CSR Ltd

CSR Subdivision, Erskine Park

Vegetation Management Plan

January 2006

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Executive Summary

GHD has prepared this Vegetation Management Plan (VMP) for CSR Ltd. The VMP covers the restoration program associated with the relocated creek, 'Southern Lands'. This VMP, and the subsequent implementation of recommended restoration works, are required to satisfy Part 3A of the *Rivers and Foreshore Improvement (RFI) Act 1948 (NSW)*, in relation to the proposed development. A Part 3A permit is required under the *RFI Act* as the proposed development occurs on protected land, which includes the bank, shore or bed of those water bodies and adjacent land within 20m of the top of their banks. The existing ephemeral creek is known as protected waters and includes perennial (flowing) or intermittent (often dry) streams under the *RFI Act*. The conditions of the *RFI Act* are administered by the Department of Natural Resources (DNR), formerly the Department of Infrastructure Planning and Natural Resources (DIPNR).

The aim of this VMP is to describe the existing site characteristics in relation to vegetation, soils and waterways, and to provide recommendations for riparian zone restoration works. The recommended vegetation restoration program described in this VMP has been developed by carrying out thorough site assessments. This also included desktop studies of previous reports, field investigations, liaison with relevant stakeholders, and review of current guidelines.

This VMP covers the restoration of approximately 5.95 hectares of a relocated ephemeral creek. The reconstruction of such a creek line and restoration of appropriate riparian vegetation (20m either side from top of bank and the creek line) will be the key outcomes of this VMP. The VMP also includes a description of works required on two small areas, located away from the creek line, to compensate for the reduced length of vegetated stream on site.

The Riparian Zone has been broken into two distinct areas. The first area, the restoration zone, will be a complete fabrication of a riparian system with the second, the regeneration zone, being restored using techniques sympathetic to the existing native vegetation.

There is an extensive ground cover over the entire site thereby minimising potential erosion threat. The regeneration zone contains significant native vegetation, re-growth of approximately 40 years of age and showing a high level of 'natural resilience'. The site contains both Sydney Coastal River Flat Forest (SCRFF) and Shale Plains Woodland (SPW) vegetation communities. Canopy tree species comprise of: forest red gum, (*Eucalyptus tereticornis),* cabbage gum (*Eucalyptus amplifolia*), grey box *(E. moluccana),)* and *Casuarina glauca.* The understorey is dominated by blackthorn, (*Bursaria* spinosa) with the ground cover varying from mixed native and introduced pasture through to pure stands of weeping meadow grass, (*Microlena* stipiodes). Other species present include thin-leafed stringy bark (*Eucalyptus euginiodes*), prickly-leaved paperbark (*Melaleuca styphelioides)* and white feather honeymyrtle (*Melaleuca decora).*

The creek and its restoration present a good opportunity to enhance the planned biodiversity corridors throughout the Erskine Park Release Area.

This VMP has been prepared in accordance with DNR guidelines and addresses the following issues: legislative requirements and VMP methodology, existing site conditions, riparian zone

protection, initial weed control, site preparation, supply of plant material, plant installation, program of works, costing, and monitoring and evaluation.

The vegetation to be restored on site will consist of appropriate mixes of canopy, mid-storey and groundcover species from SCRFF and SPW vegetation communities listed as Ecologically Endangered Communities of the Cumberland Plain (EECCP). As such these vegetation communities are listed under the *Threatened Species Conservation (TSC) Act 1995 (NSW)* and the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999.* Therefore restoration works will require a separate Section 123C licence under the *TSC Act.* All plants to be used in the restoration works will be sourced from local provenance material collected in the area and grown by local nurseries.

Most plants in the riparian zone will be planted as hikos or enviro cells. All tree and shrub species will be suitably guarded to prevent herbivory and weed competition and to encourage optimum growing conditions.

Weed control and bush regeneration works will take into account the habitat value of any weeds and the legislative requirements for their removal under the *Noxious Weeds Act 1993 (NSW).* Weed control will be carried out using physical removal and spraying techniques as appropriate. All waste vegetative matter will be disposed of off site at a suitably licensed green waste facility, and all weed propagules will be bagged, before disposal at a suitably licensed mixed waste facility.

The revegetation program will be the subject of a 24-month maintenance program that will include weed control, watering and plant replacement where necessary. The maintenance program will also include the preparation of 4 half yearly monitoring and evaluation reports, to assess the success of the restoration program and the achievement (or otherwise) of clear performance targets. A final report to satisfy practical completion requirements and the part 3A permit will also be produced. The final report will be available to interested and concerned parties. The reports will also contain a photographic record of the restoration works using fixed photo-points and a digital camera.

This VMP also contains an Opinion of Probable Costs for the restoration works to assist in accurately budgeting for these works and to allow for the estimation of the 'bond'. The bond is required to be lodged by the proponent with DNR as well as implementing the restoration works recommended in this VMP.

1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) has been engaged by CSR Ltd (CSR) to prepare a Vegetation Management Plan (VMP) for the 'Southern Lands' at Erskine Park Release Area (EPRA). The subdivision and development of the site will require the relocation of an ephemeral creek. The NSW Department of Natural Resources (DNR) has approved the relocation of the creek but in accordance with the Rivers and Foreshores Act 1948, a VMP is required. Hence this VMP has been prepared to provide a clear, concise and practical framework for the revegetation of the relocated ephemeral creek that is in accordance with the requirements of the *Rivers and Foreshore Improvement Act, 1948.*

1.2 Aims and Objectives

The VMP aims to provide a clear, concise and practical framework for the revegetation of the relocated creek.

The objectives of the VMP are:

- To determine local vegetation characteristics;
- To describe the restoration activities necessary to restore native vegetation;
- Describe the maintenance program to ensure establishment;
- Provide an appropriate costing for restoration work; and

1.3 Relationship with existing reports

Due to the large number of interested parties involved in the EPRA several reports and documentation already exist regarding the native vegetation occurring on site and possible restoration programs. The VMP has taken into consideration the impacts of the following documentation:

- Biodiversity Restoration Plan: Erskine Park Release Area, 2005;
- Conservation and Development Strategy Erskine Park Release Area, 2003;
- Vegetation Management Plan Bluescope Steel, 2004;
- Vegetation Management Plan Chep Site, 2005;
- Vegetation Management Plan Walker, 2004;
- Flora and Fauna Assessment Lots 3, 4, & 7, 2002; and
- Bush Fire Risk Management Plan, 2004.

All work to be performed on site will also be in accordance with the following guidelines:

- "Recovering Bushland" Best Practice Guidelines for Vegetation Restoration on the Cumberland Plain, DEC, 2005;
- Flora bank Seed Collection and Management Guidelines, updated 2004;

- DIPNR's Best Practice Guidelines for Bush Regeneration on the Cumberland Plain, 2004; and
- GANSW Best Practice Revegetation Guidelines, 1999.

1.4 Relevant Legislation

The VMP has been prepared in accordance with the provisions contained in relevant legislation and policy guidelines, including but not limited to the following:

1.4.1 Rivers and Foreshores Improvement Act 1948

This VMP, and the subsequent implementation of recommended restoration works, are required to satisfy Part 3A of the *Rivers and Foreshore Improvement (RFI) Act 1948 (NSW)*, in relation to the proposed development. A Part 3A permit is required under the *RFI Act* as the proposed development occurs within 40m of an ephemeral creek, considered a 'protected waterway' under the *RFI Act*. The conditions of the *RFI Act* are administered by the Department Natural Resources (DNR). The conditions of consent of the development application to Penrith City Council also require satisfactory compliance with the conditions of the *RFI Act*.

1.4.2 Threatened Species Conservation Act 1995

The objects of the Threatened Species Act (TSC Act) 1995 are to conserve biological diversity and promote ecologically sustainable development, to prevent the extinction and promote the recovery of threatened species, populations and ecological communities, to protect the critical habitat of those threatened species, populations and ecological communities that are endangered, to eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities, to ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed, and to encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

The TSC Act includes schedules which list threatened species, populations and ecological communities and key threatening processes.

1.4.3 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act) makes it an offence for a person to undertake an action that has the potential to significantly impact on a matter of 'national environmental significance' without first obtaining a permit from the Commonwealth Minister for Environment and Heritage. Matters of national environmental significance include: declared World Heritage areas; declared Ramsar wetlands; listed threatened species and ecological communities; listed migratory species; listed marine species; nuclear actions; and the environment of Commonwealth marine areas.

This VMP also addresses issues concerning licensing of restoration works under the *Threatened Species Conservation Act 1995 (NSW) (TSC)*.

1.4.4 Native Vegetation Act 2003

The Native Vegetation Conservation Act 2003 is administered by DNR.

The Native Vegetation Conservation Act includes the requirements relating to the clearing of native vegetation and protected land. The Act encourages and promotes the management of native vegetation on a regional basis in the social, economic and environmental interests of the State and prevents broad scale clearing unless it improves or maintains environmental outcomes.

1.4.5 Noxious Weeds Act 1993 (NSW)

This VMP also considers the landowner's obligations to control weeds listed as noxious in the Penrith City Council LGA under the *Noxious Weeds Act 1993 (NSW)*. In this case, the only noxious weeds found on site are African Boxthorn, Blackberry and Prickly pear, listed as a W2 and W4f category weeds respectively under the Act. As such, the owners of the site are legally obliged to 'fully and continuously suppress and destroy' these particular weeds.

1.4.6 Other Legislation and Policies

Other legislation and policies that are relevant to the VMP include:

- Hawkesbury Nepean Catchment Blue Print 2001
- Local Government Act 1993 and Local Government Amendment (Community Land Management) Act 1998
- Relevant Penrith City Council legislation and LEP

The above listed legislation has been identified as being highly relevant to the restoration activities associated with the relocated creek. This list by no means covers all relevant legislation pertaining to the site.

1.5 List of Abbreviations

The following summarises the various abbreviations used throughout the VMP.

DNR	Department of Natural Resources
DEC	Department of Environment & Conservation
LGA	Local Government Area (Penrith City Council)
LEP	Penrith Local Environment Plan
EPRA	Erskine Park Release Area
EECCP	Endangered Ecological Communities of the Cumberland Plain
SPW	Shale Plains Woodland
SHW	Shale Hills Woodland
SCRFF	Sydney Coastal River Flat Forest
TSC Act	Threatened Species Conservation Act

EP&BC Act	Environmental Protection and Biodiversity Conservation Act
BRP	Biodiversity Restoration Plan
VMP	Vegetation Management Plan
APZ	Asset Protection Zone (firebreak)

2. Site Description

2.1 Site Location

The site is located in Penrith LGA to the south of the residential suburb of Erskine Park. The site is bordered by Mamre Road to the west and Ropes Creek to the east with the southern boundary being the Sydney Catchment Authority pipeline easement. The location and site details are shown in Appendix A & B. The combined area of the site being restored is approximately 5.95 ha.

For ease of description the relocated creek site has been broken up into two distinct zones.

- **Restoration Zone** – Refers to the section of creek and associated riparian zone being totally reconstructed and located outside the biodiversity corridors. Works in this zone will be a complete fabrication for both creek construction and associated vegetation embellishment.
- **Regeneration Zone** – Refers to the section of creek and associated riparian zone located inside the biodiversity corridors. Work will occur within existing vegetation and will require sensitive restoration actions. Earthworks will be limited to the narrow drainage line only and have been designed to minimise their impact on existing native vegetation. The creek restoration program will include bush regeneration initiatives.

Refer to Appendix A for outline of above described zones.

There are two small areas of land to be restored to compensate for the reduction in vegetated creek length included in the VMP. These are shown in Appendix C and are referred to as Compensation Zone 1 and 2.

2.2 Climate

The Commonwealth Bureau of Meteorology website provides the following climatic information taken from Badgerys Creek weather station (closest station to site). Mean rainfall peaks in summer and ranges from 95 mm in January and February down 33 mm in July. Mean daily maximum temperatures range from 28.5°C in summer to 17°C in winter with mean daily minimum temperatures ranging from 17°C in summer down to 4°C in winter.

In general, autumn is the best season for planting as summer temperatures can be to high for young plants to establish and peak frosts in winter also impede survival rates. Planting in early spring can be effective as long as a suitable watering regime is implemented.

2.3 Topography

There will be significant changes to current topography, particularly in the restoration zone. The current site will be 'levelled' through an appropriate 'cut and fill' program with the bulk earthworks including the relocation and reconstruction of the creek as per Landscape Drawings in Appendix A and B.

The regeneration zone, however, will remain largely as is except for the earthworks associated with the construction of the drainage channel (again see Appendix A and B). This

area forms part of the flood plain for various small drainage lines and ephemeral creeks and as such is fairly flat. The area contains intermittent or scattered 'ponds' of water and a relatively good cover of SCRFF and SPW vegetation.

2.4 Geology and Soils

Alluvial Woodland is listed as a sub-vegetation community under Sydney Coastal River Flat Forest (SCRFF) and has been mapped as Map Unit 11 by DEC (Appendix E). Map Unit 11 often occurs exclusively along, or in close proximity to minor watercourses draining soils from Wianamatta Shale. It is the most common community found on soils of recent alluvial deposition. This is the dominant vegetation community found, and to be restored, throughout the riparian zone.

Shale Plains Woodland, mapped as Map Unit 10, by NPWS (Appendix F), predominately occurs on soils derived from Wianamatta Shale. Map Unit 11 grades into Map Unit 10 as we move away from the creek bank, usually associated with increase in slope and change in hydrology. This vegetation community will be restored on the sloped 'batters' and at the headwaters of the creek.

2.5 Hydrology

The site contains two small ephemeral drainage lines flowing from the headwaters of the South Creek Catchment towards the west from a small ridge included in the biodiversity corridors. The ridge is actually the divide between the South Creek and Ropes Creek catchments. Generally, both drainage lines are a chain of intermittent ponds, only flowing in significant rain events. The drainage lines meet at the western end of the regeneration zone and continue to flow west before entering South Creek. The majority of the site behaves as a small floodplain for the sub catchment and shows minimal signs of erosion.

The ephemeral drainage line to the north of the biodiversity corridors will be 'filled' during construction of the building pad. To 'offset' the filling of the drainage line the creek will be relocated and an appropriate riparian vegetation system recreated. This will alter the floodplain dynamics and therefore slightly change current hydraulic situation. Detailed modelling and floodplain assessment has been undertaken to finalise relocated creek design to minimise impact on floodplain function.

2.6 Vegetation

The area covered by this VMP contains two vegetation communities listed as endangered under the TSC Act, these being Sydney Coastal River Flat Forest (SCRFF) and Shale Plains Woodland (SPW) (See Appendix E and F). SCRFF communities can be found throughout the floodplain in the regeneration zone. The restoration zone currently has 'pockets' of regenerating SCRFF and SPW but these will be removed during the earthworks component of creek relocation.

Generally speaking, vegetation existing throughout the site is re-growth, approximately 40 years of age. Vegetation within the regeneration zone is in good condition and shows a high level of 'natural resilience'. The proposed restoration program has considered the high level of resilience and has been designed accordingly.

The canopy of the regeneration zone is dominated by *Casurina glauca*, with specimens of *Eucalyptus amplifolia, E. tereticornis* and *E. molucana.* The understorey is dominated by *bursaria spinosa* with only a scattering of other shrub species present. This is typical of SCRFF. The ground cover is dominated by native grasses and forbes including *Microlena stipoides, Commelina cyanea, Lomandra spp* and *Dichondra repens.* Other species present include thin-leafed stringy bark (*Eucalyptus euginiodes*) and white feather honeymyrtle (*Melaleuca decora).*

The restoration zone contains scattered representatives of canopy species from both SCRFF and SPW (as above) and includes *Eucalyptus molucana.* The understorey is literally non-existent with only scattered specimens of *Bursaria spinosa* present. The ground cover is a mixture of introduced and native grasses and includes *Themada australis, Aristita ramose* and *Dichelachne micrantha.*

The level of weed infestation is low and sporadic, particularly relating to woody weeds. Scattered specimens of both blackberry and prickly pear will be targeted during bush regeneration program with the majority of actions focusing on introduced pastures and annual weeds.

Figure 1: Vegetation in Regeneration Zone

3. Description of Proposed Development

3.1 Built Form

The proposed development to the north of the creek will form part of the Erskine Park Release Area and will include facilities compatible with this landuse.

3.2 Riparian Restoration Work

The proposed development of the 'Southern Lands' will include the relocation and restoration of an unnamed ephemeral creek.

Works within the restoration zone will achieve a complete fabrication of an ephemeral creek system and associated vegetation.

Works in the regeneration zone will be sympathetic to existing native vegetation and seek to restore a functioning ephemeral system with minimal engineering and earthworks. The narrow reconstructed channel will have an appropriate revegetation program applied. These works will be supplemented by bush regeneration activities targeting existing riparian vegetation.

The program includes the restoration of Compensation Zones 1 and 2 (See Appendix C). Works in the compensation zones will seek to revegetate drainage channels with endemic native vegetation. These works will help compensate for the reduction in vegetated creek length and have been endorsed by DNR staff. The proposed riparian zone revegetation works program is shown in Appendix D.

4. VMP Direction

4.1 Site Opportunities and Constraints

The relocation and reconstruction of the small ephemeral creek described in this VMP provides opportunities in riparian system restoration under several difficult constraints. Opportunities embraced in the restoration program include:

- Setting new benchmark in the detailed design of ephemeral drainage line within an urban environment;
- Utilising 'best practice' vegetation restoration techniques endorsed by DEC for the Cumberland Plain;
- Integrating ecological function and engineering design to achieve a balanced landscape outcome and riparian function;
- Utilising new technology to control erosion while restoring vegetation;
- Increase the size and function of existing biodiversity corridors; and
- Improve water quality leaving the development site and entering the South Creek Catchment.

Constraints encountered during project design include:

- Presence of both SCRFF and SPW, listed EEC's under both state and federal legislation;
- The role of the site as a floodplain for the sub catchment;
- The need to balance economic outcomes from the development with management of existing natural resources;
- Current land zoning; and
- Limited examples of similar projects being undertaken.

4.2 Project Tasks and Objectives

This VMP has been prepared according to the current DNR guidelines ("*How to Prepare a Vegetation Management Plan, Version 4*). This requires the VMP to address the following issues:

- Site assessment and determination of constraints (eg. flora and fauna, habitat and corridor values, hydrology, fire issues, services, drainage, topography, weeds, etc).
- Definition of project tasks (description of all tasks necessary to implement the plan).
- Preparation of a program of works.
- Liaison with other consultants, landscape architects, government agencies and local Bushcare groups, as required.
- Preparation of a plant species lists, and maps and diagrams.
- Details on site preparation (protection of existing plants, erosion control, site works, weed control, soil amelioration, seed collection, etc).

- Description of planting program and methodology.
- Description of maintenance program.
- Description of monitoring and review process.
- Addressing other potential issues (signage, other relevant legislation, other site areas, public relations, community involvement, etc).
- Preparation of costing of restoration works.

The VMP was also prepared using field investigations to determine the types and location of native vegetation and weeds on site, as well as to assess habitat, corridor connectivity, soil types and stream bank conditions. This information was supplemented by desktop research of existing reports pertaining to the site, and current vegetation maps and restoration guidelines. A full list of reference documents is included in Section 7.0.

The preparation of this VMP also involved liaison with the following stakeholders and/or review of their relevant documents pertaining to the proposed development:

- DNR and DEC
- GANSW
- John Lock & Associates Landscape Architects
- Brown Pty Ltd Engineering and Management
- Penrith City Council

4.3 Description of Key Terms

The following key terms are used throughout the description of the proposed restoration program.

- ***Regeneration*** - Refers to natural regeneration of the vegetation community;
- ***Bush regeneration*** - Refers to techniques used to assist and promote natural regeneration without utilising plant material propagated in nurseries;
- ***Revegetation*** - Refers to the planting of tube stock or similar grown from local provenance seed to re-establish vegetation;
- ***Restoration***- Refers to a combination of restoration activities and management techniques to restore native vegetation;
- ***Practical completion***-Refers to the completion of installation of revegetation activities;
- ***Maintenance*** - Refers to the minimum 24-month maintenance program applied to revegetation work to ensure plant establishment; and
- ***Final Completion*** Refers to the completion of the maintenance program.

5. Restoration Program

The following information provides a detailed description of all activities required to implement the VMP.

5.1 Site Preparation

It is assumed that all tasks outlined under the CSR Southern Lands Bulk Earthworks Plan have been completed and that actions recommended in this VMP are for works from this point through until the completion of the vegetation restoration program. Therefore all earthworks, rock installation and the 'respreading' of topsoil will have been completed for the entire length of the relocated stream.

It is important to note in this VMP that the topsoil being used will be from 'on-site' and that careful surveying of regeneration zone was undertaken to minimise disturbance to existing vegetation during earthworks.

5.1.1 Site Protection

To ensure the success of the restoration program it will be necessary to control access into the riparian zone. The restoration area will have appropriate temporary fencing erected to clearly delineate the zone. Bulk earthworks will continue outside the restoration zone, as part of the development for some time and machines will need to be restricted from the area.

The regeneration zone is situated inside the biodiversity corridors and will be enclosed by a permanent stock fence and have access controlled. Fencing will be limited to temporary fencing to delineate construction zone for earthworks until completed. No machines will be allowed outside this area in the regeneration zone.

5.1.2 Erosion control

At the completion of bulk earthworks appropriate sediment control fencing will be installed as necessary and maintained throughout the duration of the program. Installation will be in accordance with bulk earthworks sediment control plan.

Areas of exposed or re-spread topsoil will be sprayed with an appropriate hydro mulch medium. The "mixture" will include a sterile cover crop, jute fibre and a mixture of native seed. Experience has shown that using a mixture of native peas and Acacia's in the hydro mulch is a very inexpensive way to establish native vegetation in difficult sites.

The reconstructed creek line will include a number of drop structures as shown in Appendix B. Each drop structure will be revegetated with species selected from Table: 3. In addition to this, 'wetland mats' will be installed on the down stream end of each structure to control 'splash' erosion. These mats have wetland vegetation pre-germinated in jute fibre and are simply installed on site as per normal jute matting. They provide instant erosion protection and negate the need to install plants in the jute matting by hand.

5.1.3 Section 132C Licence

This legislation states that if any revegetation or weed control works are undertaken in an 'Endangered Ecological Community' (EEC), a Section 123C licence is required under the provisions of the TSC Act. As the restoration of SPW, and SCRFF is proposed for the development site, a Section 123C licence will be required, due to their listing under the TSC Act. GHD's recommends that works associated with this VMP be undertaken using existing DEC Section 132C licence currently held by CSR for Erskine Park. DEC simply request an additional copy the VMP, to verify works proposed, and copies of the regular half yearly monitoring reports (as for DNR) to keep them updated of the progress of the works.

5.1.4 Seed Collection

Experienced and qualified GANSW staff will perform seed collection activities. All seed collection, management, cleaning and storage will be in accordance with *Flora bank Seed Collection Guidelines* (prepared by Greening Australia and now accepted as industry best practice). (A copy can be provided if required)

All plant material to be used throughout the project will be of local provenance, collected from within a 5 km radius of the site. To ensure the collection process does not delay the project GANSW can supplement collection program by drawing seed from its existing seed bank for the Erskine Park Release Area. This will allow plant propagation to occur in line with timeline constraints.

5.1.5 Plant Propagation

Plant propagation refers to the germinating of collected seed and the 'growing on' of plants in enviro cells, hiko cells or forestry tubes. This activity will be managed by the GANSW wholesale nursery at Richmond.

The restoration program will include the use of wetland mats. The mats are prepared in 'jute master' erosion control matting and involves the pre-germination of wetland plants in a controlled environment before installation in the field. The mats will be installed in the channel in areas of high erosion potential and at the end of each 'drop' structure. Again, this activity will be managed by the GANSW wholesale nursery.

5.2 Revegetation

To implement the VMP and achieve DNR targets, GHD recommends a combination of revegetation techniques be employed. Each of the techniques proposed are described below.

5.2.1 Installation of T-Tape Irrigation System

Before revegetation activities commence a t-tape irrigation system will be installed throughout the restoration zone. The system will be installed underground to provide an efficient method of watering (no loss through evaporation) for such a large area for up to three years. Installation of the system helps ensure DNR survival targets are reached as the contractor can adapt watering regime to suitable climatic conditions.

5.2.2 Installation of Native Tube stock

All plant material to be used in the riparian zone restoration works will be sourced from local provenance material collected in the area.

To allow for enough lead-in time for the propagation of provenance species, seed collection should start as soon as the 123C licence approval from DEC is granted. The vegetation to be restored on site will consist of appropriate mixes of canopy, mid-storey and groundcover species from SPW, and SCRFF vegetation communities. The general percentage structural composition of canopy to middle storey to groundcovers of these communities near drainage lines is approximately 20%: 40%: 40%.

Most plants in the restoration zones will be planted as hiko or enviro cells. All tree and shrub species will be suitably guarded to prevent herbivory and weed competition, and to encourage optimum growing conditions. Guards will comprise a plastic tree guard and three bamboo stakes.

Figure 2: Restoration Zone

All plants will be installed either by hand or by mechanical planter if site conditions permit. For **hand** installation the planting hole will be a minimum of 25% larger than the planting container and its edges will be suitably 'roughed' prior to plant installation. The planting hole will then be backfilled with soil and firmly tamped down by hand and foot.

For **mechanical** installation GHD recommends the use of the 'Treeliner ®'. This planter does not utilize deep ripping techniques and as such causes minimal soil disturbance during the planting operation. It simply cuts a knife line through the soil, spreads the cut wide enough to insert the plant and then utilizes press wheels to compact the soil around the plant. The operator on the planter also places the mats and bags along side each plant.

A GANSW trained team of 5 or 6 staff will then trail behind the planter. The first member will complete the "pressing in" of the plant and place stakes at the plant. The remainder of the team co-ordinate activities to complete the bagging and staking of the plants.

Each plant will have a recycled paper disc placed around its base and then bagged using a plastic tree guard, stabilised by three bamboo stakes.

A proposed plant schedule for each vegetation community is given in Tables 1, 2 and 3. These tables provide a list of suitable species for the site at densities appropriate for those canopy, shrub, ground covers and sedges and rushes. It should be noted that this is a fairly expansive list to select from, so as to satisfy DNR approved guidelines and that not all plants will necessarily be represented in the restoration works.

Table: 1 Plant Schedule for SPW

Scientific Name	Common Name	Density
Canopy:		
Eucalyptus amplifolia	cabbage gum	1 per 10m2
Eucalyptus crebra	narrow-leaved ironbark	1 per 10m2
Eucalyptus eugenioides	thin-leaved stringybark	1 per 10 m2
Eucalyptus moluccana	grey box	1 per 10m2
Eucalyptus tereticornis	forest red gum	1 per 10m2
Middle story:		
Acacia decurrens	Sydney green wattle	1 per 2m2
Acacia falcata	hickory wattle	1 per 2m2
Acacia parramattensis	Parramatta green wattle	1 per 2m2
Bursaria spinosa	black thorn	1 per m2
Clematis glycinoides		1 per m2
Davesia ulicifolia		1 per m2
Davesia genistifolia		1 per m2
Dillwynia sieberi	parrot pea	1 per m2
Dodenea viscosa	giant hop bush	1 per m2
Melaleuca decora	white feather honey myrtle	1 per 2m2

Ozothamnus diosmifolium	everlasting	1 per m2
Pultenaea microphylla	Bush pea	1 per m2
Ground Covers:		
Aristida ramosa		4 per m2
Arthropodium milleflorum	pale vanilla lily	4 per m2
Brunoniella australis	blue trumpet	4 per m2
Chloris ventricosa		4 per m2
Chrysocephelum semipapaosum		4 per m2
Commelina cyanea	scurvy weed	4 per m2
Cymbopogon refractus	barbed-wire grass	4 per m2
Danthonia tenuior **	wallaby grass	4 per m2
Dianella longifolia	flax lily	4 per m2
Dianella revoluta		4 per m2
Dichelachne micrantha	shorthair plume grass	4 per m2
Dichondra repens		4 per m2
Echinopogon caespitosus var. caespitosus	tufted hedgehog grass	4 per m2
Glycine tabacina	love creeper	4 per m2
Hardenbergia violacea	hardenbergia	4 per m2
Hibbertia diffusa		4 per m2
Hypericum gramineum		4 per m2
Imperata cylindrica		4 per m2
Lomandra longifolia	matt rush	4 per m2
Lomandra multiflora		4 per m2
Lomandra filiformis		4 per m2
Lotus australis		4 per m2
Microlaena stipoides var. stipoides **	weeping meadow grass	4 per m2

Oplismenus aemulus		4 per m2
Themeda australis **	kangaroo grass	4 per m2
Tricoryne elatior		4 per m2
Wahlenbergia gracilis	native bluebell	4 per m2

Table: 2 Plant Schedule for SCRFF

Botanical Name	Common Name	Density
Canopy:		
Angophora floribunda	rough-barked apple	1 per 5m2
Angophora subvelutina	broad-leaved apple	1 per 5m2
Casuarina glauca	she-oak	1 per 5m2
Eucalyptus amplifolia	cabbage gum	1 per 10m2
*Eucalyptus bauerana**	blue box	1 per 10m2
Eucalyptus tereticornis	forest red gum	1 per 10m2
Middle Storey:		
Acacia parramattensis	Parramatta green wattle	1 per 2m2
Bursaria spinosa	black thorn	1 per m2
Callistemon salignus	willow bottlebrush	1 per m2
Leptospermum polygalifolium	lemon-scented tea-tree	1 per m2
Melaleuca linarifolia	snow-in-summer	1 per 2m2
Melaleuca stypheloides	prickly-leaved paperbark	1 per 2m2
Melaleuca decora	white feather honey myrtle	1 per 2m2
Ozothamnus diosmifolium	everlasting	1 per m2
Groundcovers:		
Centella asiatica		4 per m2
Commelina cyanea	scurvy weed	4 per m2

Dichondra repens		4 per m2
Einadia hastata		4 per m2
Geranium homeanum		4 per m2
Lomandra longifolia	mat rush	4 per m2
Lomandra filiformis		4 per m2
Microlaena stipoides	weeping meadow grass	4 per m2
Oplismenus aemulus		4 per m2
Pratia purperescens		4 per m2
Rubus parvifolius		4 per m2
Themeda triandra	kangaroo grass	4 per m2
Wahlenbergia gracilis	native bluebell	4 per m2

Table: 3 Wetland/Ephemeral species

Species Name	**Common Name**	**Density**
Alisma plantago-aquatica	Water plantain	8 per m2
Baumea articulata	jointed twigrush	8 per m2
Bolboschoenus spp		8 per m2
Carex opressa		8 per m2
Cotula coronopifolia		8 per m2
Damasonium minus	Star fruit	8 per m2
Eleocharis sphacelata	rush	8 per m2
Juncus usitatus	common rush	8 per m2
Ludwigia peploides		8 per m2
Marsilea hirsuta	nardoo	8 per m2
Otelia ovalifolia		8 per m2
Paspalum distichum	water couch	8 per m2
Persicaria dicipiens	slender knotweed	8 per m2

Philydrum lanuginosum	frogsmouth	8 per m2
Phragmites australis	common reed	8 per m2
Protamogeton tricarinatus		8 per m2
Schoenoplectus mucronatus	Bog Bullrush	8 per m2
Schoenoplectus validus	Great Bullrush	8 per m2
Triglochin procera		8 per m2

5.2.3 Direct Seeding

Direct seeding is the delivery of native seeds into the soil using a mechanical seeder known as the "Rodden". Acacia's and other legumes fix nitrogen in the soil while growing and can therefore greatly improve soil condition. Many of these plants also flower heavily and are therefore very attractive to birds and insects. The addition of these pollinators into the revegetation work adds diversity and brings opportunities for natural regeneration.

5.2.4 Hand Broadcasting of Native Seed

To supplement the establishment of native trees, shrubs and lower story species GHD proposes to hand broadcast native grass seed throughout the maintenance period of the restoration program. This will add further diversity to the site, particularly ground covers, and assist in achieving DNR targets for planting densities in 3A permit works when required.

The completion of the revegetation (planting works) will be considered the date of 'Practical Completion' for the restoration works and will signal the commencement of the 24 month maintenance program. The completion of the 24-month maintenance program will be considered as 'Final Completion' for the revegetation works. It should be noted that the maintenance program consists of weed control in and around the bagged plants, guard repair and replacement of plants where applicable.

The 24-month maintenance program will run concurrently with the bush regeneration program.

5.3 Maintenance Program

All plantings will be subjected to a minimum 24 – month maintenance program to ensure plant establishment and requirements of the RFI Act are met. Activities will include such things as watering, herbicide spraying and general maintenance.

5.3.1 Watering

Plants installed by the mechanical planter will be watered as required by the T-Tape irrigation system. All plants installed by hand will be 'watered in', with each plant receiving a minimum five litres. All hand plantings will then receive a further three applications of water during the

first 6 weeks to assist establishment. Should weather conditions remain dry for an extended period of time follow-up watering may be required. If so, discussion between client and contractor may be necessary to cover the cost of additional watering.

5.3.2 Maintenance Spraying

To ensure the success of the revegetation activities it is essential to control weed infestation. Weeds compete with the newly installed plants for nutrients and water thereby limiting their survival and growth rates.

Mechanically planted areas will be sprayed with a vehicle operated mechanical spray system. Areas where revegetation activities are dominated by hand planting will be sprayed with Round-up® Biactive herbicide using "back packs".

The maintenance program includes five scheduled visits targeting maintenance spraying, three in the first year and two in the second. All spraying will be carried out by suitably qualified contractors.

5.3.3 General Maintenance

Five general maintenance visits have been scheduled throughout the two - year maintenance period. These activities will include repairing damaged tree guards, monitoring survival rates, installing replacement plants as required, weeding inside the tree guards and continued follow-up spot spraying.

5.4 Weed Control and Bush Regeneration Program

GHD recommends noxious weeds are treated in a targeted weed control program and that all remaining weeds be included the bush regeneration program. All weed control and bush regeneration activities to be completed by suitably qualified contractor.

5.4.1 Target Weed Control

This component of the restoration program refers to the control of listed noxious weeds such as blackberry *(Rubus fruticosus)* and African boxthorn *(Lycium ferocissimum)* and large woody weeds such as willows and African olive. This program requires specialised equipment and chemicals and will be managed by appropriately trained GANSW staff. Control of these plants usually requires several treatments and is most effective during summer.

For a complete list of noxious weeds found throughout the site see Table 5, below.

Table: 4 Noxious Weeds in Penrith LGA Found on Site

Botanical Name	Common Name	Category
Rubus fruticosus	blackberry	**W3**

Lycium ferocissimum	African boxthorn	**W2**
Opuntia spp	prickly pear	**W4f**

Note: The category of W2, W3 and W4b is defined as follows (from *the Noxious Weeds Act 1993*):

W2 Must be fully and continuously suppressed and destroyed.

W3 = Must be prevented from spreading and its numbers and distribution reduced.

W4b Applies to weeds that do not fit W1, W2 or W3 categories but may require control in certain areas, or situations

For a complete list of Noxious weeds found throughout the Penrith LGA see Appendix G.

5.4.2 Bush Regeneration Program

The condition of the re-growth vegetation throughout regeneration zone is excellent considering its relatively young age. Vegetation in the regeneration zone has high 'natural resilience', as evident by the natural regeneration occurring across the site since grazing stock was removed.

There is only a 'scattering' of noxious and woody weeds found across the site and these will be treated in the target weed control program. Bush regeneration activities will target the perennial weed paddies lucerne and a variety of annual weeds and introduced pastures. Weeds to be treated during bush regeneration program include paddies lucerne, fleabane, scotch thistle, fireweed, kikuyu and a small patch of African love grass. Treatment techniques for these and other weeds are described in Appendix H.

Due to the low level of weed infestation the recommended bush regeneration program includes **six** sessions in the first year and **four** sessions in the second.

5.5 Monitoring and Reporting

In order to accurately evaluate the success of the riparian zone restoration works, the DNR VMP Guidelines, and the conditions of the 3A permit require that a monitoring and evaluation program is put into place for the restoration works, with regular half-yearly progress reports to be submitted to DNR by the restoration contractor.

The monitoring and evaluation program should address the following issues:

- Plant growth, percentage cover and survival rates;
- Plant losses through herbivory, disease, vandalism, storm damage or other factors;
- Weed regrowth and control measures;
- Plant replacement;
- Guard repair and weeding inside guards;
- Maintenance watering regime; and
- Stream bank erosion.

The above issues can be addressed through the set-up of simple monitoring tools in representative quadrats in the planting zone. GHD has provided a monitoring field sheet as Appendix I to help record this data.

It is also essential to keep an accurate photo-record of the progress of the restoration works by setting up an appropriate number of representative fixed photo-points across the entire restoration area. Photos should be taken by digital camera and recorded in the project file by date and discrete photo-point number. Photo-point locations should be clearly marked on site and mapped by a surveyor or by GPS.

All of the above monitoring and evaluation information is to be presented in clear and concise half-yearly monitoring reports that will be prepared by the implementing contractor. The reports will be presented in hard copy and digital format to DNR, the client and GHD. Copies may also need to be sent to DEC as part of the S123C licence conditions, and to Penrith City Council to satisfy DA conditions. An initial restoration report will be prepared at Practical Completion to provide a baseline summary of riparian zone conditions for the remaining half-yearly monitoring reports.

The half yearly monitoring reports should also contain recommendations by the restoration contractor to the client in regard to issues affecting the ongoing success of the restoration works, and the possible need for additional activities that may be required outside the normal maintenance.

6. Program of Works

It is envisaged that the site preparation works, which includes; installation of temporary fencing, seed collection, weed control, slashing and spraying will begin as soon as appropriate permits are in place (3A Permit and 123C DEC Licence) and as soon as site conditions allow. (See Appendix D)

7. Costings

An opinion of probable cost for all of the restoration works described in this VMP is presented in Table 5, below. However, it is important to remember that this is only an estimation of indicative costs based on industry standards, to assist the client in budgeting more accurately for the works, as well as to provide an indication of the restoration bond needed to be lodged with the DNR (as part of the 3A Permit under the *RFI Act 1948*).

Table: 5 Opinion of Probable Costs for Riparian Zone Revegetation Works

Item	Description	Total (ex GST)
1.	Fencing to exclude stock from riparian zone	$ 2,600.00
2.	Seed collection & Licensing	$ 29,920.00
3.	Rubbish Removal	$ 1,240.00
4.	Hydro mulching	$ 29,445.00
5.	Installation of T-Tape irrigation	$ 27,965.00
6.1.	Supply and install native plants, with guards, mat and stakes in riparian zone (26,315 Hikos)	$111,838.00
6.2.	Supply and install native wetland plants in drainage channel (18,172 enviro cells)	$ 29,984.00
6.3.	Revegetation of Compensation Zones	$ 29,324.00
6.4.	Revegetation of drop structures and installation of wetland mats	$ 15,330.00
6.5.	Direct Seeding and Hand Broadcasting (#)	$ 5,380.00
7.	Maintenance to establish revegetation work – includes herbicide, general maintenance and watering	$ 80,640.00
8.	Bush Regeneration – including target spraying (Boxthorn, Blackberry, Prickly Pear)	$ 14,970.00
9.	Project Management	$ 10,670.00
10.	Monitoring and evaluation reports (x5)	$ 11,100.00
Sub Total		$400,406.00
GST		$ 40,040.60
TOTAL		$440,446.60

Note: # indicates Practical Completion

8. References and Recommended Reading

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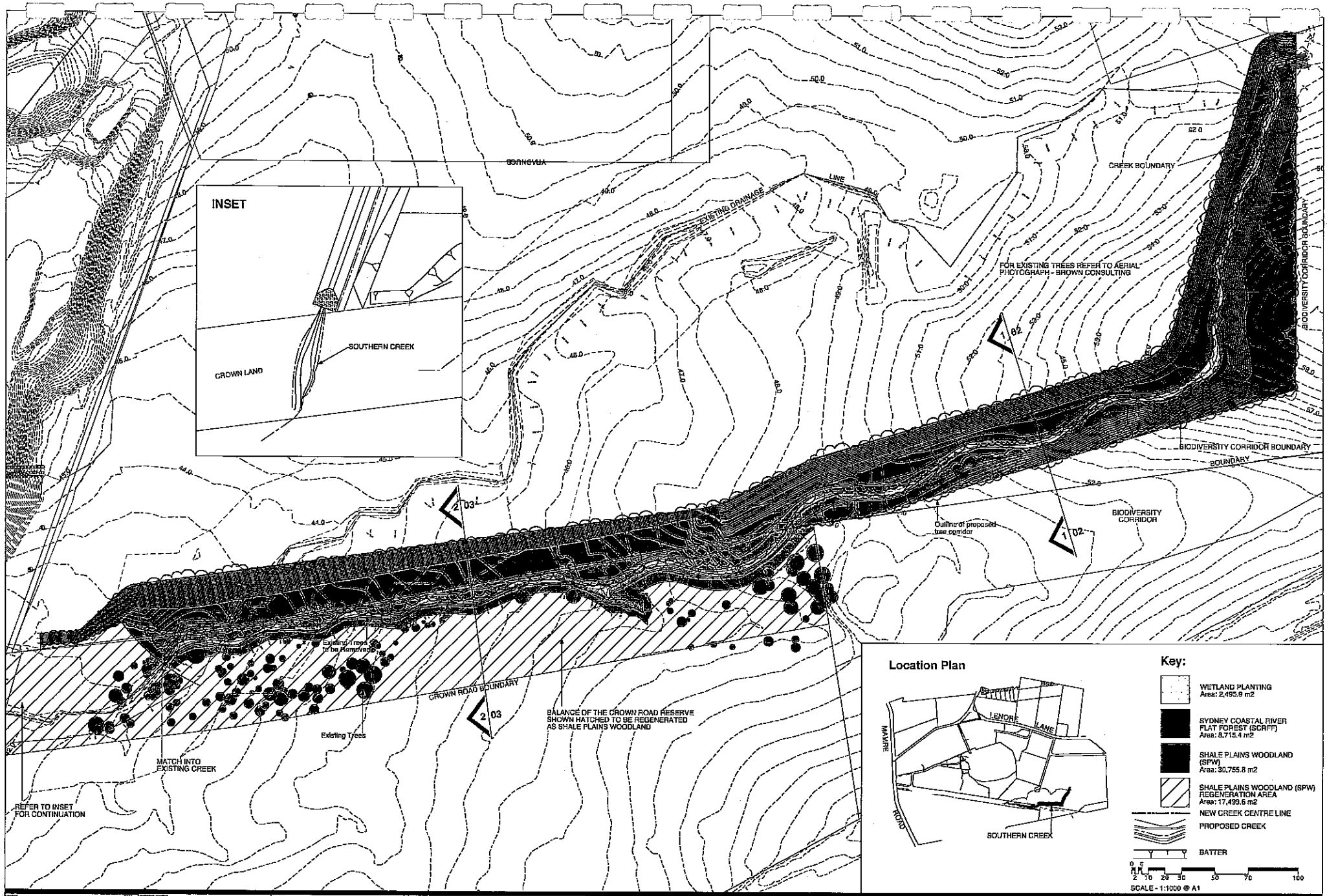
Appendix A

Landscape Plan Creek Relocation



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CSR LIMITED

LANDSCAPE PLAN
CREEK REALIGNMENT

1:1000 @ A1
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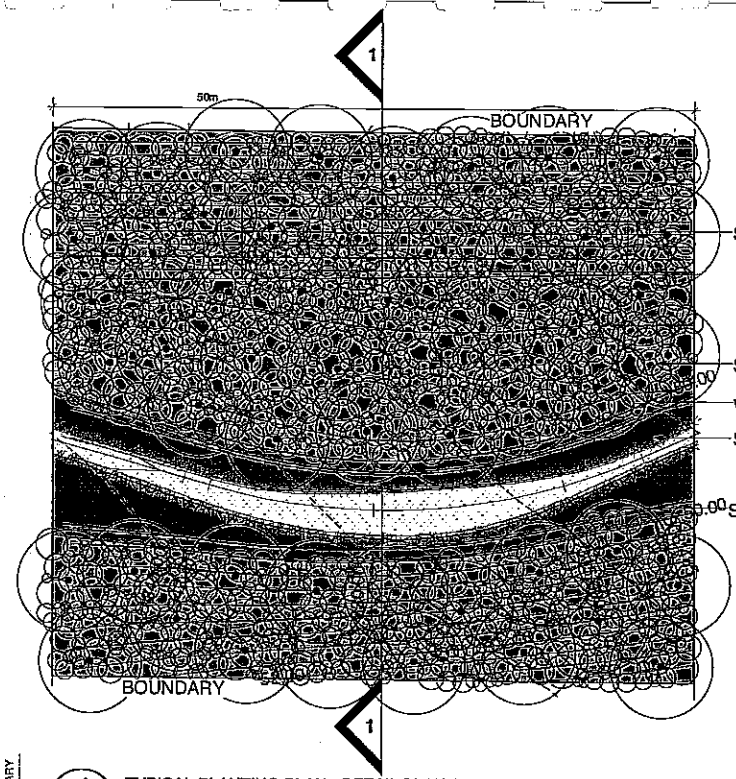
1219/LP-01

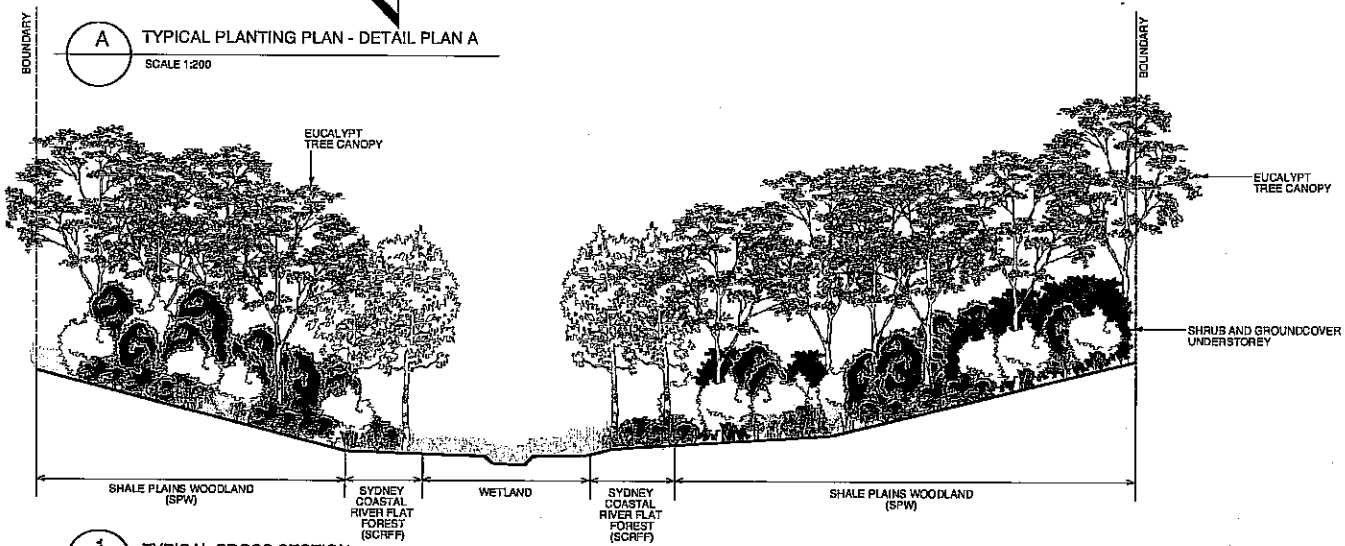
Appendix B

Landscape Sections and Details



A TYPICAL PLANTING PLAN - DETAIL PLAN A

SCALE 1:200



1 TYPICAL CROSS SECTION

SCALE 1:100

KEY:

- WETLAND PLANTING Area: 2,495.9 m2
- SYDNEY COASTAL RIVER FLAT FOREST (SCRFF) Area: 8,715.4 m2
- SHALE PLAINS WOODLAND (SPW) Area: 30,755.8 m2
- SHALE PLAINS WOODLAND (SPW) REGENERATION AREA Area: 17,499.6 m2
- PROPOSED CREEK
- BATTER

PLANT SCHEDULE

Range of selected plant species

Shale Plains Woodland (SPW) — 30,755 M2

Botanical Name	Common Name	Occurrence	Qty	Size	Plants/m2	Height
Trees						
Eucalyptus amplifolia	CABBAGE GUM	Common		Tube	1/10sqm	25
Eucalyptus crebra	NARROW LEAVED IRONBARK	Common		Tube	1/10sqm	15
Eucalyptus moluccana	GREY BOX	Dominant		Tube	1/10sqm	15
Eucalyptus fibrosa	BROAD LEAVED IRON BARK	Common		Tube	1/10sqm	
Eucalyptus eugenioides	THIN LEAVED STRINGY BARK	Common		Tube	1/10sqm	
Eucalyptus tereticornis	FOREST RED GUM	Dominant		Tube	1/10sqm	20
Melaleuca decora	WHITE FEATHER HONEYMYRTLE	Less Common		Tube	1/10sqm	1.5
Acacia parramattensis	PARRAMATTA GREEN WATTLE	Common		Tube	1/10sqm	
Shrubs						
Acacia decurrens	SYDNEY GREEN WATTLE	Common		Tube	1/sqm	10
Acacia falcata	SICKLE WATTLE	Common		Tube	1/sqm	
Bursaria spinosa	BLACK THORN	Common		Tube	1/sqm	2
Daviesia genistifolia		Less Common		Tube	1/sqm	
Daviesia ulicifolia	GORSE BITTER PEA	Less Common		Tube	1/sqm	
Dillwynia sibeni	PARROT PEA	Common		Tube	1/sqm	2.5
Dodonaea viscosa	GIANT HOP BUSH	Common		Tube	1/sqm	
Grevillea juniperina subsp. Juniperina	PRICKLY GREVILLEA	Common		Tube	1/sqm	2
Pultenaea microphylla	BUSH PEA	Less Common		Tube	1/sqm	1
Ozothamnus diosmaifolius	EVERLASTING			Tube	1/sqm	
Hardenbergia violacea	NATIVE SARSPARILLA	Less Common		Tube	1/sqm	0.4
Lissanthe strigosa	NATIVE CRANBERRY	Less Common		Tube	1/sqm	0.5
Groundcovers						
Aristida ramosa	WIRE GRASS	Common		Tube	4/sqm	
Arlalcia vagans	THREE AWNED SPEARGRASS	Less Common		Tube	4/sqm	
Brunoniella australis	BLUE TRUMPET	Less Common		Tube	4/sqm	
Danthonia racemosa var. obtusa	SLENDER WALLABY GRASS	Less Common		Tube	4/sqm	
Dichelachne micrantha	PLUMEGRASS	Common		Tube	4/sqm	
Dichondra repens	Kidney Weed	Common		Tube	4/sqm	
Lomandra filiformis ssp. filiformis	WATTLE MAT RUSH	Common		Tube	4/sqm	
Lomandra multiflora ssp. multiflora	MANY FLOWERED MAT RUSH	Common		Tube	4/sqm	
Themeda australis	KANGAROO GRASS	Common		Tube	4/sqm	

Sydney Coastal River Flat Forest (SCRFF) — 8,715 M2

Botanical Name	Common Name	Qty	Size	Plants/m2	Height
Trees					
Angophora floribunda	ROUGH-BARKED APPLE	Common	tube	1/10sqm	20
Angophora subvelutina	BROAD LEAVED APPLE	Common	tube	1/10sqm	25
Casuarina glauca	SWAMP OAK	Dominant	tube	1/10sqm	20
Eucalyptus amplifolia	CABBAGE GUM	Common	tube	1/10sqm	25
Eucalyptus moluccana	GREY BOX	Common	Tube	1/10sqm	15
Eucalyptus tereticornis	FOREST RED GUM	Dominant	tube	1/10sqm	20.
Melaleuca decora	WHITE FEATHER HONEY MYRTLE	Less Common	tube	1/10sqm	6
Melaleuca linariifolia	SNOW IN SUMMER	Common	tube	1/10sqm	2
Melaleuca styphelioides	PRICKLY PAPERBARK	Common	tube	1/10sqm	6
Shrubs					
Acacia parramattensis	PARRAMATTA GREEN WATTLE	Common	tube	1/sqm	
Bursaria spinosa	BLACKTHORN	Common	tube	1/sqm	
Lomandra longifolia	MAT RUSH	Common	tube	1/sqm	
Groundcovers					
Cymbopogon refractus	BARBWIRE GRASS	Common	Tube	4/sqm	
Dichondra repens	Kidney Weed	Common	Tube	4/sqm	
Microlaena stipoides	MICROLAENA	Common	Tube	4/sqm	
Oplismenus aemulus	BASKET GRASS	Common	Tube	4/sqm	
Themeda australis	KANGAROO GRASS	Common	Tube	4/sqm	

Wetland Species — 2495 M2

Botanical Name	Common Name	Qty	Size	Plants/m2	Height
Groundcovers/Grasses					
Baumea articulata		Less Common	tube	5/sqm	1
Bolbachenous spp.			tube	5/sqm	
Carex appressa		Common	tube	5/sqm	
Eleocaris cylindrostachys		Common	tube	5/sqm	
Eleocaris sphacelata		Common	tube	5/sqm	
Juncus prismatocarpus		Less Common	tube	5/sqm	
Juncus remotiflorus		Less Common	tube	5/sqm	
Juncus usitatus		Less Common	tube	5/sqm	
Lomandra longifolia	MAT RUSH	Common	tube	5/sqm	
Philydrum lanuginosum		Common	tube	5/sqm	2.5
Phragmites australis		Common	tube	5/sqm	1

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EASTERN SITE WORKS

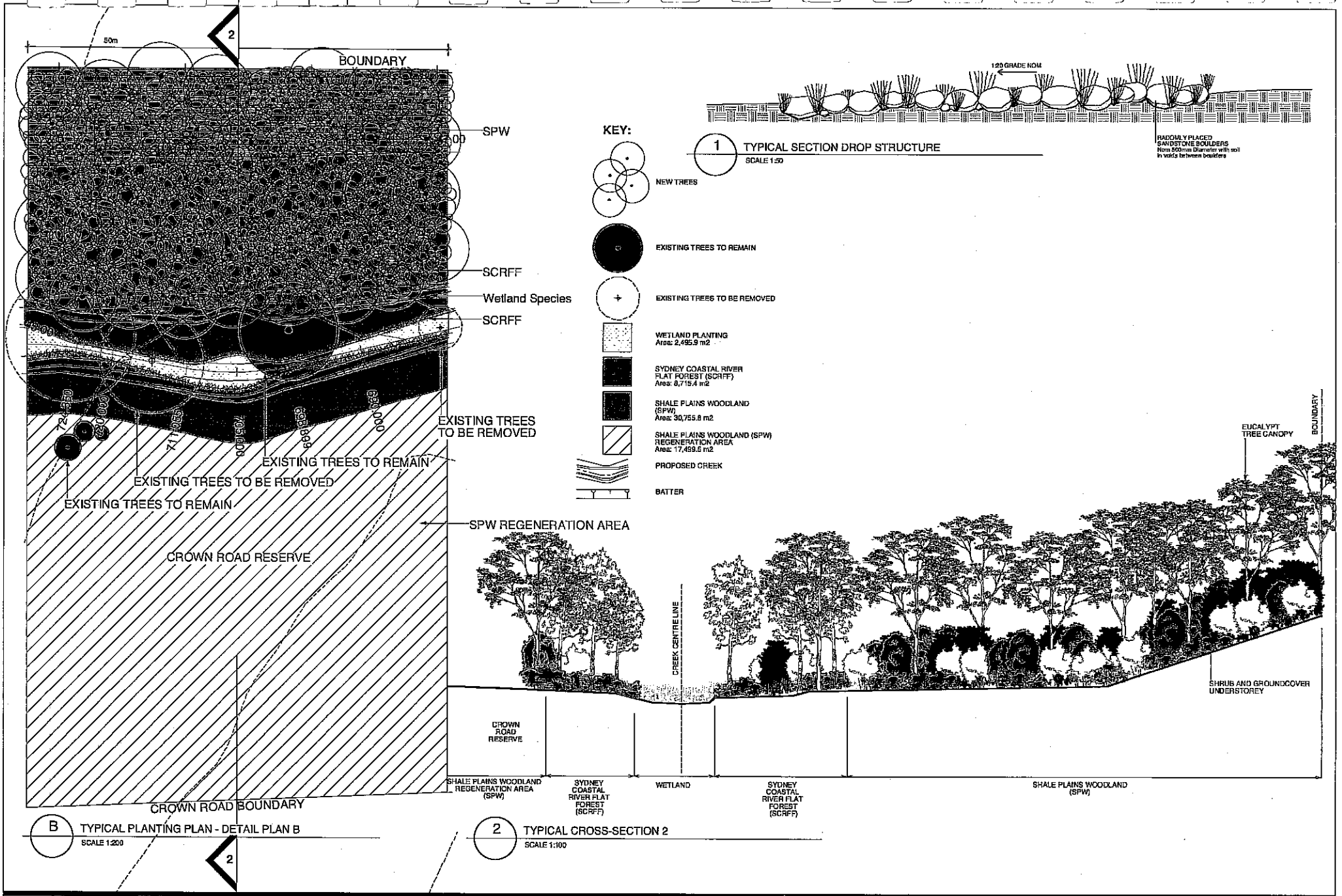
CSR LIMITED

LANDSCAPE SECTION AND DETAILS

AS SHOWN @ A1

31/08/05

1219/LP-02



1 TYPICAL SECTION DROP STRUCTURE
SCALE 1:50

B TYPICAL PLANTING PLAN - DETAIL PLAN B
SCALE 1:200

2 TYPICAL CROSS-SECTION 2
SCALE 1:100

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LANDSCAPE SECTION AND DETAILS

AS SHOWN @ A1
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Appendix C

Location of Compensation Zones

A1

PRELIMINARY

REV	DATE	DESCRIPTION	BY	VER	APP
02	09/03/2012	ADJUSTED COMPENSATION ZONE	AK		
01	19/12/2011	PRELIMINARY ISSUE	AK		
		AMENDMENTS			

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Level 2, 22 Waratah Road Merewether Park NSW Australia 2283
Telephone: 02 9963 1000 Facsimile: 02 99601099

VERIFICATION	INITIALS	SIGNATURE	DATE
DRAFTING			
DESIGN			
VERIFY			
APPROVED			

Client: CSR LIMITED

Project: SOUTHERN CREEK

Drawing: COMPENSATORY RIPARIAN CORRIDOR LOCATIONS FOR WATERCOURSE A1

Drawn by: AK	Sheet:
Design by: AK/RAP	Scale: 1:2000
Project No: WQ0033.12	
Drawing No: SK05	Rev: 02

Appendix D

Restoration Program Implementation

PROJECT IMPLEMENTATION

Relocated creek 'Southern Lands' Erskine Park

Estimated Program of Works

Temporary fencing
Seed licensing
Seed collection
Propagation
Hydromulching
Revegetation
Maintenance
Target weed control
Primery bush regen
Follow-up bush regen
Reporting
Project management

Task Name	2006 Jun wk 1	Jun wk 2	July	Aug	Sept	Oct	Nov	Dec	2007 Jan	Mar	June	Sept	Dec	2008 Jan	Mar	June	Sept	Dec	2009 Jan
Application Section 132C licence																			
Installation of temporary fencing																			
Seed Collection Program																			
Plant propagation																			
Hydromulching																			
Targeted weed control																			
Revegetation																			
Maintenance sessions																			
Primary bush regeneration																			
Follow-up bush regeneration																			
Project Reporting																			
Project Management																			

KEY

Indicates Practical Completion

Indicates Final Completion

Appendix E

DEC Description of SCRFF

Map Unit 11. Alluvial Woodland

River Flat Forest contains a number of tree species which may dominate at different sites. However, no species in the upper tree stratum was recorded in more than 50% of the sample sites. The two most common species are *Eucalyptus amplifolia* and *E. tereticornis*, with *Angophora floribunda* occurring slightly less frequently. Map Unit 11 often includes a stratum of small trees, frequently including *Acacia parramattensis subsp. parramattensis*, and less frequently *Casuarina glauca*, and sometimes *Angophora floribunda* and *Melaleuca linariifolia*. A shrub stratum is usually evident, but is often sparse and invariably dominated by *Bursaria spinosa*. Map Unit 11 often has a dense ground cover dominated by grasses such as *Oplismenus aemulus, Microlaena stipoides var. stipoides, Entolasia marginata* and Echinopogon *ovatus*. Herb species are also common, including *Solanum prinophyllum, Pratia purpurascens* and *Commelina cyanea*.

Map Unit 11 occurs exclusively along, or in close proximity to minor watercourses draining soils derived from Wianamatta Shale. It is the most common community found on soils of recent alluvial deposition. Map Unit 11 is also found on the floodplains of the major watercourse, the Hawkesbury-Nepean River, but grades into Map Unit 12 (Riparian Forest) on the terraces immediately adjacent to the river.

Previous Floristic Classifications:

River Flat Forest as described by Benson (1992), (Map Unit 9f), is herein divided into three separate communities: Map Unit 11 (River Flat Forest), Map Unit 12 (Riparian Forest) and Map Unit 5 (Riparian Woodland). Map Units 11 and 12 correspond to the major groupings 'Cumberland Plain Creek Systems' and 'Hawkesbury-Nepean River and major Tributaries' defined by DEC (1997). Map Unit 5 was included as a component of the riverine vegetation by both Benson (1992) and DEC (1997). 'Forest Red Gum – Cabbage Gum Forest', 'Forest Red Gum – Blue Gum Forest' and 'Swamp Oak Forest' (*sensu* DEC 1997) are included in Map Unit 11. The NSW Threatened Species Act (1995) lists 'Sydney Coastal River Flat Forest' as an endangered ecological community. Map Units 11 and 12 fall within the definition of this listed community. 'Camden White Gum Forest' as described by Benson (1992), (Map Unit 6d), is included within Map Unit 12.

Diagnostic Species

Trees		
Angophora floribunda	*Acacia parramatensis*	*Commelina cyanea*
Angophora subvelutina		*Lomandra longifolia*
Eucalyptus amplifolia	**Shrubs**	*Oxalis perennans*
Eucalyptus baueriana	*Bursaria spinosa*	*Alisma plantago-aquatica*
Eucalyptus deanei		*Samolus valerandi*
Eucalyptus elata	**Ground Covers**	*Bolboschoenus caldwellii*
Eucalyptus eugenioides	*Desmodium varians*	*Centipeda cunninghamii*

Eucalyptus globoidea	*Brunoniella australis*	*Cyperus trinervis*
Eucalyptus piperita subsp. Piperita	*Oplismenus aemulus*	*Lomandra multiflora*
Eucalyptus punctata	*Entolasia marginata*	*Entolasia stricta*
Eucalyptus sclerophylla	*Echinopogon ovatus*	*Microlaena stipoides*
Eucalyptus tereticornis	*Solanum prinophyllum*	*Themeda australis*
Casuarina cunninghamiana	*Pratia purpurascens*	*Glycine tabacina*

** Note: Map Unit list adapted from DEC Interpretive Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney, 2002.

Appendix F

DEC Description SPW

Map Unit 10. Shale Plains Woodland

Shale Plains Woodland is dominated by *Eucalyptus moluccana* and *E. tereticornis* with *E. crebra, E. eugenioides* and *Corymbia maculata* occurring less frequently. These species often

form a separate small tree stratum, occasionally including other species such as *Exocarpus cupressiformis, Acacia parramattensis subsp. parramattensis* and *Acacia decurrens*. A shrub stratum is usually present and dominated by *Bursaria spinosa*. Common ground stratum species include *Dichondra repens, Aristida vagans, Microlaena stipoides var stipoides, Themeda australis, Brunoniella australis, Desmodium varians, Opercularia diphylla, Wahlenbergia gracilis* and *Dichelachne micrantha*. Shale Plains Woodland is the most widely distributed community on the Cumberland Plain. It predominantly occurs on soils derived from Wianamatta Shale, but also occurs on Holocene alluvium in well-drained areas that are infrequently inundated. Isolated patches of Map Unit 10 may be found on soils derived from the Mittagong Formation, but only in the vicinity of outcrops of almost pure shale. Very rarely, it may occur on soils derived from Tertiary Alluvium, but it is more usual for Map Unit 10 to grade into Map Unit 103 (Shale Gravel Transition Forest) near the boundary of Shale and Tertiary Alluvium. Towards the edge of the Cumberland Plain, Map Unit 10 grades into Map Unit 1(Shale Sandstone Transition Forest, Low Sandstone Influence) as the depth of the shale soils decreases and the influence of the underlying sandstone increases. In the southern half of the study area Map Unit 10 grades into Map Unit 9 (Shale Hills Woodland) with increasing elevation and ruggedness. This gradation commences on the gentle rises running south from Prospect Reservoir in the centre of the plain, and south of Mulgoa Nature Reserve on the western boundary of the plain.

Previous Floristic Classifications:

Cumberland Plain Woodland as described by Benson (1992) (Map Units 9b, 10c and 10d) and as listed under the NSW Threatened Species Act (1995), is herein divided into two separate communities: Map Unit 9 (Shale Hills Woodland) and Map Unit 10 (Shale Plains Woodland). Map Unit 10 includes areas previously recognised as Map Units 9b, 10c and 10d (Benson 1992), but most often corresponds with Map Unit 10c. Although Benson (1992) ascribed vegetation in the north of the study area to Map Unit 10d these areas are included in Map Unit 10 in the present survey.

Diagnostic Species

Trees	*Acacia spp*	*Dichondra repens*
Angophora floribunda	*Melaleuca spp*	*Entolasia stricta*
Angophora subvelutina		*Microlaena stipoides*
Eucalyptus amplifolia	**Groundcovers**	*Themeda australis*
Eucalyptus baueriana	*Desmodium varians*	*Cheilanthes sieberi*
Eucalyptus crebra	*Asperula conferta*	*Brunoniella australis*
Eucalyptus eugenioides	*Dichelachne micranthra*	*Opercularia diphylla*

Eucalyptus fibrosa	*Oxalis perennans*	*Whalenbergia gracilis*
Eucalyptus globoidea	*Danthonia tenuior*	*Paspalidium distans*
Eucalyptus longifolia	*Lomandra filiformis var. Filiformis*	*Eragostis leptostachya*
Eucalyptus moluccana	*Aristida vagans*	*Dialnella longifolia*
Eucalyptus paniculata	*Gnaphalium sphaericum*	*Calandrinia pickeringii*
Eucalyptus punctata	*Goodenia hederacea*	*Danthonia setacea*
Eucalyptus tereticornis	*Arthropodium milleflorum*	*Rorippa laciniata*
Corymbia maculate	*Danthonia tenuior*	*Wurmbea biglandulosa*
	Cymbopogon refractus	*Dipodium punctatum*
Shrubs	*Echinopogon caespitosus var. caespitosus*	*Glycine clandestina*
Bursaria spinosa	*Dichopogon strictus*	*Aristida ramosa*

** Note: Map Unit list adapted from DEC Interpretive Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney, 2002.

Appendix G

Noxious Weeds of Penrith LGA

Noxious Weeds in Hawkesbury River County Council

The following weeds are declared noxious in the Hawkesbury River County Council control area **(including Baulkham Hills, Blacktown, Hawkesbury and Penrith council areas)**. The 'details' link on each listing provides further information on the legal requirements of the weed's listing and any variation in status within the local control area.

Common name	Scientific name	Category
African boxthorn	*Lycium ferocissimum*	W2
Alligator weed	*Alternanthera philoxeroides*	W1
Bathurst Noogoora Californian Cockle burrs	*Xanthium spp.*	W3
Black knapweed	*Centaurea nigra*	W1
Blackberry	*Rubus fruticosus (agg. spp.)*	W3
Broomrape	*Orobanche spp.*	W1
Cabomba	*Cabomba spp.*	W4g
Columbus grass	*Sorghum x almum*	W2
Crofton weed	*Ageratina adenophora*	W2
Dodder	*Cuscuta campestris*	W2
Giant Parramatta grass	*Sporobolus fertilis syn. Sporobolus indicus var. major*	W2
Green cestrum	*Cestrum parqui*	W2
Harrisia cactus	*Harrisia spp.*	W4f
Hawkweed	*Hieracium spp.*	W1
Horsetail	*Equisetum spp.*	W1
Johnson grass	*Sorghum halepense*	W2
Karroo thorn	*Acacia karroo*	W1

Kochia	*Kochia scoparia*	W1
Lagarosiphon	*Lagarosiphon major*	W1
Ludwigia	*Ludwigia peruviana*	W2
Mexican feather grass	*Nassella tenuissima syn Stipa tenuissima*	W1
Miconia	*Miconia spp.*	W1
Mother-of-millions	*Bryophyllum delagoense*	W2
Pampas grass	*Cortaderia spp.*	W2
Parthenium weed	*Parthenium hysterophorus*	W1
Paterson's curse,Vipers Italian bugloss	*Echium spp.*	W3
Pellitory	*Parietaria judaica*	W3
Prickly pears	*Opuntia spp.*	W4f
Privet - broadleaf	*Ligustrum lucidum*	W4b
Privet - narrowleaf	*Ligustrum sinense*	W4b
Rhus tree	*Toxicodendron succedaneum*	W2
Salvinia	*Salvinia molesta*	W2
Senegal tea plant	*Gymnocoronis spilanthoides*	W1
Siam weed	*Chromolaena odorata*	W1
Spiny burrgrass	*Cenchrus incertus*	W2
Spiny burrgrass	*Cenchrus longispinus*	W2
Spotted knapweed	*Centaurea maculosa*	W1
St John's wort	*Hypericum perforatum*	W2
Water hyacinth	*Eichhornia crassipes*	W2

Water lettuce	*Pistia stratiotes*	W1
Willows	*Salix spp.*	W4g

Taken from NSW Agriculture noxious weeds in NSW list

Appendix H

Summary of Weed Control Techniques

Recommended weed control techniques

Common Name	Botanical Name	Status	Removal Techniques
African love grass	*Eragrostis curvula*	Environmental Weed	Slash or mow before it sets seed along roads and in highly disturbed areas. Spot spray with diluted 1:100 Roundup. Hand remove isolated plants.
Dodder	*Cuscata sp.*	Environmental Weed	Hand remove.
Blackberry	*Rubus fruiticosus agg. Spp.*	Noxious Weed W2	Cut and paint crown/lignotuber with undiluted Roundup or Garlon and diesel immediately for isolated plants. Slash large populations and spray re-growth with selective herbicide Garlon, Grazon or Brushoff at flowering/fruiting stage.
Bridal Creeper	*Myrsiphyllum asparagoides*	Environmental Weed	Hand remove (i.e. by crowning with a knife) isolated plants after removing and bagging fruit. Spray large populations with Brushoff at flowering stage.
Cobblers peg	*Bidens pilosa*	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Crofton weed	*Ageratina adenophora*	Environmental Weed	Hand remove or spray with 1:100 Roundup.
Fireweed	*Senencio madagascariensis*	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Fleabane	*Conyza spp.*	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Green cestrum	*Cestrum parqui*	Noxious Weed W2	Stem scrape and paint with Garlon and diesel (i.e. both sides of stem) immediately at flowering stage. Remove and bag fruit.
Inkweed	*Phytolacca octandra*	Environmental Weed	Hand remove or cut and paint base with undiluted Roundup after removing and bagging fruit.
Kikuyu	*Pennisetum clandestinum*	Environmental Weed	Spot spray with diluted 1:100 Roundup.
Lantana	*Lantana camara*	Noxious Weed W2	Cut and paint base of trunks with undiluted Roundup immediately. Slash Lantana stems into 2x2 metre piles. Treatment of re-growth may be necessary as layering stems may re-shoot. Hand remove seedlings.
Large leaf privet	*Ligustrum lucidum*	Environmental Weed	Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup immediately before fruiting stage. Hand remove or spot spray seedlings with 1:100 Roundup.
Madiera winter cherry	*Solanum pseudocapsicum*	Environmental Weed	Stem scrape and paint with Garlon and diesel (i.e. both sides of stem) immediately

			at flowering stage. Remove and bag fruit.
Moth plant	*Araujia sericifolia*	Environmental Weed	Hand remove or cut and paint base of stems with undiluted Roundup after removing and bagging fruit.
Paddy's lucerne	*Sida rhombifolia*	Environmental Weed	Hand remove or cut and paint base with undiluted Roundup. Slash large populations and spray re-growth with 1:100 Roundup.
Pampas grass	*Cortaderia spp.*	Noxious Weed W2	Spot spray with diluted 1:70 Roundup after removing and bagging fruit/flowering stems.
Paspalum	*Paspalum dilatatum*	Environmental Weed	Spot spray with diluted 1:100 Roundup.
Prickly pear	*Opuntia spp.*	Noxious Weed W4f	Mattock/hand remove all parts of plant.
Boneseed	*Chrysanthemoides monilifera*	Environmental Weed	Spray actively growing plants, spray to wet all foliage. Spray Roundup at a ratio of 1:100.
Scotch thistle	*Onopordum acanthium*	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Broom	*Spp.*	Environmental Weed	Spray with Garlon 600 Herbicide.
Silky oak	*Grevillea robusta*	Environmental Weed	Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup immediately. Hand remove seedlings.
Small leaf privet	*Ligustrum sinense*	Environmental Weed	Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup immediately before fruiting stage. Hand remove or spot spray seedlings with 1:100 Roundup. Treatment of re-growth may be necessary as the plant has the ability to sucker from roots.
Sowthistle	*Sonchus oleraceus*	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Verbena	*Verbena spp.*	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed.
Wandering jew	*Tradescantia fluminensis*	Environmental Weed	Spot spray with 1:50 Roundup or Starane. It is photo-inhibited so should be treated on overcast days after rain. Rake and hand remove all stem fragments in small populations amongst native species.
Mother of millions	*Kalanchoe tubiflora*	Environmental Weed	Remove by hand, bag all plant material and dispose of in appropriate manner.

Appendix I

Monitoring Field Sheet

Vegetation Management Plan Monitoring Field Sheet

Project: _____ Date: _____

Quadrat: _____ Recorder: _____

Measure	Observation				Comments/Actions Required	Responsibility	Completion Date
Plant Growth (cm):							
Trees	0-5	5-20	20-50	50+			
Understorey	0-5	5-10	10-30	30+			
Ground cover	0-5	5-10	10-20	20+			
Percentage Cover (%):							
Trees	0-10	10-50	50-85	85+			
Understorey	0-10	10-50	50-85	85+			
Ground cover	0-10	10-50	50-85	85+			
Survival Rates (%):							
Trees	0-10	10-50	50-85	85+			
Understorey	0-10	10-50	50-85	85+			
Ground cover	0-10	10-50	50-85	85+			
Plant replacement required/Ha							
Trees	0-5	5-20	20-50	50+			
Understorey	0-5	5-20	20-50	50+			
Ground cover	0-5	5-50	50-100	100+			
Weed regrowth (% cover)	0-10	10-50	50-85	85+			
Condition of Tree Guards	Poor	Ok	Good				
Watering required	Yes	Some	No				
Stream bank erosion	Stable	Slight	Mod.	Severe			
Photographs:							
Number							

Location

Direction

Comments:

Site Plan

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