



MACQUARIE UNIVERSITY

University Creek

Landscape Rehabilitation Plan
(Incorporating Vegetation Management Plan)

May 2010

context

Prepared for:
Macquarie University

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Issue C

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Appendix F - 'Ecological Constraints Report; University and College Creeks Study Macquarie University' Prepared by Lesryk Environmental Consultants (2009)

Appendix G - 'University Creek Catchment Area Macquarie park, NSW' prepared by Naturally Trees Aboricultural Consulting (2009)

1.0 INTRODUCTION

In accordance with Macquarie University Concept Plan approval conditions C4 and C6 and at the request of Macquarie University Office of Major Projects and the Department of Energy and Water, CONTEXT has prepared a Landscape Rehabilitation Plan (LRP) including a Vegetation Management Plan for the existing and proposed vegetation works within the riparian corridor of University Creek.

The creek is located on the grounds of Macquarie University campus, extending from the southern boundary adjoining Moring College to Talavera Road. The creek is known as University Creek upstream of the Research Park Drive road bridge and College Creek downstream from this point until Talavera Road. For the purposes of this report, the whole watercourse will be referred to as 'University Creek'.

1.1 CONSENT REQUIREMENTS

The Department of Planning is the consent authority for the project and have issued Conditions of Consent for the Macquarie University Concept Plan MCoA which require:

- C4 Riparian Zone, Flooding and Storm water
 - (1) The Storm Water Management Plan and other various plans referred to on page 6 of the Statements of Commitments are to be:
 - (a) Integrated with the Vegetation Management Plan and Threatened Species Plan referred to on page 4 of the revised Statements of Commitments.

- C6 Flora and Fauna
 - (1) The Vegetation Management Plans, the Threatened Species Plan, and the Weed Management Plan referred to on page 4 of the Statement of Commitments shall detail responsibility for each action, and shall include on going measures.
 - (2) The Plans are to be prepared in consultation with DECC and shall be submitted for approval prior to or with the first application for new building works within each precinct.
 - (3) All future development is to be undertaken in accordance with the 'Guidelines for Development Adjoining Department of Environment and Conservation Land by DECC dated 2006.

1.2 REPORT STRUCTURE

This report has been prepared in accordance with the NSW Office of Water guidelines *'How to Prepare a Vegetation Management Plan'* and *'Watercourse and Riparian Rehabilitation Requirements'*

This report was written in conjunction with Lesryk Environmental Consultants who completed the VMP for Sydney Turpentine Ironbark Forest (STIF) located on the south eastern bank of the creek (refer to Appendix A). The LRP and VMP should be read in conjunction with the Macquarie University Precinct E Landscape Management Plan prepared by Context Landscape Design, also for this concept plan approval.

The LRP and VMP for University Creek draws extensively from the previously prepared following documents

- Coffey Geotechnics, 2009, 'Geomorphological Assessment of University Creek, North Ryde.'

This report assess the geomorphological condition of University Creek and recommends the improving of the appearance, geomorphological and ecological condition and stability of the channel and near channel materials.

- Context Landscape Design, 2009, 'Macquarie University Creek Study Landscape Opportunities and Constraints; University and College Creeks.'

This document analyses the landscape opportunities and constraints of the riparian zone in a campus situation.

- Lesryk Environmental Consultants, 2009, 'Ecological Constraints Report; University and College Creeks Study Macquarie University.'

Lesryk, in this report identifies the significant flora and fauna communities existing within the riparian corridor and analyses the resultant development constraint.

- Naturally Trees Aboricultural Consulting, 2009, 'University Creek Catchment Area Macquarie park, NSW'

This report audits the vigour, longevity and significance of the existing trees within the riparian corridor.

1.3 LEGISLATION REVIEW

The following Vegetation Management Plan has been written in accordance with the following legislative acts;

- Water Management Act 2000
- Environmental Protection and Biodiversity Conservation Act 1999
- State Fisheries Management Act

2.0 GENERAL SITE CONDITIONS

2.1 SOIL

Macquarie University is located at the geological boundary of the Hawkesbury Sandstone and the Ashfield shales of the Wianamatta Group. The gently undulating topography, remnant shale/sandstone transition forest communities (Sydney Turpentine Ironbark Forest, Sandstone Ridgetop Woodland) and occasional loose sandstone boulders in the creek line reflect this characteristic landscape typology.

As noted in the Geomorphologic Assessment conducted by Coffey Geotechnics, 'the geological profile typically consists of topsoil or pavement overlying residual clay. The Bedrock is generally shallow throughout the site, with the depth of overlying clay generally decreasing with elevation – i.e. the thickest clays appear to be found in proximity to the creek channel'.

2.2 EXISTING VEGETATION

University Creek, although a 'natural' watercourse, has been altered over the past 50 years, with culverts, storm water inlets, constructed creek beds and banks contributing to its current flow and flood regime. The creek zone to south east and downstream is subject to periodic flooding.

The riparian corridor has been physically defined and limited by the development of the campus buildings, infrastructure and recreation zones over the last four decades and is often less than the desired 20m in width from the top of the bank (The 20m corridor was identified in the previous Opportunities and Constraints Report prepared by Context 2009). The current planting defines the creek line and creates a range of landscape experiences and comprises of open parklands and mown lawns set within rising topography on either side of the creek. The majority of the trees within the riparian corridor are native and are believed to have been planted in the late 1960's and early 1970's.

Remnant stands of Sydney Turpentine Ironbark Forest (STIF) and Sydney Sandstone Ridgetop Woodland occur within the riparian zone and have been assessed by Lesryk Environmental Consultants for inclusion in this VMP. It is important to note that these vegetation communities are also present elsewhere within the University Campus, however fall out of the study area. Refer to Appendix C for the Existing Conditions Diagram.

Due to the diverse landscape characteristics along the corridor, University Creek has been divided into a number of precincts or 'reaches' A-F. The reaches are consistent with the reaches identified in the Coffey Geomorphological Assessment (2009) and Landscape Opportunities and Constraints (Context Landscape Design, 2009). For the purposes of this LRP VMP, the reaches will form management zones within the riparian corridor.

The existing condition of each reach has been fully described in the 'Geomorphological Assessment of University Creek, North Ryde' (Coffey) and 'Macquarie University Creek Study Landscape Opportunities and Constraints; University and College Creeks' (Context), refer to Appendix D

3.0 PROPOSED REHABILITATION AND VEGETATION WORKS

3.1 PURPOSE

The purpose of the proposed rehabilitation and revegetation works within the riparian corridor of University Creek is to achieve environmental benefits through increase of the baseline biodiversity and landscape value of the site. In principle the approach to vegetation management and rehabilitation is to maintain the original riparian corridor vegetation, stabilise the creek banks and to rehabilitate the STIF vegetation community.

3.2 VEGETATION MANAGEMENT PRINCIPLES

The vegetation management principles for the riparian corridor are to;

- Ensure the survival and enhancement of the STIF ecological community;
- Increase the biodiversity, habitat potential and protect and enhance the riparian ecosystem;
- Offset significant tree loss within the riparian corridor and the greater precinct E area;
- Maintain and improve bank stability;
- Contribute to water quality improvements of University Creek;
- Emphasise weed removal and diminish weed seed dissemination this site and increase the dissemination of native species; and
- Enhance the visual quality of the riparian corridor and the overall landscape character of the Macquarie University campus.

3.3 OVERALL CREEK MASTER PLAN

Refer to Landscape Management Plan for Illustrative Landscape Master Plan

3.4 TREE REMOVAL

As a result of the proposed engineering creek works, approximately 17 trees will be required to be removed from within the riparian corridor, 8 of those have been identified as moderately significant. All trees located within the STIF vegetation community will be retained and protected throughout all construction works.

3.5 OFFSET PLANTING

The loss of existing trees will be offset by an overall increase of trees within the riparian corridor as a result of the rehabilitation and planting works. The loss of any significant trees is required to be effectively offset by the planting of two of the same species in a suitable location within the core riparian zone.

A comprehensive offset planting strategy for the entire campus is being developed by Lesryk for the tree loss to occur as a result of the Station North Development.

3.6 GENERAL REHABILITATION

The core zone of the riparian corridor, the area 10m offset from the top of bank on both verges of the creek will generally be rehabilitated by infill planting around the existing trees. The new planting will be of a mix of trees, shrubs and groundcovers of species specific to each reach, refer to Appendix H for plant schedules. The vegetated buffer will be a mix of mass planting and open space allowing for pedestrian movement and seating nodes whilst providing a buffer edge to the main riparian vegetation. The new planting will take into account the proposed flood zones, by the use of appropriate species for the microclimatic and hydraulic conditions, refer to Stormwater Management Plan prepared by TTW.

The replanting of the riparian zone should be undertaken by a qualified landscape contractor with bush regeneration experience.

3.6.1 Reach A

- Infill planting of trees, shrubs and groundcovers along the southern bank to enhance the existing planting.
- The northern bank will be planted with a mix of trees, shrubs and groundcovers to the desired density 10m offset from the top of bank, replacing the existing turf.
- Informal border planting of *Pennisetum alopecuroides* and *Lomandra longifolia* set amongst some sandstone boulders is proposed for the perimeter of the new planting to minimise access and buffer the area from weed infestation.

3.6.2 Reach B

- STIF area to be retained, protected and enhanced by the implementation of a staged weed removal program allowing for the unassisted rehabilitation of the zone, refer to Appendix A.
- *Lomandra longifolia* and sandstone boulder buffer to be informally installed around the perimeter of the STIF area to minimise access and weed disturbance.
- Soften and stabilise the installation of the new creek crossing embankment rip rap with sways of macrophytic sedge and grass plantings.
- Install erosion control matting (equal to Jutemaster) to all batters greater than 1:3 prior to planting as per manufacturer's details.
- The northern bank (within Cochlear Global Headquarters's boundary) to be mass planted in accordance with DEM Landscape plan and specification.

- The new batters adjoining the creek crossing within the riparian corridor will be massplanted with native grass species to aid in soil stabilisation and to prevent weed infestation into the creek line.
- Copsed tree planting is proposed for the south east corner of the reach with some groundcover planting to open the space to the adjoining turf area.
- No tree planting is to be installed in areas affected by the roadworks to be constructed at a later stage. Instead turf and native grasses are to be used to stabilise batters and to increase the area of open space.
- All species used are to be consistent STIF community species

3.6.3 Reach C

- Soften and stabilise the installation of the new creek crossing embankment rip rap with sways of macrophytic sedge and grass plantings.
- Infill planting of copsed tree plantings and groundcover sways along the northern bank to increase the biodiversity value of the reach and bank stability.
- Infill planting of groundcover sways and accent shrubs along the southern bank to increase visual amenity, habitat potential and bank stability.
- Informal border planting of copsed Eucalypt species around the perimeter of the existing planting to frame the riparian corridor and the adjoining open expanse of turf, maintaining current parkland aesthetic.
- Plant a mix of macrophyte sedge and grass species in the proposed in channel pools to aid in diversifying the aquatic habitat.

3.6.4 Reach D

- Infill planting of trees along both banks to increase amenity and to provide continuous canopy cover.
- Infill planting of native grasses and groundcover species on all batters aid in bank and soil stability.
- Install erosion control matting (equal to Jutemaster) to all batters greater than 1:3 prior to planting as per manufacturer's details.
- Minimum 8m turf verge is to be retained along Research Park Drive with copsed Eucalypt and Angophra stands to allow for views through to the northern areas of campus while extending the area of open space suitable for seating and rest areas.
- The northern bank is to receive infill planting of trees, shrubs and groundcovers to the desired density to the boundary of the riparian corridor. The new planting is to have a perimeter of dense *Lomandra longifolia* and *Pennisetum alopecuroides* plantings, set amongst sandstone boulders to act as a weed buffer from the turf area.
- In the area adjoining the northern bank, existing trees are to be retained and turf made good.
- Existing pathways are to be retained and made good and native grass planting to be installed in between the existing paths along the northern verge.

3.6.5 Reach E

- Soften and stabilise the installation of the new creek crossing embankment rip rap with sways of macrophytic sedge and grass plantings.
- Massplant batter on the north of the new the creek crossing with native grass species.
- Remove turf from the basin area on the southern bank of the creek near Innovation Road and mass plant with native macrophyte sedge and grass species. Install stands of copped Eucalypt and Angophora trees to filter the view into the basin from the roadway.
- Infill planting of shrubs and groundcovers in garden areas to cover bare earth to aid in stabilising the soil during a storm event.
- Retain existing path on northern bank and make good the turf.
- Remove turf from all areas that lie in the 10 offset from the top of bank and massplant with a mix of grass and macrophyte species.

3.6.5 Reach F

- The new batters defining the basin will be massplanted with native grass species to aid in soil stabilisation and to prevent weed infestation into the creek line.
- Install erosion control matting (equal to Jutemaster) to all batters greater than 1:3 prior to planting as per manufacturer's details.
- Massplant the base of the basin with a mix of macrophyte grass and reed species with high sheer strength 4/m².
- Infill planting of trees and groundcovers along the eastern bank to Talavera Road .
- Infill planting of trees, shrubs and groundcovers along the northern to increase the visual amenity and bank stability.
- Install screen shrubs behind the retaining wall adjoining the southern bank.

3.7 GENERAL WEED IDENTIFICATION AND REMOVAL

A number of weeds have been identified in the ecological assessment conducted by Lesryk, however as part of the planting works within the core riparian zone, all weed species should be removed.

- Weed removal within the riparian zone should be undertaken by a qualified landscape contractor with bush regeneration experience.
- Shrub and groundcover weed species should be removed by hand in accordance with standard bush regenerating techniques and industry best practice.
- Trees are to be felled using a chain saw and the stump removed. In situations where the root zone of the weed species is aiding bank stabilisation, the stump should be retained and painted with a Biactive Glyphosate herbicide suitable for use in riparian areas.
- Any tree or shrub species displaying habitat potential should be retained until the animals have been safely removed.
- All green waste from weed removal should be taken from site and disposed of in accordance with Macquarie University's waste management protocols.

After the primary weed removal program is complete, follow up weeding should occur in the same areas that have been previously weeded and should occur no longer than 3 months after the initial weeding program. Follow up weeding should occur every quarter for the first 24 months after the new planting has been installed.

3.8 SOIL AND BANK STABILISATION

- In areas where erosion of the creek banks and batters is evident, planting stabilisation works should occur to prevent further scouring and soil loss.
- Species are to be endemic and appropriate for the soil and hydraulic conditions.
- In areas where the grade of the batters and bank is greater than 1:3 appropriate cover crop shall be installed prior to planting to stabilise the earth prior to plant establishment.

3.9 PLANTING PROGRAM AND METHODS

- The planting of the riparian zone should begin once the engineering work has been completed on the creek.
- To accommodate view sheds, flood and building constraints reaches A and B will have a different planting density to reaches C, D, E and F. Trees, shrubs and groundcovers generally should be planted in reaches A and B to achieve the final maximum density of;
 - Trees 1/9m²
 - Shrubs 1/4m²
 - Groundcovers 4/m²
- Trees, shrubs and groundcovers generally should be planted in reaches C, D, E and F to achieve the final minimum density of;
 - Trees 1/64m²
 - Shrubs 1/16m²
 - Groundcovers 4/m²
- Planting is to be carried out using best horticultural practices. No fertiliser is to be used in conjunction with planting, however if necessary, water retaining crystals can be installed, as per manufacturer's specification;
- Areas identified for planting will be marked out on the ground and weed control performed. If soil is compacted, the area is to be deep ripped to a depth of 300mm, except beneath the canopy of existing trees. The planting area is to be mulched and planted in accordance with the species and densities and specified.
- Grass and groundcover species should be planted as soon as possible to stabilise the soil and creek bank.
- As it is best for planting to occur throughout the Autumn months, it is recommended that tree and shrub planting should occur between March and August.
- Where turf exists and revegetation is to occur, prepare planting sites by controlling existing cover in rows using a Biactive Glyphosate herbicide.
- It is recommended that plant species characteristic of the STIF community be used within reaches A and B. Plant species recommended for reaches C, D, E and F have been detailed in

- plant schedules, refer to Appendix H.
- Macrophytic grass species are recommended to be planted within the creek line and along the top of bank areas.
- Establish a polythene or recycled cardboard tree guard around each tree and shrub to facilitate the use of herbicides throughout the establishment period and to protect young plants from weed invasion.

3.10 SEED/PLANT SOURCES

All plant material will be tubestock or maxi cell with the exception of native grasses where viro cells can be used. It is recommended that the macrophyte species be supplied in border edge to aid establishment and limit plant loss in a storm event.

Plants must be grown from or cuttings taken from provenance stock. Greening Australia or local commercial nurseries specialising in native species can be contacted as they have a range of seed from the local provenance. Provided orders are placed in advance, consignment propagation can be carried out from local stock.

3.11 SYDNEY TURPENTINE IRONBARK FOREST

3.11.1 Rehabilitation

The area identified as Sydney Turpentine Ironbark Forest contains remnant indigenous vegetation with varying densities of environmental weed species present. This area is less disturbed or modified than other riparian areas of University Creek and there are signs of natural regeneration occurring. Beneath the patches of environmental weeds there are a number of indigenous ground covers present. A separate Vegetation Management Plan (Lesryk, 2010) has been prepared for this area taking into account the site conditions and the ecological significance of this area. The management strategy for rehabilitation of this area is to undertake bush regeneration weed control works to facilitate the natural recruitment of indigenous flora from the existing seed source.

3.11.2 Weed Identification and Removal

Weed control in this area shall be undertaken by and experienced and qualified bush regeneration contractor and it is important that weed control be undertaken in a sensitive manner selectively removing exotic weed species whilst retaining resilient or emerging indigenous species.

3.11.3 Planting Program and Methods

Because of the inherent resilience no planting is proposed in this area. The focus of the rehabilitation is to encourage the recruitment and establishment of the existing flora species, many of which are not available commercially or propagated successfully

4.0 TREATMENT MEASURES

4.1 PROTECTIVE MEASURES

4.1.1 Protection of Existing Vegetation

Existing vegetation will need protection during construction and establishment. During construction and establishment, temporary fencing will be placed at the extent of area to be protected, preferably beyond the drip line of the trees to be protected. The fencing methods will include flagging tape, stakes and temporary fencing. It will clearly identify the area to be protected and restrict access to the protected zone. Following completion of construction (including establishment), all temporary works will be removed when they are no longer required.

4.2 TREE REMOVAL AND DISPOSAL OF VEGETATION AND MATERIALS ON SITE

All significant trees removed as a result of University Creek construction works is to be replaced by the same species and planted in a suitable location corresponding with the relevant vegetation community within the riparian corridor.

Any significant tree removed for construction works will be retained whole or in sections, and placed on the ground in reaches A and B of the riparian corridor to provide habitat for native fauna. All other native vegetation that is identified for removal will be chipped for use within riparian rehabilitation areas as mulch. All weed material will be separated and removed from the cleared material prior to chipping. The mulch will be stockpiled at approved locations around the site and shall be used in locations from where it was derived to ensure any seed stock located within the mulch will be located in appropriate site conditions. Any vegetation, topsoil or other materials not identified for re-use shall be either disposal of off-site or in an area where the material will not wash into existing vegetation and or University Creek.

5.0 SCHEDULE OF WORKS

5.1 GENERAL

- The required rehabilitation works for the riparian corridor should occur immediately after the proposed creek engineering works has been implemented.
- Construction works derived from the precinct E concept plan will be staged over several years, the planting of the riparian corridor may need to be delivered several times to ensure maximum establishment of the vegetation.
- Where the creek engineering works will impact existing trees, new tree planting should be avoided until works are complete. Instead groundcover planting should be implemented to stabilise the banks and prevent weed infestation.
- Rehabilitation of the STIF will take precedence and the required works, especially weed removal should be immediately implemented to prevent further degradation and allow natural revegetation to occur

5.2 SYDNEY TURPENTINE IRONBARK FOREST

The Vegetation Management Plan for the Sydney Turpentine Ironbark Forest area (Lesryk, 2010) identifies 4 stages in the rehabilitation process.

The Stage 1, initial weed control should commence prior to the proposed creek engineering works to identify the extent of the Sydney Turpentine Ironbark Forest area and restrict access for engineering activities or works.

The following stages are detailed in the Vegetation Management Plan for the Sydney Turpentine Ironbark Forest area (Lesryk, 2010) and include:

Stage 2 - secondary weed control - 0-6 months after completion of stage 1

Stage 3 - maintenance year 1 - 6-18 months after completion of stage 1

Stage 4 - maintenance year 2 - 18-30 months after completion of stage 1

5.3 SOFTWARES SCHEDULE

The following table identifies the key tasks and responsibilities that are required to implement the VMP within the riparian corridor.

Table 1 Softworks Schedule		
Task	Action	Responsibility
Protection of existing vegetation	Undertake measures required prior to any work commencing, refer to 4.1.1	All site personnel.
Temporary Construction Measures	Erosion and Sediment Control Plan to be implemented prior to any construction commencing on the creek.	Site Superintendent
Construction Fence exclusion zone	Construct fencing to ensure general construction access is limited within riparian corridor.	Fencing set out is to be inspected and approved by the site superintendent.
Seed Collection/ Cuttings	Collect seed from any significant tree to be removed. Where seed of species is not available refer 3.10. Refer to 4.2 for vegetation removal	Bush Regeneration Contractor Landscape Architect
Stripping Top Soil	Strip and stockpile topsoil for reuse. In particular where topsoil has the potential for indigenous seed bank utilise in riparian corridor. Where topsoil has exotic grass present, stockpile for use outside of the core riparian zone where turf is proposed. Stockpile varied topsoils and subsoil separately and identify stockpiles clearly for reuse. Review weed seed sources in topsoil and treat weeds using best practice principles.	Site Superintendent
Weed Control and Removal	Refer to 3.7	Landscape Contractor
Topsoil Application	Re-spread topsoil over profiled ground levels to min. 300mm depth. Re-spread mulch to stabilise areas. Install jutesh to batters with a grade steeper than 1:4 refer to 3.8	Landscape Architect to sign off planting works

6.0 POTENTIAL ENVIRONMENTAL AND VISUAL IMPACTS OF PROPOSED WORKS

This loss of existing trees required to implement the proposed engineering works will have a slight impact upon the general aesthetics and landscape character of the University campus and there may be some loss of habitat. However, the loss of trees will be offset by the rehabilitation planting within the riparian corridor. All significant trees lost will be replaced in an appropriate area within the corridor and will be maintained and protected.

The rehabilitation of the existing vegetation communities, including the STIF will increase the viability and biodiversity value of the riparian zone. Areas that were once trees in turf within the core riparian zone will be regenerated with understorey and groundcover species, increasing the bank stability and both aquatic and terrestrial habitat capability. This will be enhanced by the removal of weed species which will lessen the chances of future weed infestations both on campus and within other bushland areas in close vicinity.

The increase of internal creek planting will aid in stabilising the creek bed, banks and batters and will have no negative environmental impact. The planting will create a more viable aquatic habitat and will aid in increasing the water quality of the creek. It will also aid in the visual amenity of the proposed engineering works by softening the rock batters and retaining walls.

7.0 MONITORING

7.1 MAINTENANCE STRATEGIES

- All planting should be maintained by the landscape Contractor for a period of 24 months and the University Maintenance division thereafter.
- Artificial watering should be undertaken for the first 12 months. Beyond that time frame plants should be suitably established.
- Evaluation of planting success at 3 months after planting and immediate replanting if loss rates reach 20% or more. All tree species lost should be replaced immediately.
- Weed control practices which prevent seeding of weed species and controls weed growth by application of appropriate herbicide or manual removal, refer to section 3.7
- Spraying for the control of insects or damage.

7.2 ACCESS

Access into the riparian corridor throughout the establishment period should be limited to the designated pedestrian ways. Areas designated for pedestrian and or passive recreational use should be left operational and clearly defined. Signage informing of the rehabilitation works should be implemented to prevent pedestrians from using and potentially damaging the newly planted areas.

Visual access through the riparian corridor should be maintained to comply CPTED best practice principles.

7.3 INSPECTION AND CHECKLISTS DURING SITE WORKS

Inspections during the site works are to be undertaken by the Site Manager to ensure the ongoing protection of all existing vegetation and new revegetation works during construction. The inspections will review all protective measures such as erosion, vehicle and public access barriers, and the correct disposal of vegetation and materials as well as monitoring of the health and well-being of existing and new vegetation. The inspections shall occur weekly or after high rainfall events and will be documented in a logbook. An inspection checklist shall be prepared and filled out during each inspection.

7.4 RESPONSIBILITIES

The Macquarie University Office of Major will hold the first level of responsibility for the implementation of the Landscape Rehabilitation Plan incorporating Vegetation Management Plan. The on-going, day-to-day implementation, monitoring and reviewing of the plan will be undertaken by the Manager of the Macquarie University Maintenance Department.

8.0 COSTINGS

<p>context</p> <p>University Creek, Macquarie University, Landscape Softworks Opinion of Probable Cost Issue A - Vegetation Management Plan 28-May-10</p>				
DESCRIPTION	QTY	UNIT	UNIT RATE	TOTAL
REACH A				
Supply trees, shrubs and ground covers				
Supply Trees (tubestock)	130	ea	\$4.80	\$624
Supply Shrubs (Virocell)	90	ea	\$3.80	\$342
Supply Groundcovers (Virocell)	10600	ea	\$0.70	\$7,420
Preparation and Planting				
Cultivate and ameliorate as required	1770	m ²	\$4.00	\$7,080
Prepare and plant tubestock	130	ea	\$1.50	\$195
Prepare and plant Virocell/border edge	10690	ea	\$0.70	\$7,483
Supply and Install polythene tube to all trees and shrubs	220	ea	\$1.85	\$407
Supply and Install 75mm organic mulch layer to all reach (excluding internal creek works)	5000	m ²	\$9.00	\$45,000
Maintenance				
104 weeks	104	weeks	\$300	\$31,200
REACH A SUBTOTAL				\$99,751
REACH B (Excluding STIF)				
Supply trees, shrubs and ground covers				
Supply Trees (tubestock)	50	ea	\$4.80	\$240
Supply Shrubs (Virocell)	20	ea	\$3.80	\$76
Supply Groundcovers (Virocell)	4500	ea	\$0.70	\$3,150
Preparation and Planting				
Cultivate and ameliorate as required	2000	m ²	\$4.00	\$8,000
Prepare and plant tubestock	50	ea	\$1.50	\$75
Prepare and plant Virocell/border edge	4520	ea	\$0.70	\$3,164
Supply and Install polythene tube to all trees and shrubs	70	ea	\$1.85	\$130
Supply and Install 75mm organic mulch layer to all reach (excluding internal creek works)	2500	m ²	\$9.00	\$22,500
Maintenance				
104 weeks	104	weeks	\$300	\$31,200
REACH B SUBTOTAL				\$68,535
REACH C				
Supply trees, shrubs and ground covers				
Supply Trees (tubestock)	70	ea	\$4.80	\$336
Supply Groundcovers (Virocell)	21000	ea	\$0.70	\$14,700
Preparation and Planting				
Cultivate and ameliorate as required	3800	m ²	\$4.00	\$15,200
Prepare and plant tubestock	70	ea	\$1.50	\$105
Prepare and plant Virocell/border edge	2100	ea	\$0.70	\$1,470
Supply and Install polythene tube to all trees and shrubs	70	ea	\$1.85	\$130
Supply and Install 75mm organic mulch layer to all reach (excluding internal creek works)	3800	m ²	\$9.00	\$34,200
Maintenance				
104 weeks	104	weeks	\$300	\$31,200

REACH D				
Supply trees, shrubs and ground covers				
Supply Trees (tubestock)	35	ea	\$4.80	\$168
Supply Shrubs (Virocell)	50	ea	\$3.80	\$190
Supply Groundcovers (Virocell)	9000	ea	\$0.70	\$6,300
Preparation and Planting				
Cultivate and ameliorate as required	1500	m ²	\$4.00	\$6,000
Prepare and plant tubestock	35	ea	\$1.50	\$53
Prepare and plant Virocell/border edge	50	ea	\$0.70	\$35
Supply and Install polythene tube to all trees and shrubs	35	ea	\$1.85	\$65
Supply and Install 75mm organic mulch layer to all reach (excluding internal creek works)	2250	m ²	\$9.00	\$20,250
Maintenance				
104 weeks	104	weeks	\$300	\$31,200
REACH D SUBTOTAL				\$64,070
REACH E				
Supply trees, shrubs and ground covers				
Supply Trees (tubestock)	32	ea	\$4.80	\$154
Supply Groundcovers (Virocell)	6000	ea	\$0.70	\$4,200
Preparation and Planting				
Cultivate and ameliorate as required	1000	m ²	\$4.00	\$4,000
Prepare and plant tubestock	32	ea	\$1.50	\$48
Prepare and plant Virocell/border edge	6000	ea	\$0.70	\$4,200
Supply and Install polythene tube to all trees and shrubs	32	ea	\$1.85	\$59
Supply and Install 75mm organic mulch layer to all reach (excluding internal creek works)	3460	m ²	\$9.00	\$31,140
Maintenance				
104 weeks	104	weeks	\$300	\$31,200
REACH E SUBTOTAL				\$75,001
REACH F				
Supply trees, shrubs and ground covers				
Supply Trees (tubestock)	10	ea	\$4.80	\$48
Supply Shrubs 200mm pot	54	ea	\$6.00	\$324
Supply Groundcovers (Virocell)	8400	ea	\$0.70	\$5,880
Preparation and Planting				
Cultivate and ameliorate as required	1700	m ²	\$4.00	\$6,800
Prepare and plant tubestock	10	ea	\$1.50	\$15
Prepare and plant 200mm pot shrubs	54	ea	\$3.00	\$162
Prepare and plant Virocell/border edge	8400	ea	\$0.70	\$5,880
Supply and Install polythene tube to all trees and shrubs	35	ea	\$1.85	\$65
Supply and Install 75mm organic mulch layer to all reach (excluding internal creek works)	1700	m ²	\$9.00	\$15,300
Maintenance				
104 weeks	104	weeks	\$300	\$31,200
REACH F SUBTOTAL				\$65,188
TOTAL				\$370,134
10% Contingency				\$37,013
GRAND TOTAL				\$407,147
Exclusions and Assumptions				
Quantities given are estimates only and should be used purely as an opinion				
Assumes soil is of average quality and hardness				
Does not include any hardworks				
Based on Controlled Activity Submission 28 May 2010				
Excludes GST				

8.2 SYDNEY IRONBARK TURPENTINE FOREST REHABILITATION

The following cost estimates have been provided for the implementation of the Vegetation Management Plan for the STIF area (prepared by Lesryk, refer to Appendix A)

Table 2 - STIF Costings		
Stage	Action	Estimated Cost
Stage 1	Initial weed control	\$ 3560
Stage 2	Secondary weed control	\$ 8360
Stage 3	Maintenance Year 1	\$ 9640
Stage 4	Maintenance Year 2	\$ 4520

9.0 PERFORMANCE EVALUATION

The performance of the proposed revegetation and rehabilitation works will be evaluated by the following;

- Decrease in bank erosion;
- Increase of the ecological value of the STIF community;
- Eradication of tree weed species;
- Reduction in the extent of flowering and seeding herbaceous weeds.
- Minimum 50% reduction in annual and climbing weeds in 24 months;
- Plant survival rates in re-vegetated areas is greater than 80% after 12 months; and
- Revegetation is at a competitive advantage and competitive weed species are controlled for at least 24 months from the time of planting.

Site photos have been taken in the surveyed locations and are included in the survey drawings. Photos are to be taken 6, 12 and 24 months after the time of planting in the surveyed locations to monitor and evaluate the performance indicators.

APPENDIX A

Vegetation Management Plan for Sydney Turpentine Ironbark Forest
Area Macquarie University Ryde - Prepared by Lesryk Environmental
Consultants (2010)



vegetation management plan for sydney turpentine ironbark forest area macquarie university, ryde

prepared by
Mark Couston CPESC. - Ass. Dip. Env. Ctri. (CSU), Grad. Dip. Env. Mgmt. (CSU), Cert. Soil & Water Mgmt. (UWS), MESA, MECA. ;
DECCW Scientific Licence No. S11031, DPI - Animal Research Authority 04-4786

3rd may 2010



PO Box 3001, Bundeena, NSW 2230
Phone: 9523 2016
Fax: 9544 1835
Email: admin@lesryk.com.au

Background

This vegetation management plan has been prepared to outline the rehabilitation works within an area of Sydney Turpentine Ironbark Forest adjacent University Creek, within the grounds of Macquarie University at Ryde. A detailed flora and fauna survey and habitat assessment was carried out within the University grounds and the Ecological Constraints Report (Lesryk, 2009) identified the area covered by this plan as being of high ecological constraint to future development.

Existing Site

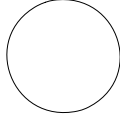
For the purposes of this report, the area of indigenous vegetation on the south eastern side of University Creek, adjacent the boundary of the Moring Baptist Bible College, will be referred to as the site. The site is one of the few pockets of indigenous vegetation within the Macquarie University grounds and this area retains species that are characteristic of the endangered Sydney Turpentine Ironbark Forest ecological community. This area has been subject to previous disturbances including the partial clearing of the vegetation associated with past land management practices and soil disturbance associated with excavations and installation of sewer mains. Despite these disturbances the vegetation on the site has regenerated over the years and currently has an open forest structure predominately comprising of indigenous species. Low to moderate levels of environmental weeds have established on the site and without proper management, these weeds will increasingly smother the native vegetation and further degrade the site.

Objective of the plan

This plan forms part of a broader vegetation management plan associated with the riparian areas of University Creek and this plan has been specifically developed to address the more ecologically sensitive parts of the riparian corridor. The objective of this vegetation management plan is consistent with the Office of Water's guidelines, being:
" to provide for a stable watercourse and riparian corridor which emulates the native vegetation communities in the area".

Contents

- Page 1 - this cover page
- Page 2 - local and site context
- Page 3 - existing site habitats
- Page 4 - existing site floristics
- Page 5 - rehabilitation / regeneration of sydney turpentine ironbark forest
- Page 6 - specifications site photographs for monitoring purposes.



prepared by
mark couston

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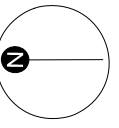
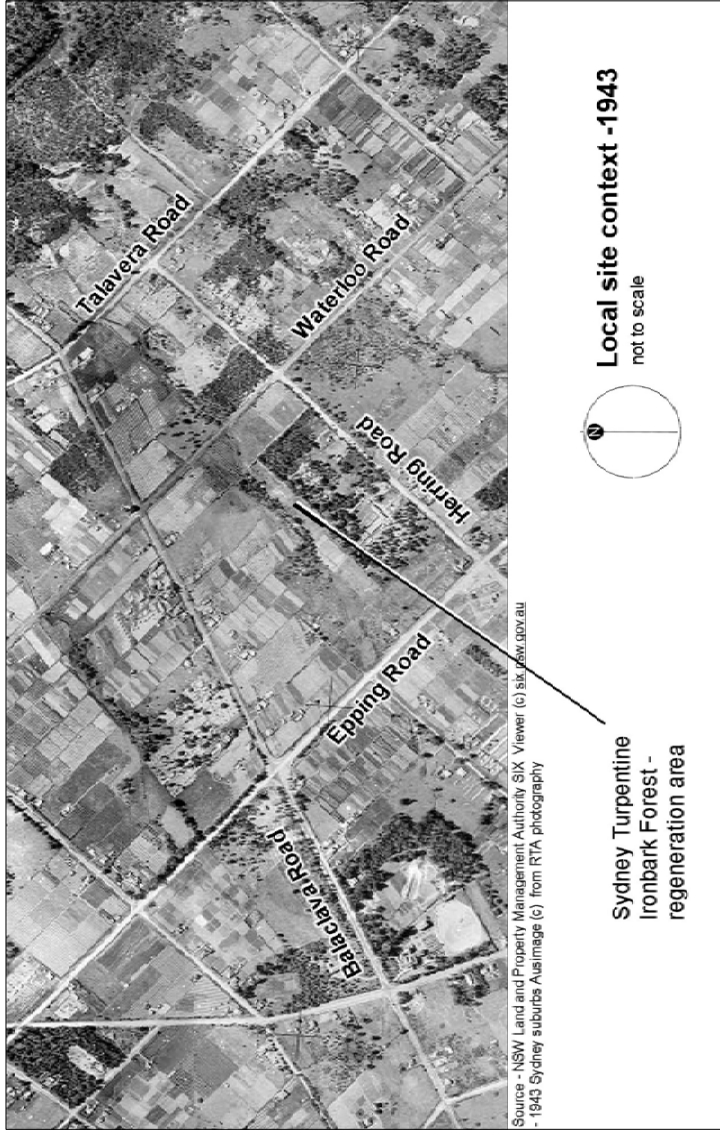
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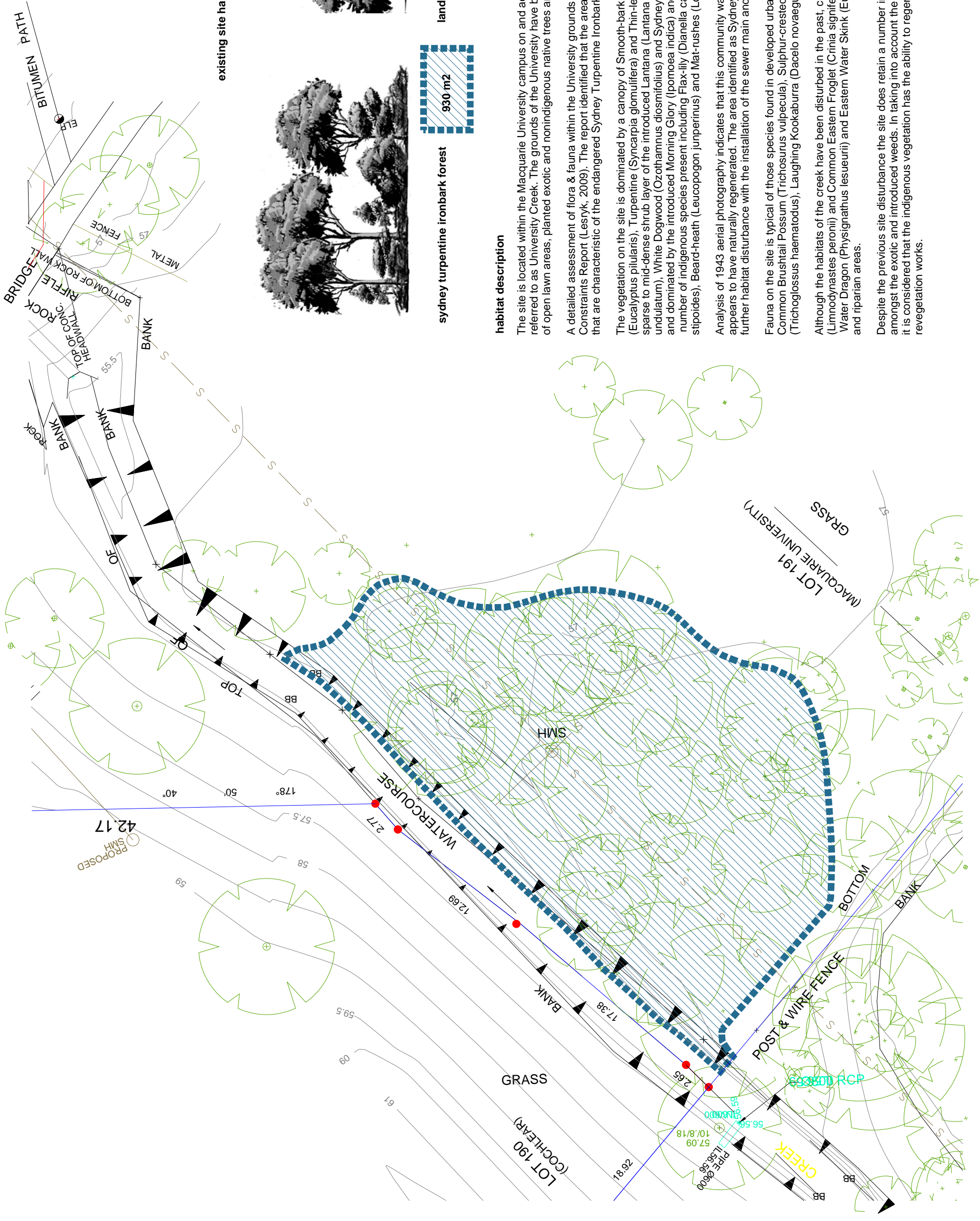
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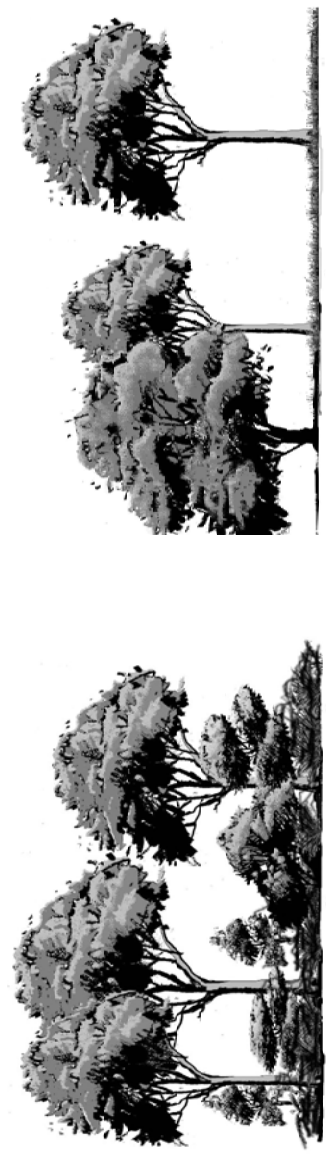
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project
**vegetation management plan for
 sydney turpentine ironbark forest area
 macquarie university, ryde**

drawing title
local & site context



existing site habitats



landscaped precincts

n/a

habitat description

The site is located within the Macquarie University campus on and adjacent the south eastern banks of an open watercourse referred to as University Creek. The grounds of the University have been substantially developed and the landscape consists of open lawn areas, planted exotic and nonindigenous native trees and small pockets of indigenous vegetation.

A detailed assessment of flora & fauna within the University grounds was conducted and documented in "Ecological Constraints Report (Lesryk, 2009). The report identified that the area covered in this Vegetation Management Plan has species that are characteristic of the endangered Sydney Turpentine Ironbark Forest ecological community.

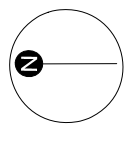
The vegetation on the site is dominated by a canopy of Smooth-barked Apple (*Angophora costata*) along with Blackbutt (*Eucalyptus pilularis*), Turpentine (*Syncarpia glomulifera*) and Thin-leaved Stringybark (*Eucalyptus eugenioides*). There is a sparse to mid-dense shrub layer of the introduced Lantana (*Lantana camara*) and the native Sweet Pittosporum (*Pittosporum undulatum*), White Dogwood (*Ozothamnus diosmifolius*) and Sydney Golden Wattle (*Acacia longifolia*). The groundcover is dense and dominated by the introduced Morning Glory (*Ipomoea indica*) and Panic Veldt Grass (*Ehrharta longiflora*) however there are a number of indigenous species present including Flax-lily (*Dianella caerulea* var *producta*), Weeping Meadow Grass (*Microlaena stipoides*), Beard-heath (*Leucopogon juniperinus*) and Mat-rushes (*Lomandra* spp).

Analysis of 1943 aerial photography indicates that this community was at that time restricted to the edge of the creek and appears to have naturally regenerated. The area identified as Sydney Turpentine Ironbark Forest has also been subject to further habitat disturbance with the installation of the sewer main and sewer man-hole within the site.

Fauna on the site is typical of those species found in developed urban areas where there is some tree cover and includes, Common Brushtail Possum (*Trichosurus vulpecula*), Sulphur-crested Cockatoo (*Cacatua galerita*), Rainbow Lorikeet (*Trichoglossus haematodus*), Laughing Kookaburra (*Dacelo novaeguineae*) and Noisy Miner (*Manorina melanoccephala*).

Although the habitats of the creek have been disturbed in the past, common fauna species such as Striped Marsh Frog (*Limnodynastes peronii*) and Common Eastern Froglet (*Crinia signifera*) have colonised the aquatic habitats and Eastern Water Dragon (*Physignathus lesueurii*) and Eastern Water Skink (*Eulamprus leuraensis*) can be found on the creek banks and riparian areas.

Despite the previous site disturbance the site does retain a number indigenous ground covers and understorey species amongst the exotic and introduced weeds. In taking into account the number and diversity of indigenous species on the site, it is considered that the indigenous vegetation has the ability to regenerate and recover without the need for supplementary revegetation works.



prepared by
mark coustoun

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project
**vegetation management plan for
sydney turpentine ironbark forest area
macquarie university, ryde**

drawing title
existing site habitats



Vegetation Structure	Exotic Biomass %	Weed Scale	Calculated Weed Class
canopy	< 10%	1	canopy weed scale x 0.5 = **
	10% - 30%	2	
	31% - 60%	3	
understorey	< 10%	1	understorey weed scale x 0.2 = **
	10% - 30%	2	
	31% - 60%	3	
ground cover	< 10%	1	ground cover weed scale x 0.3 = **
	10% - 30%	2	
	31% - 60%	3	

note: where the canopy is absent use understorey Weed Scale

note: where the understorey is absent use ground cover Weed Scale

Reporting (* / ** / **)

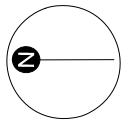
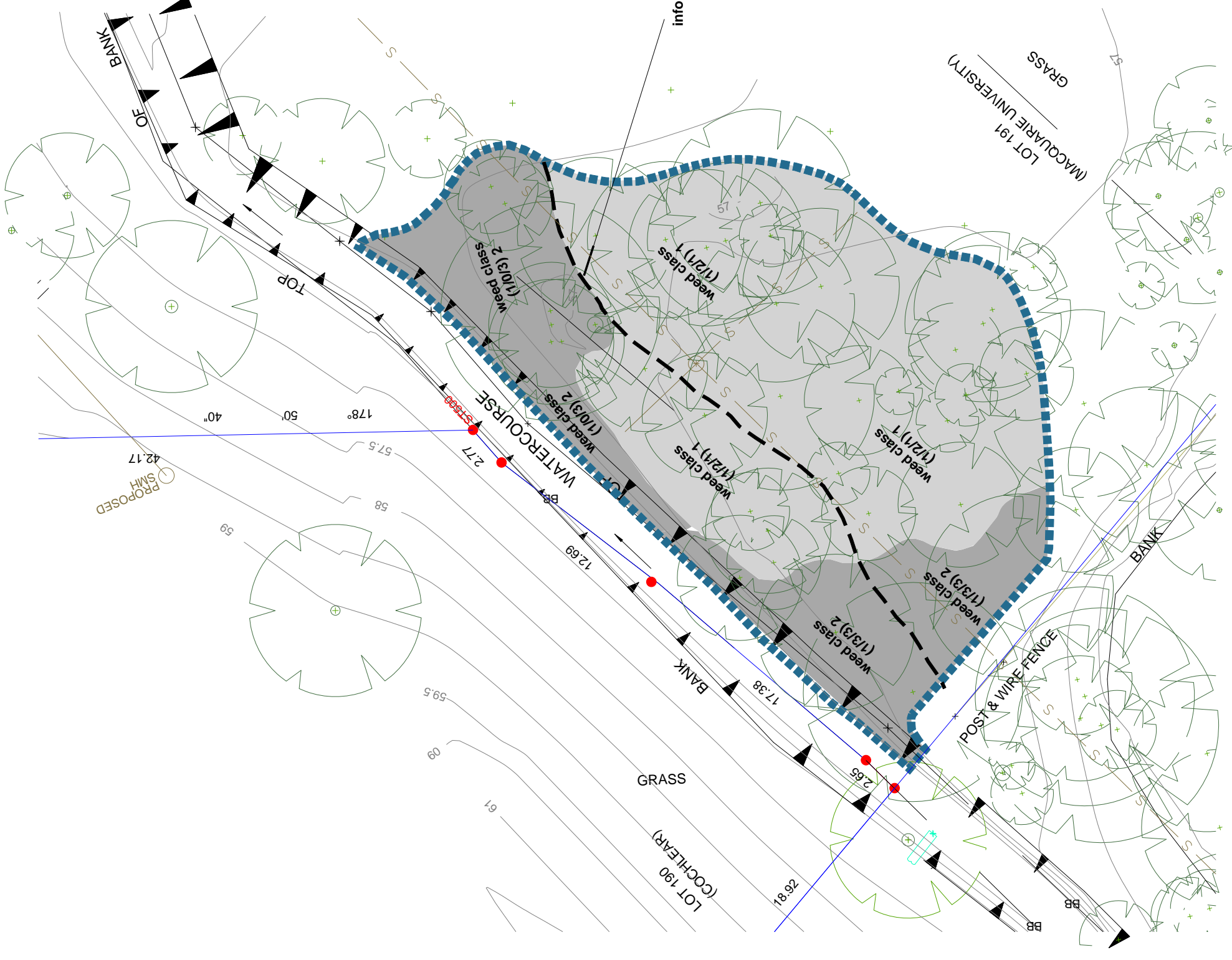
weed class	area
weed class 1 (little or no weed)	600 sq m
weed class 2 (low levels of weeds)	330 sq m
weed class 3 (moderate levels of weeds)	not recorded on site
weed class 4 (high levels of weeds)	not recorded on site

characteristic indigenous species

Genus species	Common Name
<i>Acacia longifolia</i>	Sydney Golden Wattle
<i>Angophora costata</i>	Sydney Red/Rusty Gum
<i>Angophora floribunda</i>	Rough-barked Apple
<i>Corymbia gummifera</i>	Red Bloodwood
<i>Dianella caerulea</i>	Blue Flax Lily
<i>Dichondra repens</i>	Kidney Weed
<i>Eriolasia marginata</i>	Bordered Panic
<i>Eriolasia stricta</i>	Wiry Panic
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus pilularis</i>	Blackbutt
<i>Glycine clandestina</i>	Twining Glycine
<i>Hibbertia aspera</i>	Rough Guinea Flower
<i>Hibbertia empetrifolia</i>	-
<i>Imperata cylindrica</i>	Blady Grass
<i>Leucopogon juniperinus</i>	Prickly Beard-heath
<i>Lomandra filiformis</i>	Wattle Mat-rush
<i>Lomandra gracilis</i>	-
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
<i>Microlaena stipoides</i>	Weeping Grass
<i>Oplismenus imbecillis</i>	Basket Grass
<i>Ozothamnus diosmifolius</i>	White Dogwood
<i>Pericaria lepathifolia</i>	Pale Knotweed Herb
<i>Ptilotopus undulatum</i>	Native Daphne
<i>Pratia purpurascens</i>	Whiteroot
<i>Pseuderanthemum variabile</i>	Pastel Flower
<i>Syncaipia glomulifera</i>	Turpentine
<i>Typha orientalis</i>	Broad-leaf Cumbungi, Bulrush
<i>Veronica plebeia</i>	Trailing Speedwell
<i>Viola hederacea</i>	Ivy-Leaved Violet

characteristic weed species

Genus species	Common Name
<i>Asparagus aethiopicus</i>	Asparagus Fern
<i>Bidens pilosa</i>	Cobbler's Peg
<i>Cinnamomum camphora</i>	Camphor Laurel
<i>Cytisus sp.</i>	Broom
<i>Cytisus scoparius</i>	Scotch Broom
<i>Ehrharta erecta</i>	Panic Veldtgrass
<i>Ipomoea indica</i>	Blue Morning Glory
<i>Jacaranda mimosifolia</i>	Jacaranda
<i>Lantana camara</i>	Lantana
<i>Ligustrum lucidum</i>	Large Leaf Privet
<i>Ligustrum sinense</i>	Small Leaf Privet
<i>Olea europaea subsp. cuspidata</i>	African Olive
<i>Paspalum urvillei</i>	Vasey Grass
<i>Passiflora edulis</i>	Common Passionfruit
<i>Pennisetum clandestinum</i>	Kikuyu Grass
<i>Senna pendula</i>	Cassia
<i>Sporobolus indicus</i>	Parramatta Grass



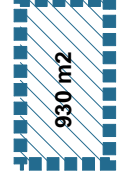
site rehabilitation units



n/a

landscaped precincts

performance measures
- refer landscape plan



sydney turpentine ironbark forest - regeneration

performance measures
- conditions retained that encourage the natural establishment of indigenous flora.
- the area is to be maintained periodically so as to achieve less than 5% weed biomass at all times.
- there must be no signs of sediment deposition or bank erosion at all times.
- no additional planting shall occur.

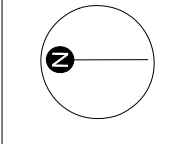
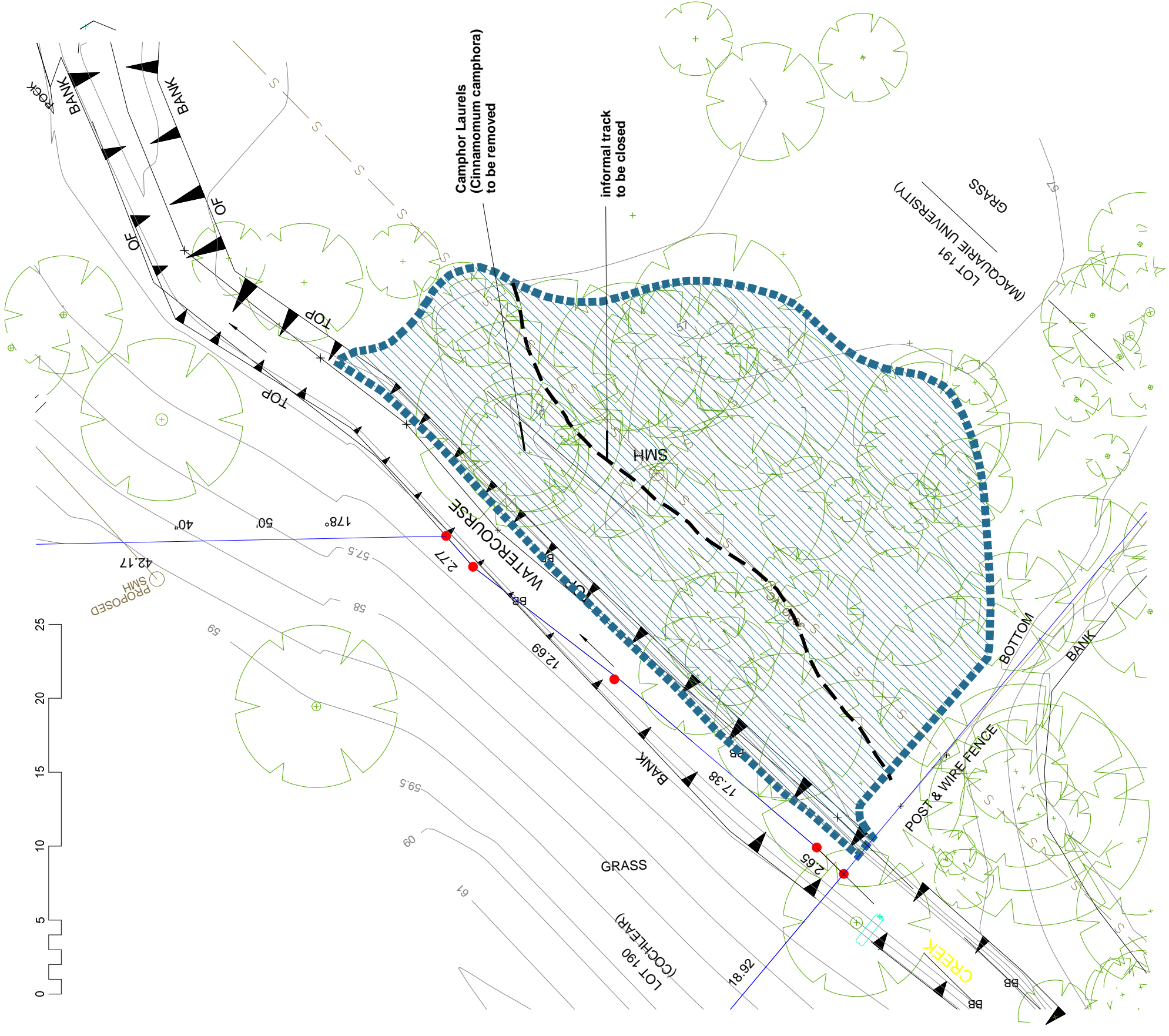
rehabilitation procedure (refer specifications sheet 6)

Stage 1 - initial weed control
1.1 - An environmental monitoring / compliance auditing program is to be established and implemented by a suitably qualified person to ensure compliance with site controls and plan performance criteria.
1.2 - An environmental awareness and identification of environmental protection zones is to be incorporated as part of the site induction program for contractors along with OH&S practices.
1.3 - An experienced and qualified Bush Regeneration Contractor (refer sheet 6 specifications) is to be engaged to undertake the vegetation management works associated with this plan.
1.4 - The Camphor Laurel (Cinnamomum camphora) trees within the site area are to be felled leaving the root systems and low stumps (approximately 0.1m) in place. The stumps are to be immediately treated with herbicide (refer specifications sheet 6) after cutting to prevent them resprouting.
1.5 - Weed control is to be undertaken across the site treating all exotic flora species in accordance with standard bush regeneration techniques (refer specifications sheet 6).
1.6 - The performance measures must be achieved at each stage of rehabilitation.
1.7 - The site supervisor or project manager must maintain records, details and photographs of the work undertaken during this period for inclusion in final reports to the Office of Water.

Stage 2 - secondary weed control - 0-6 months after completion of stage 1
2.1 - The informal track is to be closed off using branch or log debris or constructed bollards and the fence on the creek bank between the University grounds and Morling Baptist Bible College shall be reinstated.
2.2 - The interface between the Sydney Turpentine Ironbark Forest and the adjacent mown grass is to be formalised by a timber mowing edge, rock boulders or a similar.
2.3 - Weed control is to be undertaken across the site treating all exotic flora species in accordance with standard bush regeneration techniques (refer specifications sheet 6) at a minimum of 1 month intervals.
2.4 - The performance measures must be achieved at each weed control interval.
2.5 - The site supervisor or project manager must maintain records, details and photographs of the work undertaken during this period for inclusion in final reports to the DECCW's Office of Water.
2.6 - The project report shall be prepared and submitted to the DECCW's Office of Water.

Stage 3 - maintenance year 1 - 6-18 months after completion of stage 1
3.1 - Weed control is to be undertaken across the site treating all exotic flora species in accordance with standard bush regeneration techniques (refer specifications sheet 6) at a minimum of:
- 2 monthly intervals during 6-12 months after completion of stage 1;
- 3 monthly intervals during 12-18 months after completion of stage 1.
3.2 - The performance measures must be achieved at each weed control interval.
3.3 - The site supervisor or project manager must maintain records, details and photographs of the work undertaken during this period for inclusion in final reports to the DECCW's Office of Water.
3.4 - The year 1 maintenance report shall be prepared and submitted to the DECCW's Office of Water.

Stage 4 - maintenance year 2 - 18-30 months after completion of stage 1
4.1 - Weed control is to be undertaken across the site treating all exotic flora species in accordance with standard bush regeneration techniques (refer specifications sheet 6) at a minimum of 4 monthly intervals during 18-30 months after completion of stage 1;
4.2 - The performance measures must be achieved at each weed control interval.
4.3 - The site supervisor or project manager must maintain records, details and photographs of the work undertaken during this period for inclusion in final reports to the DECCW's Office of Water.
4.4 - The final report incorporating Stages 1-4 shall be prepared and submitted to the DECCW's Office of Water.



specifications

Bush regeneration

Bushland Regeneration is the activities carried out to provide conditions that facilitate the natural recruitment or germination of endemic flora species. It primarily involves the progressive control of weed species in a systematic manner of primary weed control, follow-up weed control (often several follow-up sessions) and maintenance over an identified works area. Typically work areas progress from areas of little weeds and expand to adjacent works areas. It is recommended that these activities are undertaken by specialised and experienced bush regeneration contractors.

Bush regeneration contractors

Bush regeneration contractors are companies or individuals who have experience and qualifications in bush regeneration activities. Contractors must provide an experienced site supervisor with minimum qualifications of a TAFE Certificate II in Bush Regeneration or Conservation & Land Management and must be eligible for membership to Australian Association of Bush Regenerators.

Crushed sandstone mulch

Crushed sandstone mulch is to be comprised of clean crushed sandstone, free of clay, weed propagules, road base and other foreign matter and should comprise <5% fines and rocks with a maximum diameter of 100mm. Crushed sandstone mulch shall be laid to a depth of 50-75mm.

Erosion & sediment controls

All erosion and sediment controls such as berms, sediment fences, rumble zones sediment basins and site drainage flow paths must be designed and constructed in accordance with Managing Urban Stormwater: Soils and Construction. 4th Edition (Landcom, 2004), New South Wales Government.

Herbicide usage

Glyphosate based herbicides can be used in conjunction with weed control techniques and is to be used in accordance with the product label and registration. Herbicide usage must be undertaken in a manner or method that does not cause harm to endemic species or new plantings and there is no contamination of surface or ground waters.

Weed control

Weed control is to be undertaken using standard bush regeneration techniques such as hand weeding or with the use of Glyphosate based herbicides when necessary (eg. cut & paint, stem scrape, spot spraying).

Weed material disposal and temporary storage on site.

Weed material containing seed or weed material capable of spreading vegetatively shall be removed from site and disposed of at an appropriate location where it will not cause further environmental damage.

Temporary storage of weed material prior to disposal can occur on site where it is stored, outside drainage lines, on an impervious surface and it is covered with a material that adequately contains the weed debris.



figure 6.1 the regeneration area looking south west along the informal track

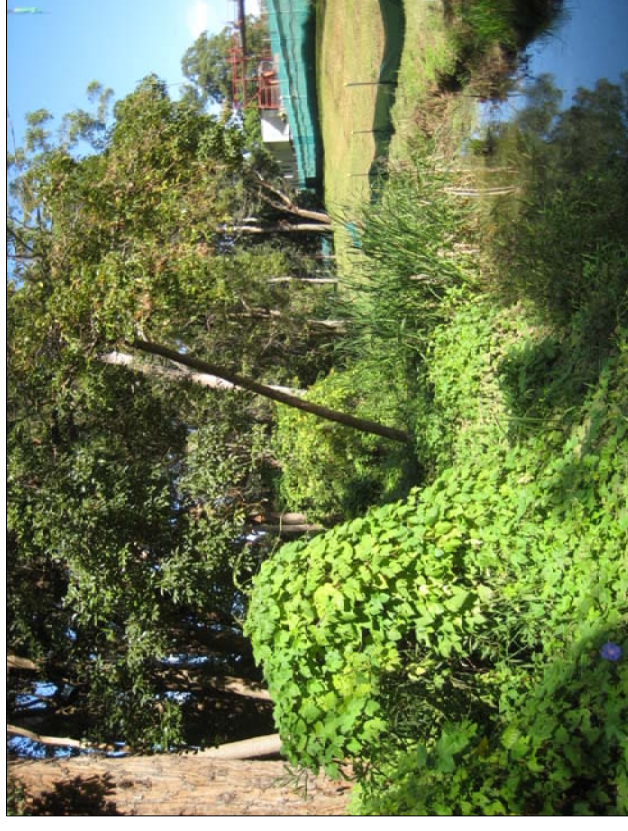
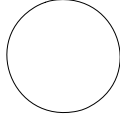


figure 6.2 the regeneration area looking south west along the watercourse



figure 6.3 the regeneration area looking north east along the informal access track



5th May 2010

Ms Cate Wallace
Context
PO Box A866

SYDNEY SOUTH NSW 1235

Dear Ms Wallace,
Re: Cost Estimates - Vegetation Management Plan for Sydney Turpentine Ironbark Forest Area Macquarie University, Ryde

The following cost estimates have been provided for the implementation of the Vegetation Management Plan for Sydney Turpentine Ironbark Forest Area Macquarie University, Ryde (Lesryk. 03/05/10) for the

The cost estimates are based upon the 4 stages in the plan being:

Stage	VMP STIF sheet	Est. Costing
Stage 1 - initial weed control	5	\$ 3,560
Stage 2 - secondary weed control	5	\$ 8,360
Stage 3 - maintenance year 1	5	\$ 9,640
Stage 4 - maintenance year 2	5	\$ 4,520
Total Project Costs		\$ 26,080

Details of the cost estimates and tasks within each stage are outlined in the table appended to this document.

If you have any queries or would like clarification on any information in relation to this matter please contact me.

Yours sincerely

Mark Couston CPESC.

Ass. Dip. Env. Ctrl. (CSU), Grad. Dip. Env. Mgmt. (CSU),
Cert. Soil & Water Mgmt. (UWS), MESA, MECA.
DECCW - Scientific Licence No. S11031, DPI - Animal Research Authority 04-4786

Detailed Cost Estimates – Implementation of Vegetation Management Plan for Sydney Turpentine Ironbark Forest area (Lesryk, 03/05/10)

Stage/Task	VMP Sheet	Equipment	Materials	Labour (hrs)	Hourly Rate	Unit Costs	Sum	Stage Subtotal
Stage 1 - initial weed control	5							\$ 3,560
Tree Removal		Chain Saw		8	\$ 40		\$ 320	
Weed Control		Hand Tools	Herbicide	64	\$ 40		\$ 2,560	
Monitorint & Reporting				4	\$ 170		\$ 680	
Stage 2 - secondary weed control	5							\$ 8,360
Weed control		Hand Tools	Herbicide	192	\$ 40		\$ 7,680	
Monitorint & Reporting				4	\$ 170		\$ 680	
Stage 3 - maintenance year 1	5							\$ 9,640
Weed control		Hand Tools	Herbicide	224	\$ 40		\$ 8,960	
Monitorint & Reporting				4	\$ 170		\$ 680	
Stage 4 - maintenance year 2	5							\$ 4,520
Weed control		Hand Tools	Herbicide	96	\$ 40		\$ 3,840	
Monitorint & Reporting				4	\$ 170		\$ 680	
Total Project Costs							\$ 26,080	

APPENDIX B

Planting Schedules

Schedule 1 - Reach A		
Botanic Name	Common Name	Installation Size
Primary Tree Species		
Angophora costata	Smooth Bark Apple	Tube stock
Corymbia gummifera	Red Bloodwood	Tube stock
Eucalyptus haemastoma	Scribbly Gum	Tube stock
Eucalyptus piperita	Sydney Peppermint	Tube stock
Associated Tree Species		
Angophora hispida	Dwarf Apple	Tube stock
Eucalyptus punctata	Grey Gum	Tube stock
Eucalyptus sieberi	Silver Top Ash	Tube stock
Understorey Trees		
Acacia myrtifolia	Myrtle Apple	Tube stock
Acacia suaveolens	Sweet Scented Wattle	Tube stock
Shrubs		
Banksia ericifolia	Heath Banksia	Viro Cell
Banksia spiulosa	Hairpin Banksia	Viro Cell
Dillwynia retorta	Eggs and Bacon	Viro Cell
Grevillea speciosa	Red Spider Flower	Viro Cell
Isopogon anemonifolius	Broad Leaved Drum Sticks	Viro Cell
Leptospermum trinervium	Paper Bark Tea Tree	Viro Cell
Lomatia silaefolia	Wild Parsley	Viro Cell
Persoonia levis	Dark Papery Bark	Viro Cell
Groundcovers, grasses and Sedges		
Baumea articulata*	Jointed Twig Rush	Border edge
Carex apressa*	Tall sedge	Border edge
Dianella revoluta	Flax Lily	Viro Cell
Gahnia sieberiana*	Saw Sedge	Border edge
Isolepis nodosa*	Knobby Club Rush	Border edge
Juncus usitatus*	Common Rush	Viro Cell
Lomandra glauca	Common Mat Rush	Viro Cell
Lomandra longifolia	Twisted Mat Rush	Viro Cell

Schedule 2 - Reach B		
Botanic Name	Common Name	Installation Size
Primary Tree Species		
<i>Angophora costata</i>	Smooth Bark Apple	Tube stock
<i>Eucalyptus paniculata</i>	Grey Ironbark	Tube stock
<i>Syncarpia glomulifera</i>	Turpentine	Tube stock
Associated Tree Species		
<i>Eucalyptus fibrosa</i>	Red Ironbark	Tube stock
<i>Eucalyptus globoidea</i>	White Stringy Bark	Tube stock
<i>Eucalyptus punctata</i>	Grey Gum	Tube stock
Understorey Trees		
<i>Acacia falcata</i>	Silver Mallet	Tube stock
<i>Melaleuca decora</i>	White Feather Myrtle	Tube stock
Shrubs		
<i>Acacia longifolia</i>	Sydney Golden Wattle	Viro Cell
<i>Daviesia ulicifolia</i>	Native Gorse	Viro Cell
<i>Pittosporum revolutum</i>	Yellow Pittosporum	Viro Cell
Groundcovers, grasses and Sedges		
<i>Baumea articulata</i> *	Jointed Twig Rush	Border edge
<i>Carex apressa</i> *	Tall Sedge	Border edge
<i>Cyperus gracililis</i> *	McCoy Grass	Border edge
<i>Danthonia linkii</i>	Wallaby Grass	Viro Cell
<i>Danthonia racemosa</i>	Wallaby Grass	Viro Cell
<i>Dianella revoluta</i>	Flax Lily	Viro Cell
<i>Gahnia sieberiana</i> *	Saw Sedge	Border edge
<i>Hardenbergia violacea</i>	Purple Coral Pea	Viro Cell
<i>Isolepis nodosa</i> *	Knobby Club Rush	Border edge
<i>Juncus usitatus</i> *	Common Rush	Border edge
<i>Lomandra glauca</i>	Pale Mat Rush	Viro Cell
<i>Lomandra longifolia</i>	Common Mat Rush	Viro Cell
<i>Pandorea pandorana</i>	Wonga Wonga Vine	Viro Cell
<i>Themeda australis</i>	Kangaroo Grass	Viro Cell

Schedule 3 - Reach C		
Botanic Name	Common Name	Installation Size
Primary Tree Species		
<i>Angophora costata</i>	Smooth Bark Apple	Tube stock
<i>Eucalyptus grandis</i>	Flooded Gum	Tube stock
<i>Syncarpia glomulifera</i>	Turpentine	Tube stock
Associated Tree Species		
<i>Casuarina cunninghamiana</i>	River oak	Tube stock
<i>Eucalyptus fibrosa</i>	Red Ironbark	Tube stock
<i>Eucalyptus globoidea</i>	White Stringy Bark	Tube stock
Understorey Trees		
<i>Acacia falcata</i>	Silver Mallet	Tube stock
<i>Melaleuca decora</i>	White Feather Myrtle	Tube stock
Shrubs		
<i>Acacia longifolia</i>	Sydney Golden Wattle	Viro Cell
<i>Daviesia ulicifolia</i>	Native Gorse	Viro Cell
<i>Pittosporum revolutum</i>	Yellow Pittosporum	Viro Cell
Groundcovers, grasses and Sedges		
<i>Baumea articulata</i> *	Jointed Twig Rush	Border edge
<i>Carex apressa</i> *	Tall Sedge	Border edge
<i>Cyperus gracililis</i> *	McCoy Grass	Border edge
<i>Danthonia linkii</i>	Wallaby Grass	Viro Cell
<i>Danthonia racemosa</i>	Wallaby Grass	Viro Cell
<i>Dianella revoluta</i>	Flax Lily	Viro Cell
<i>Gahnia sieberiana</i> *	Saw Sedge	Border edge
<i>Hardenbergia violacea</i>	Purple Coral Pea	Viro Cell
<i>Isolepis nodosa</i> *	Knobby Club Rush	Border edge
<i>Juncus usitatus</i> *	Common Rush	Viro Cell
<i>Lomandra glauca</i>	Pale Mat Rush	Viro Cell
<i>Lomandra longifolia</i>	Common Mat Rush	Viro Cell
<i>Pandorea pandorana</i>	Wonga Wonga Vine	Viro Cell

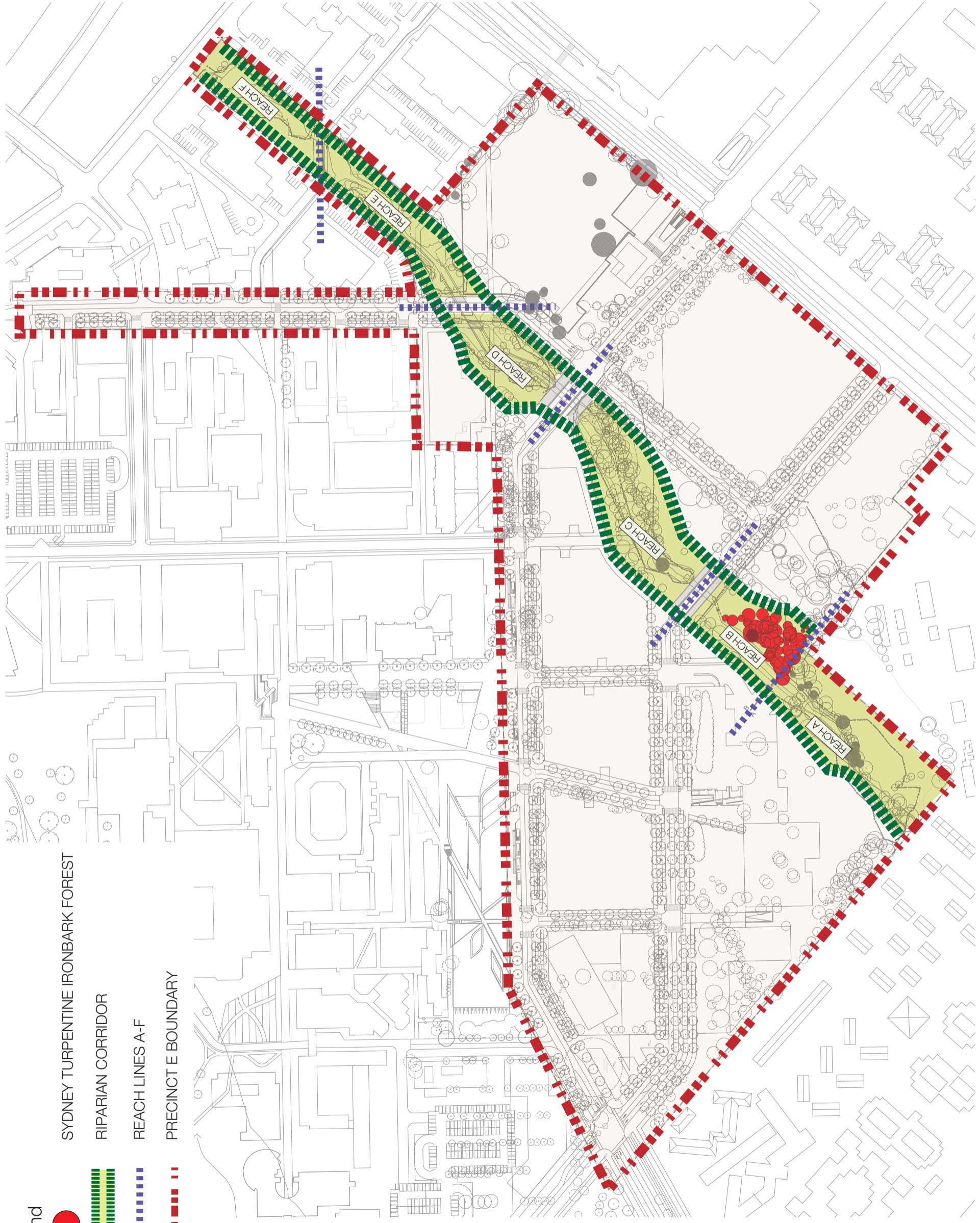
Schedule 4 - Reach D		
Botanic Name	Common Name	Installation Size
Primary Tree Species		
Angophora costata	Smooth Bark Apple	Tube stock
Eucalyptus saligna	Sydney Blue Gum	Tube stock
Syncarpia glomulifera	Turpentine	Tube stock
Associated Tree Species		
Casuarina cunninghamiana	River Oak	Tube stock
Eucalyptus globoidea	White Stringy Bark	Tube stock
Eucalyptus punctata	Grey Gum	Tube stock
Melaleuca decora	White Feather Myrtle	Tube stock
Shrubs		
Acacia longifolia	Sydney Golden Wattle	Viro cell
Daviesia ulicifolia	Native Gorse	Viro cell
Pittosporum revolutum	Yellow Pittosporum	Viro cell
Groundcovers, grasses and Sedges		
Baumea articulata*	Jointed Twig Rush	Border edge
Carex apressa*	Tall Sedge	Border edge
Cyperus gracillilis*	McCoy Grass	Border edge
Dianella revoluta	Flax Lily	Viro cell
Gahnia sieberiana*	Saw Sedge	Border edge
Isolepis nodosa*	Knobby Club Rush	Border edge
Juncus usitatus*	Common Name	Border edge
Lomandra glauca	Pale Mat Rush	Viro cell
Lomandra longifolia	Common Mat Rush	Viro cell
Pandorea pandorana	Wonga Wonga Vine	Viro cell
Themeda australis	Kangaroo Grass	Viro cell

Schedule 5 - Reach E		
Botanic Name	Common Name	Installation Size
Primary Tree Species		
<i>Angophora costata</i>	Smooth Bark Apple	Tube stock
<i>Eucalyptus saligna</i>	Sydney Blue Gum	Tube stock
<i>Syncarpia glomulifera</i>	Turpentine	Tube stock
Shrubs		
<i>Acacia longifolia</i>	Sydney Golden Wattle	Viro cell
<i>Callistemon 'Endeavour'</i>	Bottlebrush	Viro cell
<i>Doryanthes excelsa</i>	Gynea Lily	Viro cell
<i>Pittosporum revolutum</i>	Yellow Pittosporum	Viro cell
<i>Westringia fruiticosa</i>	Native Rosemary	Viro cell
Groundcovers, grasses and Sedges		
<i>Baumea articulata</i> *	Jointed Twig Rush	Border cell
<i>Carex apressa</i> *	Tall Sedge	Border cell
<i>Cyperus gracillilis</i> *	McCoy Grass	Border cell
<i>Dianella revoluta</i>	Flax Lily	Viro cell
<i>Gahnia sieberiana</i> *	Saw Sedge	Border cell
<i>Isolepis nodosa</i> *	Knobby Club Rush	Border cell
<i>Juncus usitatus</i> *	Common Rush	Border cell
<i>Lomandra longifolia</i>	Common Mat Rush	Viro cell
<i>Pandorea pandorana</i>	Wonga Wonga Vine	Viro cell
<i>Themeda australis</i>	Kangaroo Grass	Viro cell



Schedule 6 - Reach F		
Botanic Name	Common Name	Installation Size
Primary Tree Species		
<i>Angophora costata</i>	Smooth Bark Apple	Tube stock
<i>Eucalyptus saligna</i>	Sydney Blue Gum	Tube stock
<i>Syncarpia glomulifera</i>	Turpentine	Tube stock
Groundcovers, grasses and Sedges		
<i>Baumea articulata</i> *	Jointed Twig Rush	Border edge
<i>Carex apressa</i> *	Tall Sedge	Border edge
<i>Cyperus gracillilis</i> *	McCoy Grass	Border edge
<i>Dianella revoluta</i>	Flax Lily	Viro cell
<i>Doryanthes excelsa</i>	Gynea Lily	Viro cell
<i>Gahnia sieberiana</i> *	Saw Sedge	Border edge
<i>Isolepis nodosa</i> *	Knobby Club Rush	Border edge
<i>Juncus usitatus</i> *	Common Rush	Border edge
<i>Lomandra longifolia</i>	Common Mat Rush	Viro cell
<i>Lomandra obliqua</i>	Twisted Mat Rush	Viro cell
<i>Pandorea pandorana</i>	Wonga Wonga Vine	Viro cell
<i>Themeda australis</i>	Kangaroo Grass	Viro cell

APPENDIX C

Existing Conditions Diagram
Tree Retention/Removal Plan



Legend

-  SYDNEY TURPENTINE IRONBARK FOREST
-  RIPARIAN CORRIDOR
-  REACH LINES A-F
-  PRECINCT E BOUNDARY

Legend



TREES TO BE REMOVED AS A RESULT OF PROPOSED ROAD RESERVE WORKS

EXISTING TREES TO BE RETAINED

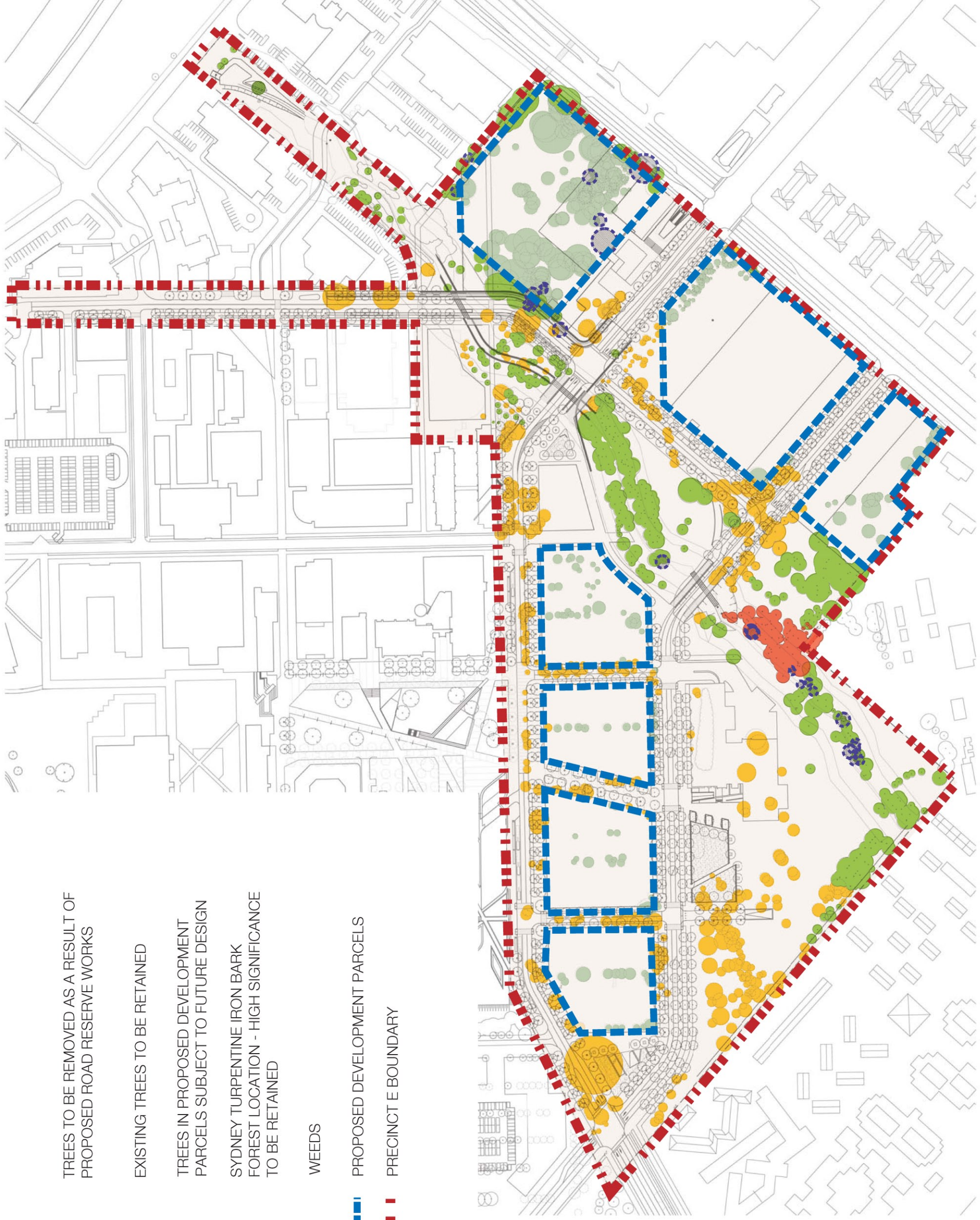
TREES IN PROPOSED DEVELOPMENT PARCELS SUBJECT TO FUTURE DESIGN

SYDNEY TURPENTINE IRON BARK FOREST LOCATION - HIGH SIGNIFICANCE TO BE RETAINED

WEEDS

PROPOSED DEVELOPMENT PARCELS

PRECINCT E BOUNDARY



APPENDIX D

'Geomorphological Assessment of University Creek, North Ryde' prepared
by Coffey Geotechnics (2009)

**GEOMORPHOLOGICAL ASSESSMENT OF
UNIVERSITY/COLLEGE CREEK
MACQUARIE UNIVERSITY, NORTH RYDE**

Macquarie University

GEOTLCOV23810AB-AB_Rev1
18 November 2009

18 November 2009

Macquarie University
North Ryde
2113

Attention: Cameron Downing

Dear Cameron

RE: Geomorphological Assessment of University Creek, North Ryde

Macquarie University (the University) has commissioned Coffey Geotechnics Pty Ltd (Coffey) to carry out a geomorphological assessment of University/College Creek. This report provides assessments of the following:

- Background on land-use, geology and topography of the University Creek area
- Historic creek change (updated in this revision of the report);
- Current geomorphological condition, sediment dynamics and flood response of the creek;
- Flood-related geomorphological issues;
- Creek improvement and flood management options and recommendations.

This report should be read in conjunction with Appendix A "Important Information about your Coffey Report". Should you have any questions regarding our assessment or recommendations, please contact Lucy Ellis on 9911 1000.

For and on behalf of Coffey Geotechnics Pty Ltd



Lucy Ellis

Senior Geomorphologist

Distribution: Original held by Coffey Geotechnics Pty Ltd
1 copy held by Coffey Geotechnics Pty Ltd
Electronic copy to Macquarie University

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Figure 6: Typical Channel Characteristics along Reach A

Figure 7: Wide culvert mid-way along Reach F and narrow pipe at downstream end of Reach F, demonstrating a significant reduction in flow capacity

Drawings

Drawing 1: Location Map and Master Plan of Proposed Development near to University Creek

Drawing 2: Simulation of 1984 Flood (source: City of Ryde)

Drawing 3: Simulation of 1990 Flood (source: City of Ryde)

Drawing 4: Historic Channel Change, 1943 – 2009 (Rev1)

Drawing 5: Overview of Geomorphological Condition and Sediment Dynamics of University Creek

Appendices

Appendix A: Important Information About Your Coffey Report

1 INTRODUCTION

1.1 Purpose of the Geomorphological Investigation

Macquarie University (the University) has commissioned Coffey Geotechnics Pty Ltd (Coffey) to carry out a geomorphological assessment of University/College Creek. This creek is known as University Creek upstream of the Research Park Drive road bridge and College Creek downstream of the bridge. For the purposes of this report, we have referred to the whole watercourse as “University Creek”.

The University is currently developing sites in the eastern area of the campus: “Station Site North” and “Station Site South” (see Drawing 1). University Creek runs south to north across the development site, roughly parallel to Herring Road. The development sites have been subject to historic uncontrolled flooding and large areas of the sites are within the 20 year flood zone.

In order to manage flooding within the development site, the University has commissioned creek studies, with the aim of:

- Maximising the development site areas adjacent to the creeks through controlled flooding at specific locations away from the proposed buildings/infrastructure;
- Reducing the likelihood of flooding upstream of existing constrictions (generally road bridges);
- Maintaining the principles of the Concept Plan, including road alignments (i.e. creek crossings);
- Retaining the Cochlear and Hearing Hub sites intact; and
- Improving the visual appearance and biodiversity of the creek areas.

The University have also asked that the creek design consider the following:

- Existing stormwater constraint at Talavera Road;
- Lack of potential flood detention areas downstream of Talavera Road; and
- Avoiding transferring problems elsewhere, e.g. upstream flooding or downstream erosion, especially avoiding negative impacts to the Lane Cove National Park, located downstream of the site.

Coffey is working in conjunction with Taylor Thompson Whitting (TTW), the consultant drainage engineers. The geomorphological assessment findings presented in this report are intended to inform a subsequent geotechnical investigation (Coffey), creek flood modelling and sustainable re-design of the creek geometry/flood response (TTW).

1.2 Scope of Work and Methodology

This report presents the findings of our geomorphological assessment, in accordance with our Project Scope (GEOTLCOV23810AB-AA, dated 13 October 2009). Our project aims, taking the overarching aims into consideration, are to assess:

- The natural creek alignment and geometry; and channel change over time;
- The current geomorphological condition of the creek and natural processes acting;
- The likely behaviour of the creek both in its current state and under different realignment options; and
- Potential opportunities and constraints associated with improving the geomorphological condition, visual appearance and flood capacity of the creeks.

This is a preliminary study, so at the time of writing, we do not know what flood control options are being considered. We also understand that the University's Master Plan for the development is subject to change.

Our geomorphological assessment methodology was as follows:

- A short desk-based study to collate information related to geomorphological issues, such as geology, topography, land-use, past studies, artificial modification and locations and causes of flooding; and
- A walkover assessment of the creek to assess the current geomorphological condition and processes.

We have used the terms "left" and "right" bank according to standard geomorphological convention, which assumes the observer is facing downstream.

2 DESK STUDY

2.1 Review of Available Information

2.1.1 Information Sources

We reviewed readily available information relevant to the project, including:

- Geotechnical and contaminated land investigations;
- Ecological assessments; and
- Flood studies.

These sources of information are listed in Section 6.

2.1.2 Site Background: Land-Use, Geology and Topography

Macquarie University campus, in the vicinity of University Creek, comprises open parkland intermixed with university buildings, infrastructure and car parks. The open parkland generally consists of lawn with pockets of woodland. There are two areas of remnant Turpentine Ironbark forest (EDAW, 2006). The buildings adjacent to the creek are of mixed use, including student accommodation, light industry (part of the Research Park) and, at the time of writing, a construction site (Cochlear).

The University campus is located to the south of the Lane Cove National Park, with the two major creeks (University Creek and Mars Creek, to the west) flowing into the Lane Cove River. The University grounds are generally gently undulating, above the steep sides of the Lane Cove valley.

The Sydney 1:100,000 Geology Sheet and existing geotechnical ground investigations indicate that the site area is situated at the boundary between Ashfield Shale of the Wianamatta Group and the underlying Hawkesbury Sandstone (Douglas Partners, 2008a; Coffey, 2009). These two major rock units are separated by laminites of the Mittagong Formation. As far as we are aware, shale has not been found on site. Laminite has been found underlying the highest elevation area of the site, within the Cochlear and Station Site North development areas.

The geological profile typically consists of topsoil or pavement overlying residual clay. Within the Cochlear site, up to nearly 4m of fill was encountered (Douglas Partners, 2008a). Although fill was not encountered at the Station Site North (Coffey, 2009), fill up to 3.5m was observed to the north (between Station Site North and Technology Road; Golder Associates, 1999). It is not known whether other areas of fill are present within the study area.

Bedrock is generally shallow throughout the site, with the depth of overlying clay generally decreasing with elevation – i.e. the thickest clays appear to be found in proximity to the creek channel.

2.1.3 Flood History

Flooding of the University campus has occurred on the following dates (City of Ryde, 2007)

- 8 November 1984, approximately 1 in 20 year flood (see Drawing 2)
- 5 December 1989
- 7 and 10 February 1990 (See Drawing 3)
- 12 February 2007

These maps indicate that the 1 in 20 year event was of sufficient magnitude to cause major flooding of the site. Constrictions along the creek caused ponding of floodwaters. This caused overbank flows across roads and footpaths, and close to (and possibly within) buildings. During both the 1984 and 1990 events, floodwater ponding occurred upstream of all major creek crossings (road and foot bridges).

2.2 Historical Change of University Creek

Coffey assessed the historical change in creek course and character, using the 1943 aerial image (available from the Department of Lands website) and information from previous reports. Drawing 4 illustrates these differences, and has been revised since our earlier report (GEOTLCOV23810AB-AB) to include information from the 1970 aerial photograph.

By 1943, the Macquarie Park area had already been extensively altered from its natural condition. Widespread clearance of indigenous vegetation had occurred to make way for orchards, market gardens and poultry farms (EDAW, 2006; Douglas Partners, 2008b). In its natural state, it is likely that the creek channel would have consisted of inter-connected shallow pools. Flooding would have spilled overbank relatively frequently, with overland flow through dense indigenous vegetation. However, in the 1943 image, the creek appears largely channelised: relocated, straightened and confined.

In the 1943 image, the Station Site North area appears to have been cleared of vegetation shortly before the photograph was taken. The area also appears to have been subject to recent overland unconfined flow (i.e. out-of-bank flooding), shown in Figure 4. Gully erosion has also occurred. It is possible that the floodwaters attempted to reoccupy a former creek course.

In the 1970 image, construction of Macquarie University was well underway. Several buildings, roads and car parks had been constructed, particularly in the central campus areas. The aerial image appears to show excavation of the creek along Reaches A and D (See Section 3.2 and Drawing 5 for reach definition). This could have been associated with sewer laying (Reach A) or creek realignment (Reach D).

The following historic changes have occurred:

- Dense, mature vegetation has become established. When the University was established in 1967, around 25,000 trees were replanted (EDAW, 2006). Only isolated areas of remnant Sydney Turpentine Ironbark forest remain (see Figure 4). These appear to have become smaller since EDAW's assessment in 2006;
- The course of Reaches D, E and F have been diverted since 1970, presumably to allow construction of Research Park Drive and the Research Park. Reach D has become more sinuous since this realignment.

3 FIELD STUDY

3.1 Site Visits

Coffey Senior Geomorphologist, Lucy Ellis, visited the site on 14 October 2009 and 22 October 2009. Stephen Brain, TTW Technical Director, was present on the earlier visit.

3.2 Contemporary Geomorphological Condition of University Creek

During the site visit, six geomorphological reaches were identified, each with different characteristics. These are summarised below and in Drawing 5.

3.2.1 Reach A



Figure 1 Typical channel characteristics along Reach A

On first appearances, Reach A shows signs of degradation, with exposed tree roots, tree trunks curved at the base and high banks (see Figure 1). However, there is little evidence of recent erosion, other than just below the entrance pipe, around other stormwater/sewage pipes, and just upstream of a tree root width constriction. The banks, although high, are composed largely of stiff to very stiff residual clay that has been eroded near-vertically to over 1.5m in height.

Some material (both artificial and natural) has accumulated on the bed of the channel. Vegetation, including immature trees, has become established. It is, therefore, likely that degradation occurred in response to a past trigger, such as channelisation, and the creek has now adjusted to the contemporary regime.

3.2.2 Reach B



Figure 2 Typical channel characteristics along Reach B

Reach B is the most visually appealing of all those assessed, with low banks, a grassy riparian corridor and in-channel vegetation. There is evidence of minor bed degradation and bank erosion, particularly around pipe inlets.

At the downstream end of Reach B, a large rock armour-faced dam has been constructed, presumably to produce controlled flooding over the park land (i.e. a flood detention dam). As the left bank is higher and steeper than the right, due to the local topography, flows will preferentially flood over the right bank.

3.2.3 Reach C



Figure 3 Typical channel characteristics along Reach C

At the upstream end of Reach C, sediment (including rock from the dam) has been deposited just downstream of the piped section, at a wider section of the channel. Reach C shows signs of minor bed degradation, although this has been limited by several small bedrock bed elevation controls. Sandstone cobbles have been eroded from the banks and deposited in the downstream section. All pipes entering the reach were perched approximately 0.3m above the current water level.

At the downstream end of the reach, the concrete apron of the Waterloo Road inlet pipe is perched above the low flow water level. A concrete footbridge has been constructed across the channel, with flows passing beneath through a small pipe. Again, the left bank is higher and steeper than the right, so flows will preferentially flood over the right bank.