extinct (Fisheries Management Act, 1994)
P	- Protected (National Parks and Wildlife Act, 1974)
P13	- Protected Plants (National Parks and Wildlife Act, 1974)

U	- Unprotected

12.1 Threatened Flora Species

Plants	Scientific Name	Common Name	Legal Status	Count
Apocynaceae				
	Marsdenia viridiflora subsp. viridiflora		E2	16
Casuarinaceae				
	Allocasuarina glareicola		E1	33
Fabaceae (Faboideae)				
	Dillwynia tenuifolia		V	160
	Pultenaea parviflora		E1	60
Fabaceae (Mimosoideae)				
	Acacia bynoeana	Bynoe's Wattle	E1	37
Lobeliaceae				
	Hypsela sessiliflora		E1	7
Myrtaceae				
	Eucalyptus benthamii	Camden White Gum	V	6
	Micromyrtus minutiflora		E1	45
Orchidaceae				
	Pterostylis saxicola	Sydney Plains Greenhood	E1	1
Proteaceae				
	Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	V	151
	Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	2
	Persoonia nutans	Nodding Geebung	E1	168
Thymelaeaceae				
	Pimelea spicata	Spiked Rice-flower	E1	6

12.2 Threatened Fauna Species

	Scientific Name	Common Name	Legal Status	Count
Amphibia				
Hylidae				
	Litoria aurea	Green and Golden Bell Frog	E1	9
Aves				
Acanthizidae				
	Pyrrholaemus saggitatus	Speckled Warbler	V	13
Accipitridae				
	Circus assimilis	Spotted Harrier	V	1
	Hieraaetus morphnoides	Little Eagle	V	3
	Lophoictinia isura	Square-tailed Kite	V	4
Anatidae				
	Stictonetta naevosa	Freckled Duck	V	2
Ardeidae				
	Botaurus poiciloptilus	Australasian Bittern	V	1
	Ixobrychus flavicollis	Black Bittern	V	1
Burhinidae				
	Burhinus grallarius	Bush Stone-curlew	E1	2
Cacatuidae				
	Callocephalon fimbriatum	Gang-gang Cockatoo	V	6
	Calyptorhynchus lathami	Glossy Black-Cockatoo	V	6
Ciconiidae				
	Ephippiorhynchus asiaticus	Black-necked Stork	E1	4
Estrildidae				
	Stagonopleura guttata	Diamond Firetail	V	2

Meliphagidae				
	Grantiella picta	Painted Honeyeater	V	1
	Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	3
	Xanthomyza phrygia	Regent Honeyeater	E1	15
Neosittidae				
	Daphoenositta chrysoptera	Varied Sittella	V	37
Petroicidae				
	Melanodryas cucullata	Hooded Robin	V	1
	Petroica boodang	Scarlet Robin	V	12
	Petroica phoenicea	Flame Robin	V	5
Psittacidae				
	Glossopsitta pusilla	Little Lorikeet	V	4
	Lathamus discolor	Swift Parrot	E1	31
	Neophema pulchella	Turquoise Parrot	V	2
Scolopacidae				
	Limosa limosa	Black-tailed Godwit	V	1
Strigidae				
	Ninox connivens	Barking Owl	V	2
	Ninox strenua	Powerful Owl	V	1
Tytonidae				
	Tyto novaehollandiae	Masked Owl	V	13
Gastropoda				
Camaenidae				
	Meridolum corneovirens	Cumberland Plain Land Snail	E1	126
Mammalia	Scientific Name	Common Name	Legal Status	Count

Dasyuridae				
	Dasyurus maculatus	Spotted-tailed Quoll	V	4
Molossidae				
	Mormopterus norfolkensis	Eastern Freetail-bat	V	20
Petauridae				
	Petaurus australis	Yellow-bellied Glider	V	1
	Petaurus norfolcensis	Squirrel Glider	V	3
Phascolarctidae				
	Phascolarctos cinereus	Koala	V	5
Pteropodidae				
	Pteropus poliocephalus	Grey-headed Flying-fox	V	44
Vespertilionidae				
	Chalinolobus dwyeri	Large-eared Pied Bat	V	4
	Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	4
	Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	23
	Myotis macropus	Southern Myotis	V	14
	Scoteanax rueppellii	Greater Broad-nosed Bat	V	11

13. Appendix 4 Monitoring form example

13.1 Floristic Site Survey Form – Quadrat

General quadrat information:

Quadrat id:	Date:	Site:	Recorder:
Quadrat size:	**Photo id:**	**Corner of quadrat photo taken from:**	**Compass bearing for photo direction:**
GPS coordinates: Easting:	**Northing:**	**Corner of quadrat that coordinates are for:**	**Compass bearing from 1st corner to 2nd:**

Vegetation structure:

Stratum	Height (m)	% cover	Dominant species

Revegetation success:

Measure	Observation			Comments/actions required
Percent cover – native	%			
Percent cover - weed	%			
Densities	**No. of plants**	**Survival rates**	**% survival**	
Trees				
Shrubs				
Groundcovers				
Growth across quadrat:	uniform	patchy	sparse	
Herbivory detected:	no	some	extensive	

General site info:

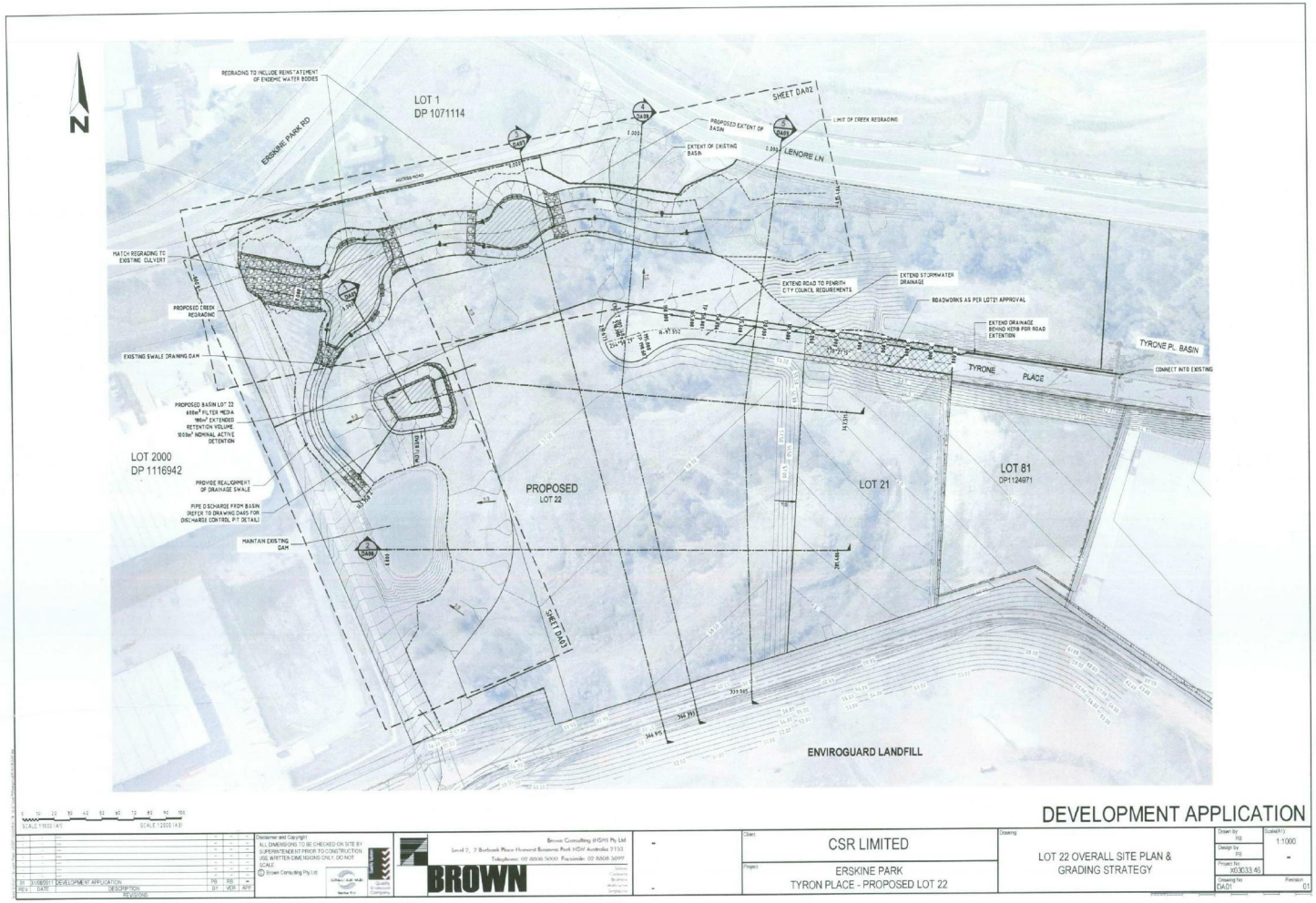
Erosion control measures in good condition? (comment)

Tree guards in good condition? (comment)

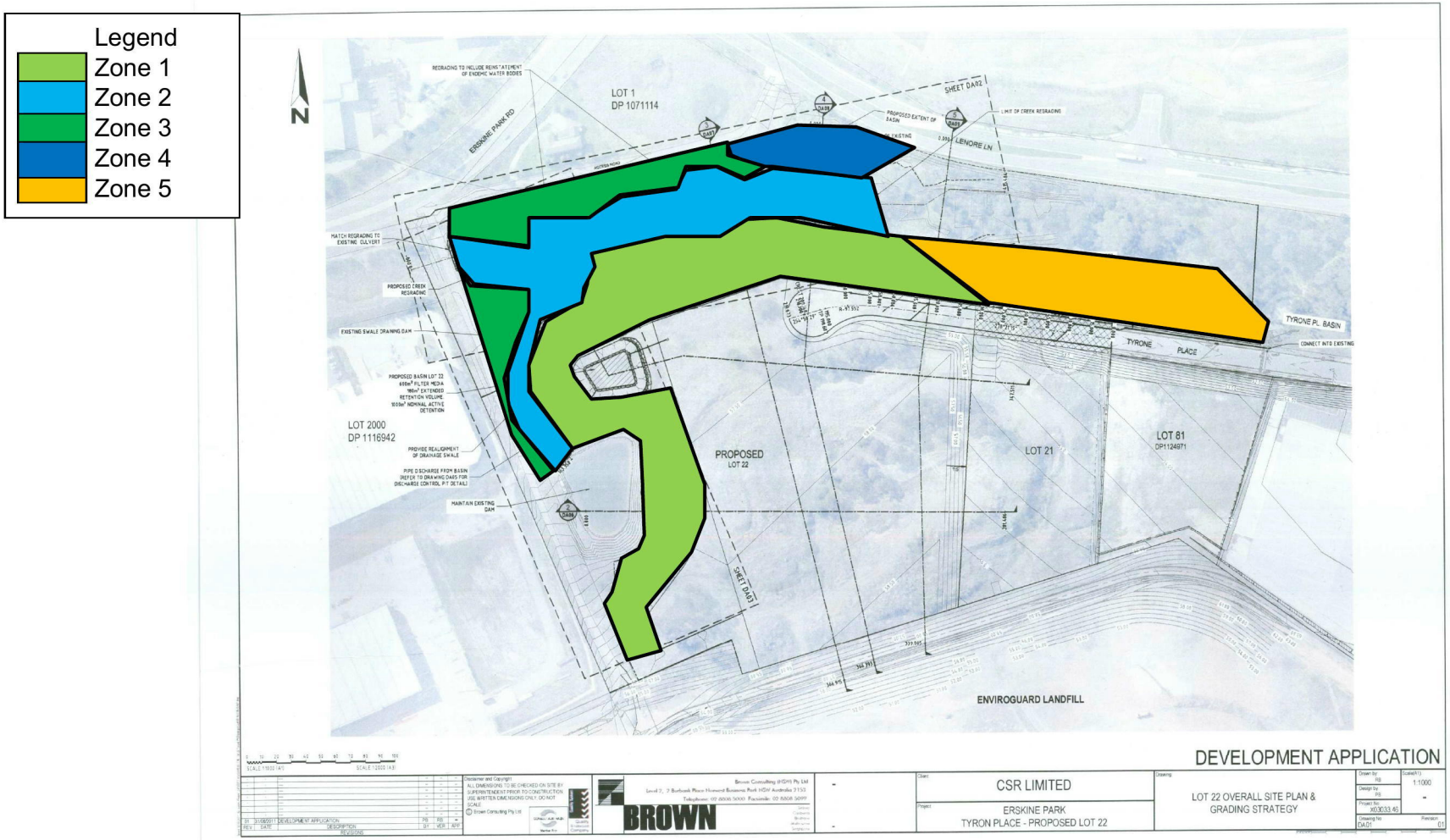
Irrigation system functioning properly? (comment)

Additional comments:

14. Appendix 5 Site Plan



15. Appendix 6 Site Plan with Zoning



Lot 22 Tyrone Place

Ecological Report

Prepared for CSR Building Products Ltd.

by WetlandCare Australia

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Lot 22 Tyrone Place, Erskine Park currently stands as a drained wetland with input from an unnamed creek which flows through the property. A diverse range of native plants exist on site, interspersed with a variety of exotic plants (see table 1). Although no formal fauna studies have occurred, a range of faunal species have been observed on site including; frogs, snakes, lizards and numerous wetland and woodland birds.

The current ecological function of the wetland area is that of habitat provision and water quality improvement. The previous draining of the wetland for weed control and future development nearby has left the main wetland site relatively dry with no standing open water. This has allowed a number of native *Juncus* species to recolonise.

In order to maintain ecological function for the proposed creek realignment and wetland system, design and construction details should:

- Include a floodplain element
- Include open water and littoral zones
- Retain mature trees where possible for seed production
- Maximise potential habitat and include water polishing elements such as macrophyte zones, sedimentation pond and water level control structures
- Remove or control all pest species

The inclusion of these elements will ensure the ecological benefits of the site are maintained and improved in terms of both habitat provision and ecological function.

Recommendations provided herein relate to current working drawings X030033 Drawingset A3 20110902_110920 provided to us by CSR Building Products Ltd. WetlandCare Australia request to review any amended drawings and would appreciate the opportunity to have a representative on site during construction phases, particularly of wetland ponds and riffle zones.

Table 1. Weeds and native plants recorded on site

Native	Weed
Bolboschoenus fluviatilis	**Typha sp.**
Carex spp	**Araujia sericifera**
Casuarina glauca	**Asparagus asparagoides**
Chenopodium sp.	**Aster squamatus**
Cynodon dactylon	**Cirsium arvense**
Juncus subsecundus	**Cortaderia jubata**
Ludwigia peploides	**Cyperus eragrostis**
Myriophyllum sp.	**Juncus acutus**
Paspalum distichum	**Paspalum dilatatum**
Persicaria decipiens	**Ranunculus sceleratus**
Persicaria hydropiper	**Rubus anglocandicans**
Persicaria lapathifolia	**Salix fragilis**
Triglochin microtuberosum	**Salvinia molesta**
Triglochin procerum	**Solanum pseudocapsicum**

Eastern Gambusia *(Gambusi holbrooki*) have been observed in the existing creek. NSW DPI has listed Eastern gambusia as noxious in NSW. Eastern gambusia is an aggressive predator and is listed as a Class 1 noxious species outside the greater Sydney area. They are known to attack, kill and eat small native fish, water bugs, frog eggs and tadpoles. They compete for food with native fish, eat their eggs and attack and kill the fry. Gambusias also eat frog eggs and attack tadpoles by nipping their tails, often killing the tadpoles. They also eat many different types of water bugs.

Recommendations

- Provision should be made for the dispersal of native animals to the adjacent eastern site by staged earthworks beginning at the western end of the site.
- An opportunity exists prior to earthworks to relocate frog species from existing wetland area upstream to existing creek.
- Remove all *Juncus acutus* and stockpile for drying out and disposal.
- Remove all other weeds, notably Blackberry, Willows and Pampas Grass.
- Large stands of *Bulboschoenus fluviatilis* exist in the main wetland; these should be retained where possible however in the event of earthworks in existing stands, the bulbs should be collected and stored for replanting following works.
- Collect seed from existing stands of *Carex* sp. and native *Juncus* sp. for hand broadcasting following works.
- Collect seed from existing Melaleuca and Casuarina species for propagation and revegetation.
- Retain remnant Eucalypts where works are to begin on eastern section of creekline.
- Install high density patchwork planting for wetland revegetation (6 - 8 plants /m^2).

- Remove Gambusia from existing creek prior to connection to new creekline.
- Open water pond construction should ensure a range of depths are provided (as a guideline 30% < 0.5m, 50% 0.5 – 1.0m, 20% > 1.5m but not more than 2.5m)
- Install rocks in centre of larger wetland to provide a refuge island. This should be low in profile and not more than 30cm above normal water level.
- Outlet drain from existing southern dam should be planted out with appropriate wetland littoral zone species outlined in Table 2 as part of the treatment train for water quality objectives.
- All artificial rock riffle structures must be constructed so they are not a barrier to fish migration. The gradient of the downstream face should not be less than 1:20 (ie. not steeper) and the upstream face and sides no greater than 1:4. Rocks used must resist erosion and match local geology. Some oversized rocks should be used to create complex hydraulic flows and provide a range of habitat conditions. A shallow V-shaped crest should be formed across the riffle to concentrate flows to the centre, reducing the chance of flows outflanking the riffle zone and thus allowing fish passage for a greater range of flows.
- Rock cairns should be placed on outer bends of channel to prevent erosion during high flows.
- All large trees removed during earthworks should be retained for use as habitat elements. Large woody debris should be installed as per design drawings X030033.
- Any surface that has been graded to expose subsoil must have clean topsoil applied to a minimum depth of 200mm and covered with coir netting prior to planting. Top soil removed from the site as part of earthworks should not be reused due to the risk of spreading *J. acutus* seeds.
- Ongoing monitoring and management of weeds, particularly *J. acutus,* is essential.

Table 2. Species suitable for wetland, littoral zone and floodplain revegetation

Aquatic	Littoral zone	Ecotone	Floodplain
	Baumea articulata	*Carex appressa*	*Capillipedium spicigerum*
Ludwigia peploides	*Bulboschoenus caldwellii*	*Juncus usitatus*	*Casuarina glauca*
Myriophyllum papillosum	*Bulboschoenus fluviatilis*	*Juncus subsecundus*	*Lomandra longifolia*
Triglochin procerum	*Lepironia articulata*	*Lomandra longifolia*	*Melaleuca linariifolia*
Triglochin microtuberosum	*Philydrum lanuginosum*	*Phragmites australis*	*Melaleuca styphelioides*
	Paspalum distichum	*Paspalum distichum*	*Poa labillardieri*
	Schoenoplectus validus	*Triglochin striatum*	*Themeda australis*

WetlandCare Australia is willing to assist CSR during the construction phase of the proposed creek realignment and wetland establishment to ensure the best ecological outcomes are achieved.