VEGETATION MANAGEMENT PLAN FOR THE YORK ROAD BUSHLAND

OCTOBER 2002

PREPARED FOR COLIN GING & PARTNERS & MORIAH WAR MEMORIAL COLLEGE

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1 INTRODUCTION

1.1 Background Information

The York Road Bushland is a small area of remnant native vegetation located in the suburb of Queens Park in Waverley Local Government Area. The site is approximately 3 hectares in size, and comprises land currently owned by the NSW TAFE Commission, the Department of Community Services (DOCS), and the Centennial Park and Moore Park Trust (**hereafter 'CPMPT'**). Surrounding land uses include residential areas to the north and south, playing fields and residential areas to the east, and Queens Park to the west (see Figure 1).

Moriah War Memorial College (**hereafter 'Moriah College'**) currently occupies part of a triangular parcel of land bounded by Queens Park Road, Baronga Avenue and York Road. The College has identified the need to expand their existing facilities and this is outlined by way of a Master Plan prepared by Rice Daubney Architects (March 29, 2000). In order to facilitate the required expansion, the College intends to acquire the 2 adjacent sites through a long- term lease agreement. The adjoining sites are the former TAFE site Lot 22 (0.4857 hectares), and the DOCS site Lot 1 (1.44 hectares).

The remaining land within the York Road Bushland is Lot 23 (1.07 hectares), which was formerly part of part of a larger land lot owned by TAFE (see UBMC 1996). Lot 23, the subject of this Vegetation Management Plan (**hereafter the 'subject site'**), was transferred to CPMPT on 20 August 1998.

Remnant native bushland [1] occurs on approximately 1.069 hectares (35.6%) of land in the greater York Road site (UBMC 2000a). The plant community has been identified (UBMC 1996a) as a modified form of Eastern Suburbs Banksia Scrub (**hereafter 'ESBS'**), which is listed as an 'endangered ecological community' by the NSW *Threatened Species Conservation Act 1995* (**hereafter '*TSC Act*'**), and as 'threatened' by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (**hereafter the '*EPBC Act*'**) (see Appendix 1).

The proposed expansion of Moriah College, as indicated in the Stage 1 Master Plan, will necessarily impact on remnant bushland in Lot 22 (former TAFE site). In consideration of this impact, a statutory review of the impact of the proposed vegetation clearing, including a minor portion of the ESBS bushland, was undertaken in support of a Development Application (DA) by the College to Waverley Council (**hereafter 'Council'**) (DA submitted 5 March 2000). Accordingly, the Eight-part Test of Significance, as determined under Section 5A of the NSW *Environment Planning and Assessment Act 1979,* was prepared for the development proposal (UBMC 2000b).

The Eight-part Test of Significance concluded that the impact of the proposed development on the remnant bushland within the Lot would be 'insignificant', and that a Species Impact Statement was not required. Nevertheless, the consent authority Waverley Council has required the applicant Moriah College, to prepare a Species Impact Statement for the proposed development on the former TAFE site.

The findings of the Species Impact Statement (UBMC 2000c) were in agreement with the earlier assessments: i.e. that the impact of the proposed development on remnant bushland on Lot 22 would be 'insignificant' in terms of current State and Commonwealth legislation.

Notwithstanding the outcome of the Eight-part Test and the Species Impact Statement prepared for Lot 22, Moriah College noted that a minor impact on the ESBS bushland would arise from the proposed development, and that an opportunity existed for bushland rehabilitation on the adjoining Lot 23 as an offset to the Lot 22 outcome.

[1] The term 'bushland' – as used in the VMP – is a modified version of the definition set out in SEPP-19 (see Section 1.3.2. of the VMP)

In consultation with major stakeholders, CPMPT, Council, NSW National Parks and Wildlife Service (**hereafter 'NPWS'**), and members of the local community, Moriah College has reached an agreement whereby the College will provide a commitment to assist the rehabilitation of the degraded ESBS bushland on the CPMPT site Lot 23. The Development Application for the Stage 1 Moriah College Master Plan was lodged with Waverley Council on this basis.

1.2 The Vegetation Management Plan

The primary aim of the Vegetation Management Plan for the York Road Bushland (**hereafter the 'VMP'**) is to provide guidelines and recommend appropriate strategies for the protection, rehabilitation, and on-going management of remnant ESBS on Centennial Parklands' Lot 23.

The VMP will:

- Provide the strategic planning framework for future management,
- Assess site opportunities and constraints;
- Identify impacts and site management issues; and
- Recommend appropriate strategies and actions to guide the bushland rehabilitation process in the ESBS remnant on CPMPT land Lot 23;
- Provide a generic template for the management of other small bushland remnants within the Parklands (see UBMC 1996b).

The VMP for the York Road Bushland is intended to serve as a 'stand alone' document. For this reason, a site history, a review of previous studies and investigations, and background information relating to the history of the proposed development on the former TAFE site Lot 22 have been included in this report.

The terms and definitions used in the VMP are taken from sources such as:

- Australian Natural Heritage Charter (IUCN 1996, updated 2002)
- Centre for Plant Biodiversity Research (2002) – Short Glossary of Botanical Terms
- NSW Agriculture, NSW (2000). Glossary – Soil Management Terminology
- Environmental Protection Authority NSW (2001) – Glossary of Terms
- Flora of New South Wales – Vols. 1-4 (1991-1993) Royal Botanic Gardens, Sydney.

Please see the Appendices for the **Glossary** of definitions and terms used in the VMP.

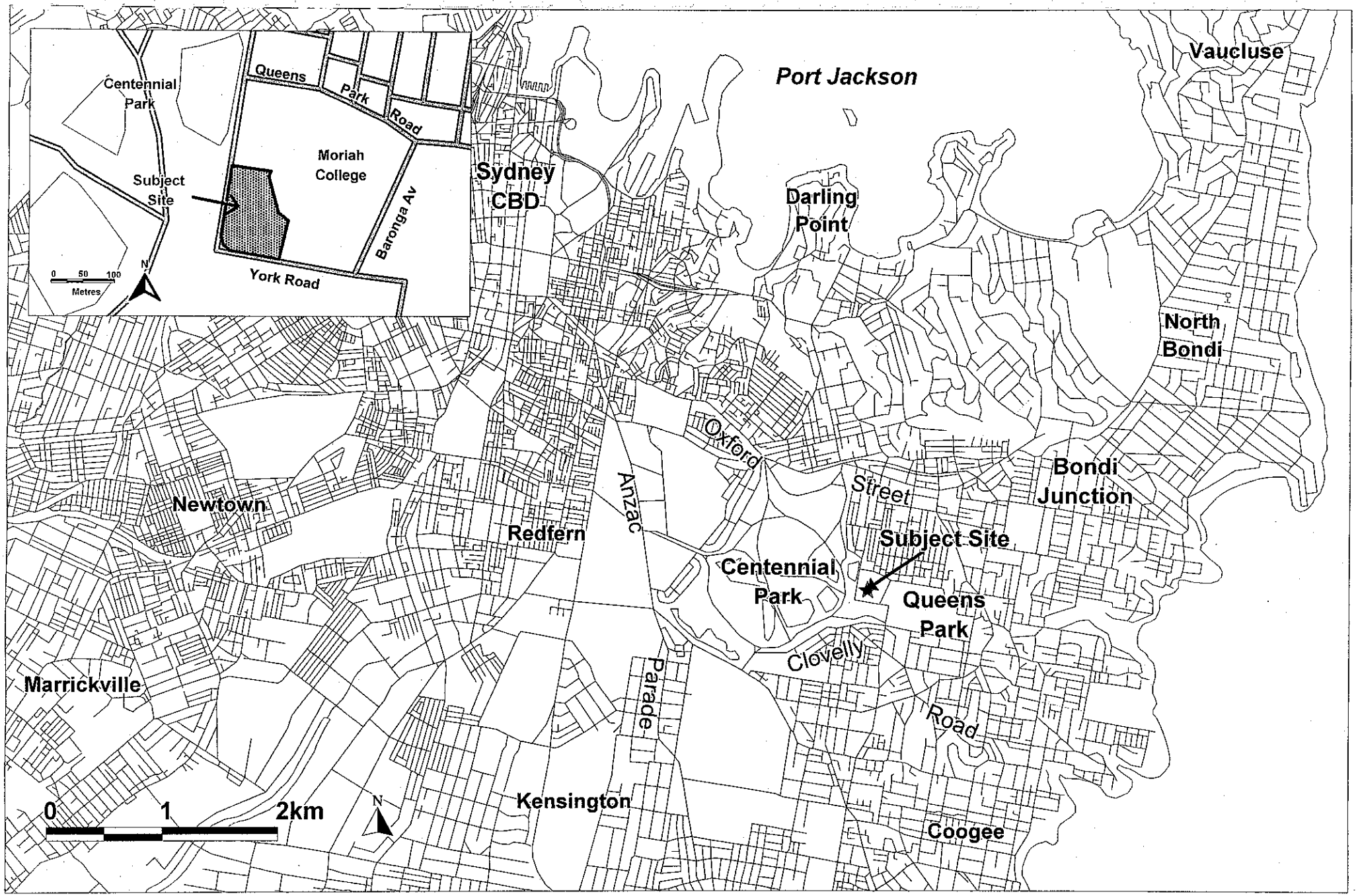

Figure 1
Location of Subject Site

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1.3 Rationale for Vegetation Management Plan

1.3.1 *Moriah College Development Master Plan*

Moriah College Stage 1 Development Proposal

The Master Plan has been developed in 2 stages. Stage 1 of the Master Plan proposes the development of Lot 22 (former TAFE site), and will cater for the needs of the College to the year 2004. Development Application 282/00 for the Stage 1 development was lodged with Waverley Council on 5 May 2000, with a final DA Consent issued on 29 November 2001.

Stage 1 implementation will involve the demolition of some existing buildings, construction of new buildings, car parking and roadways, and the refurbishment of existing buildings on an expanded site incorporating the existing campus (Lot 3 DP 701512) and the former TAFE site (Lot 22 DP 879582).

Stage 2 of the Master Plan will cater for College needs to the year 2007, and will be contained to sites in Lot 3 (existing College), Lot 22 (former TAFE site), and the DOCS site (Lot 1 DP 701512). A Development Application is not envisaged at this stage.

In order to provide an overview of the proposed development in relation to bushland management on Lot 23, the Stage 1 Master Plan has been included in this report as Figure 2.

1.3.2 *Moriah College Lease of TAFE Land (Lot 22)*

Moriah College proposes to expand the existing College campus onto adjacent land known as the TAFE site Lot 22. Occupation of this land has been agreed with the Minister of Education under the terms of an Agreement for Lease (March 1999). The lease agreement will be signed upon approval by Environmental Australia.

1.3.3 *Centennial Park & Moore Park Trust Land (Lot 23)*

As part of the conditions of the proposed TAFE site lease, the Minister of Education has required that an exchange of 'Letters of Understanding' be completed between CPMPT and Moriah College. These Letters were required to address issues relating to the suitable development of Lot 22 by Moriah College in respect of the Lot 23 Bushland reserve. These issues include:

- Elimination of water run-off from Lot 22 onto Lot 23;
- Provision of appropriate boundary security between the sites;
- Consultation with CPMPT with respect of any Development Application lodged by Moriah College for Lot 22; and
- Representation by Moriah College on the body responsible for the management of the bushland on Lot 23.

The commitment between the parties, addressing the above-listed issues, was implemented by way of a Moriah College 'Letter of Understanding' dated 15 March 2000.

1.3.4 *Land Owner Consent*

On the 20 August 1998, the NSW Department of Education (TAFE) transferred the ownership of Lot 23 (DP-879582) to CPMPT. It was intended that Lot 23 form a component of the Centennial Parklands[2], and that it be managed by the Trust as a flora reserve.

[2] Centennial Parklands is the area comprising Centennial, Moore & Queens Parks, as managed by the CPMPT.

The York Road Bushland is currently managed as part of Centennial Parklands, but as funds are not immediately available for bush regeneration or other rehabilitation activities, no active programs have been set in place.

As an offset to the development of the former TAFE site Lot 22, Moriah College has offered to fund a program of works designed to rehabilitate and restore the remnant bushland on CPMPT land Lot 23 over a period of 5-years.

1.3.5 Memorandum of Understanding

In order to implement the actions set out in the Letter of Understanding (15 March 2000), Moriah College proposed that their commitment to the rehabilitation of bushland on Lot 23 be documented by way of a Memorandum of Understanding.

The Memorandum of Understanding provides a framework for achieving a number of key project objectives. These are set out below.

- Management responsibility of the implementation of the Memorandum of Understanding.
- Protection and security for the site and the associated flora and fauna communities.
- Rehabilitation of the existing ESBS bushland.
- Rehabilitation of the bushland and non-bushland portions of the site to form a quality example of ESBS bushland.
- Opportunity for community participation.
- Opportunity for community interpretation of the result of the rehabilitation process.

At the time of writing, the Memorandum remains in draft form. It will not be signed by the parties until the Federal Minister for the Environment concurs with the development proposal on Lot 22. This agreement is pending.

1.3.6 Legislative Approvals

Waverley Council considered the proposed Memorandum of Understanding between Moriah College and CPMPT as part of the Development Application submitted for the Stage 1 Master Plan development. Council subsequently issued DA Consent No LD 282/00 (deferred commencement 6 June 2001) on this basis.

As part of the DA consideration, a comprehensive round of consultation was held with the Threatened Species Unit of the NPWS. This consultation considered the technical aspects of bushland rehabilitation and management arrangements, and concluded with concurrence by the NPWS to the project (12 November 2001).

1.3.7 Bushland Management Group

The Letters of Understanding (see Section 1.2.3) require that CPMPT to be consulted on any proposed development on Lot 22, and for Moriah College to be represented on any future body established to oversee the management of the bushland remnant on Lot 23.

Centennial Parklands has convened a Bushland Management Group (**hereafter the 'BMG'**) to advise CPMPT on stakeholder issues and technical matters relating to the rehabilitation and management of remnant bushland in Centennial Parklands. The BMG will assist in the preparation of the York Road VMP, and once this Plan is adopted, it is anticipated that the BMG will oversee its implementation.

The BMG will also assist the Trust to develop site-specific management plans for other remnant sites within Centennial Parklands (see UBMC 1996b).

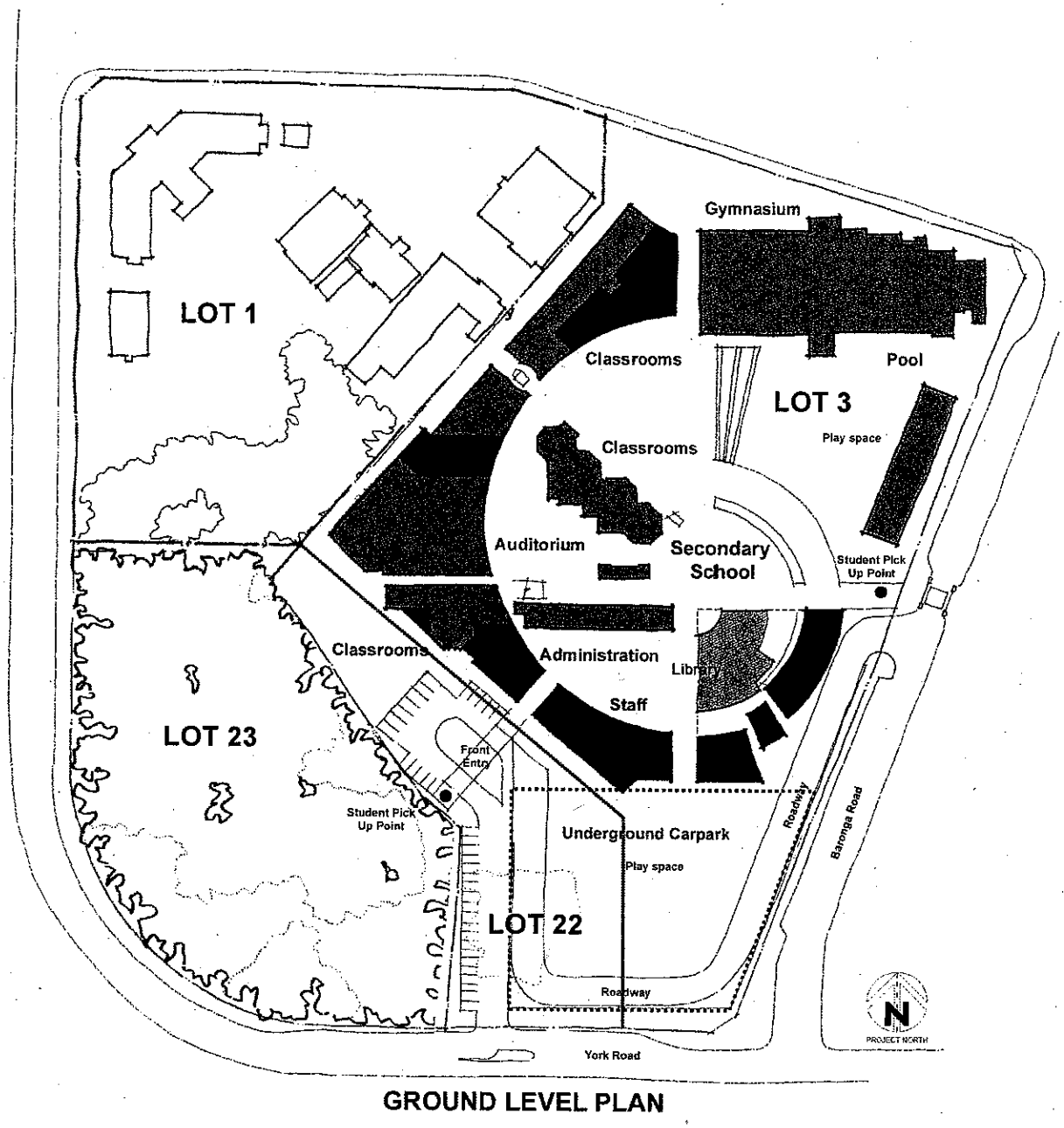

Figure 2. Master Plan of Proposed Development

1.4 Planning and Legislative Framework

A number of local planning policies, State and Commonwealth Acts and policies are relevant to the management of remnant bushland in Waverley Local Government Area.

A summary of the planning and legislative framework has been provided in Appendix 2. The most relevant items are listed in Table 1.

Table 1. Summary of Policies, Local Planning & Legislative Requirements

	Relevant Policy / Legislation
Waverley Council Local Planning Instruments	*Waverley Local Environment Plan 1996*
	Waverley Park Management Plan
	Tree Preservation Order 1993
NSW State Legislation	*Environmental Planning & Assessment Act 1979*
	Environmental Planning & Assessment Regulation 2000
	Local Government Act 1993
	Threatened Species Conservation Act 1995
	National Parks & Wildlife Act 1974
	Noxious Weeds Act 1993
	Soil Conservation Act 1974
	Rural Fires Act 1997
	Heritage Act 1977
	Protection of the Environment Operations Act 1997
Commonwealth Legislation	*Environment Protection and Biodiversity Conservation Act 1999*

2 REPORT PURPOSE AND OBJECTIVES

2.1 Vision

A vision statement envisages 'an improved state' for a system that can be achieved at some time in the future. However, as most bushland remnants exist in a highly modified landscape, attempts to restore the system to pre-disturbance conditions must recognise this, and work within contemporary constraints. Such constraints will include issues such as fragmentation, genetic isolation, suspension of pre-development fire regimes, altered soil profiles and nutrient budgets, limited resources for on-ground works and political expediency.

The rehabilitation strategies proposed for such highly impacted bushland remnants must strive to maximise existing and potential ecological benefits. With these constraints in mind, the vision for the York Road Bushland is stated as follows:

> *Within 5 years, the remnant Eastern Suburbs Banksia Scrub on Lot 23 (York Road Bushland) will protected, maintained and floristically improved, sufficient to provide a suitable habitat for the future viability of the indigenous flora and fauna, along with opportunities for education and interpretation of the natural significance of the site.*

2.2 Key Goals and Objectives

2.2.1 Environmental

Key environmental goals and objectives identified by the VMP are set out below.

- To conserve (meaning to protect, maintain and monitor) the ESBS bushland remnant at York Road in recognition of the *TSC Act 1995*, and *EPBC Act 1999*, and in accordance with the principles of the NPWS draft ESBS Recovery Plan.
- To provide a sustainable ESBS habitat[3] for native flora and fauna species.
- To identify threats and impacts to the sustainability of the bushland remnant.
- To recommend appropriate strategies and actions to ameliorate threats and impacts and promote sustainable management of the bushland remnant.
- To provide a management framework and a staged works plan to achieve the environmental goals over a 5-year period, for joint implementation by CPMPT and Moriah College under the terms of the Memorandum of Understanding.
- To enhance existing species diversity[4] and restore the structural integrity of the ESBS bushland, in accordance with the descriptions provided in the NSW Scientific Committee's Final Determination (23 August 2002).
- To provide a set of initial environmental guidelines to provide sustainable management of the ESBS in the long-term.

2.2.2 Legislative Compliance

The York Road Bushland has been identified as an areas of remnant ESBS in accordance with the description given in the Schedules of the *TSC Act 1995* and described by the Commonwealth *EPBC Act 1999*.

[3] Where 'habitat' means the structural environment where an organism lives for all or part of its life (ANHC 2002).

[4] Where 'species diversity' is defined as the variety of species in a place (ANHC 2002)

The environmental legislation states that all listed species; populations and ecological communities must be conserved and protected from significant impacts. Significant impacts have been identified by the *TSC Act 1995* as those which may:

- Disrupt the life cycle of the species or population;
- Remove or modify a significant area of habitat;
- Cause the isolation of areas of habitat; or
- Affect critical habitat.

As the owner of Lot 23, CPMPT must ensure that existing and future land uses and management practices do not result in, or indirectly cause any of the impacts listed above.

The VMP for the York Road Bushland has been prepared accordance with the guidelines and requirements of current State and Commonwealth government legislation, and in anticipation of the NPWS draft ESBS Recovery Plan (in preparation).

The VMP has necessarily been prepared prior to the release of the ESBS draft Recovery Plan, and consequently it cannot incorporate detailed strategies and actions that may be contained therein. However, the VMP has been prepared in anticipation of the draft Plan, using a similar format, and identifying a range of generic strategies similar to those set out in other Recovery Plans published by the NPWS [5].

2.2.3 Community Issues

The VMP has identified a number of goals and objectives directly related to community issues – principally as they apply to the potential use of Lot 23 for passive recreation, scientific study and public education.

In accordance with the Charter adopted by Centennial Parklands, the VMP will provide strategies:

- To manage the bushland in order to provide a range of recreational and educational opportunities for the community.
- To identify ways to enhance community appreciation of, and participation in bushland management activities.
- To promote community awareness of bushland management issues; and
- To encourage the community to participate in a range of environmentally friendly activities such as Bushcare, WIRES and Friends of Centennial Parklands.

There are a number of areas where it is proposed to involved members of the community in the rehabilitation planning, on-ground works and future management of the York Road Bushland. These are:

- Participation in the planning and decision making process;
- Establishing the bushland as a public resource for educational and recreational uses, in keeping with the charter adopted by Centennial Parklands;
- Interpretation, using appropriate signage and printed material to provide information and to encourage educational uses by local school children and other visitors;
- Formation of a voluntary community Bushcare group to participate in the bush regeneration activities;

[5] Template provided by draft Recovery Plan for Cooks River Clay Plain Scrub Forest NPWS 2000

- Inclusion in the Activities and Programs organised and run through Centennial Parklands, to encourage environmental awareness and education of the broad community.

2.2.4 Centennial Park & Moore Park Trust Asset Creation

The York Road Bushland (Lot 23 DP-879582) was transferred to CPMPT (Centennial Parklands) from the NSW Department of Education (TAFE) in 1998.

The land Lot had not been actively managed by the Department for many years, and since its transfer the site has not been maintained at the same standard as the remainder of Centennial Parklands. However, since ownership was transferred to the Trust it has actively sought the development of a vegetation management plan, and has undertaken on-going liaison with the NPWS and Waverley Council to ensure that a Site Recovery Plan is developed for the ESBS remnant on Lot 23.

Implementation of the VMP (this report) aims to put in place a process of active bushland rehabilitation, extending initially over a 5-year period, and to ameliorate existing threats to the remnant bushland. However, in order to achieve all of the goals and objectives set out in the VMP (see Section 5.3), it is envisaged that a substantially longer period, at least 10-years in duration, will be required.

Although the bushland remnant at York Road will always require the allocation of resources for active management and maintenance, it is anticipated that the strategies and actions proposed in this VMP will restore[6] a form of ESBS appropriate to a remnant of this size; will enhance species diversity; restore structural integrity; and improve local landscape linkages, values and visual amenity.

After bushland rehabilitation work is completed, Centennial Parklands will gain a valuable asset with the potential for limited and guided public visitation and/or educational uses.

[6] Where 'restoration' means returning existing habitats to a known past state, or to an approximation of the natural condition by repairing degradation, by removing introduced species, or by reinstatement (in the VMP, reinstatement = restoration) (ANHC 2002)

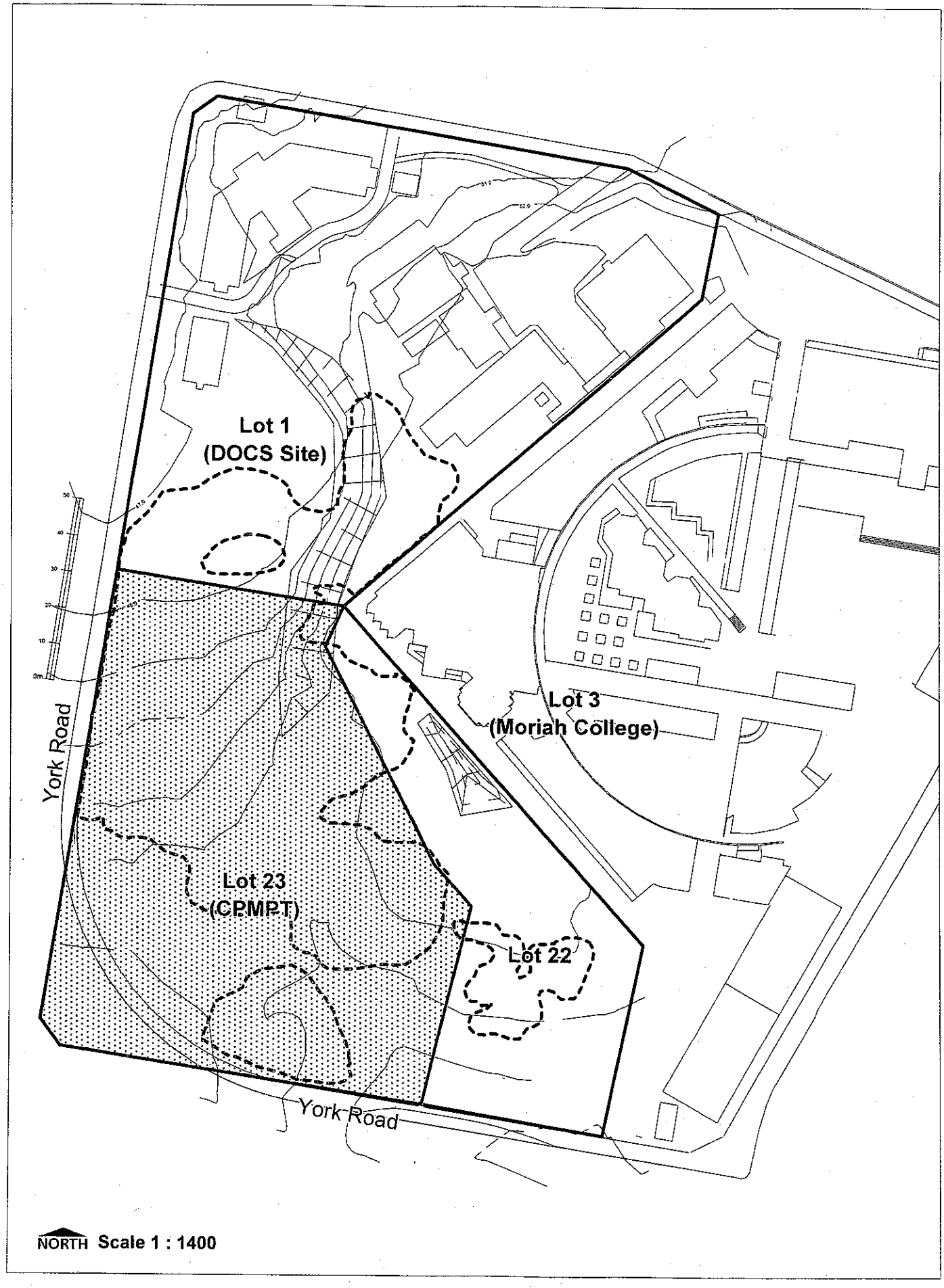

Figure 3
Details of Study Area

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3 THE STUDY AREA

3.1 Site Definition

3.1.1 Site Identification

The subject site, Lot 23 (DP 879582) York Road Bushland is 1.07 hectares in size. The southern and western boundaries are defined by York Road. Lot 1 (DOCS site) forms the northern boundary, while Lot 22 (former TAFE site, now leased to Moriah College) defines the eastern boundary (see Figure 3).

3.1.2 Local and Regional Positioning

Lot 23 is bounded to the east by Moriah College, to the north by the Eastern Suburbs Hospital Complex, and to the south and west by Centennial Parklands. Residential development and commercial areas dominate the local landscape in the surrounding suburbs of Kensington, Randwick, Woollahra, Bondi Junction, Paddington, and Moore Park.

Within the surrounding urban areas, native vegetation is limited, potentially occurring only in residential gardens, on road verges and in local parks and reserves. Within nearby Centennial Parklands, which cover an area of 220 hectares, a diverse range of habitats is present, including water bodies, woodlands and tree-lined roads. While the Parklands retain some small areas of remnant native vegetation, these are highly modified sites (eg Bird Sanctuary) or comprise sites with only small numbers of a very few species (UBMC 1996b).

In Sydney's Eastern Suburbs (Waverley, Randwick, Botany) local parks may contain remnant (or planted) trees and shrubs characteristic of the vegetation communities that existed prior to European settlement, but these areas cannot be described as 'bushland' (see Section 1.3.2). The main conservation reserve in the Region is Botany Bay National Park, which is approximately 10 kilometres from the York Road Bushland.

3.1.3 Site History

The York Road Bushland originally formed part of the Macquarie (Sydney) Common, which was dedicated in 1811 to provide grazing for local settlers. The land was incorporated into Centennial Park in 1887, but in 1929 York Road was extended through the eastern portions of the Park to provide a connecting link to Victoria Road. The construction of York Road effectively isolated the bushland, and severed its connectivity to the Park.

Ownership of the 5.7-hectare parcel of land on the eastern side of York Road (which contains the present-day bushland) was transferred to the Department of Health in 1930, and the Eastern Suburbs Hospital was built on part of the site in 1935 (now Lot 1). At this time, the larger York Road site was substantially modified, with changes including clearing of most native vegetation, top dressing with fly ash and bitumen to stabilise the loose sands, earthworks and importation of fill to create building platforms, and the construction of access tracks and a parking lot (UBMC 1996, 2000a).

The remaining land was subdivided into 3 land lots, of which Lots 2 and 3 were transferred to the TAFE Commission in the 1980s. DOCS retained ownership of Lot 1. Subsequent to this (1984), Moriah College obtained a 99-year lease on the eastern half of the former Eastern Suburbs Hospital site (now Lot 3) from the NSW Department of Public Works for the development of the existing College campus.

In 1996, the remaining vacant land (amalgamated into Lot 2) was declared surplus to TAFE needs and Urban Bushland Management Consultants (UBMC) was commissioned by NSW State Property on behalf of the TAFE Commission to prepare a habitat assessment of bushland on the amalgamated Lot 2 site with a view to its correct disposal for other uses.

This document - *Habitat Assessment Lot 2 York Road, Bondi Junction* (September 1996) - identified the bushland as a (modified) regrowth form of Eastern Suburbs Banksia Scrub, a plant community determined as an 'endangered ecological community' in the Schedules of the *TSC Act 1995*. As less than 1% of this plant community type remains in the Sydney Region, and as a number of native fauna of local conservation concern are known, or thought to utilise this type of vegetation community, the York Road Bushland was considered by the NSW Scientific Committee to be of 'high' local and regional conservation significance.

As the result of the UBMC Report (1996a), and in view of intensive community interest in the future use of the site and representations made by Waverley Council, conservation groups and State government agencies, NSW State Property determined that Lot 2 should be subdivided in order to allow the preservation of the identified ESBS bushland, and to allow development of the balance of the land.

To this end, Lot 23 DP 879582 (1.07 ha) and Lot 22 DP 879582 (0.485 ha) were created, with the boundary line between the 2 land lots being determined by the presence of native vegetation on the site, and by geophysical factors.

As the more degraded site, Lot 22 was considered NSW State Property to be suitable for development. Subsequently Moriah College commenced negotiations to secure a long-term lease on the site to facilitate expansion of the College campus.

Lot 23 was then transferred to the ownership of CPMPT (20 August 1998) by the Minister of Education and Training, with the intention that the bushland form a component of the Centennial Parklands, and that it be managed by the Trust as a flora reserve.

Figure 4 shows the location of the land Lots in relation to the remnant bushland boundaries at the York Road site. Land Lot details are provided in Table 2.

3.1.4 Previous Investigations

In preparing the York Road VMP, reference has been made to a number of previous studies, reports, and publications conducted both in the general locality, and specifically for the subject site. These include:

- Perumal Murphy P/L (1993) *Waverley Council Heritage Study.*
- Waverley Council (1994/95) *State of the Environment Report.*
- SauveTerre Consultants (1995) *Remnant Vegetation Map*, unpublished report prepared for Waverley Council.
- Urban Bushland Management Consultants (1996a) *Habitat Assessment - Lot 2, York* Road, Bondi Junction. Unpublished Report prepared for State Property, September 1996.
- Urban Bushland Management Consultants (1996b) *Weed Management Strategy for Centennial Park, Moore Park and Queens Park.* Unpublished report for CPMPT, November 1996.
- Ecological Surveys and Planning (1997) *Species impact Statement for the Proposed Developmentally Disabled services Facility, York Road - Queens Park.* Unpublished Report for Waverley Council, November 1997.
- Urban Bushland Management Consultants (1999a) *Moriah War Memorial College - Summary Bushland Report.* Unpublished Report prepared for Colin Ging & Partners, December 1999.
- Urban Bushland Management Consultants (1999b) *Review of Bushland on Lot 1, York Road, Bondi Junction, Summary of Findings - Field Investigations.* Unpublished Report prepared for Colin Ging & Partners, 18th November 1999.

- Urban Bushland Management Consultants (2000a) *York Road Bushland, Queens Park – Survey of Remnant Vegetation & Fauna Habitat on Lots 1 (DP 701512), 22 and 23 (DP 879582).* Report prepared for Moriah War Memorial College, February 2000.
- Urban Bushland Management Consultants (2000b) *York Road Bushland, Queens Park – Impact Assessment of Moriah War Memorial College Master Plan for Building Development on Remnant Vegetation & Fauna Habitat in Lot 1 (DP 701512) & Lots 22 & 23 (DP 879582).* Report prepared for Moriah War Memorial College, April 2000.
- Urban Bushland Management Consultants (2000c) Species Impact Statement York Road Bushland Lot 22 (DP 879582).

While findings and other information from these documents have been incorporated, the main resource documents for the preparation of the VMP have been:

1) *York Road Bushland, Queens Park – Survey of Remnant Vegetation & Fauna Habitat on Lots 1 (DP 701512), 22 and 23 (DP 879582)* (UBMC 2000a);

2) *York Road Bushland, Queens Park – Impact Assessment of Moriah War Memorial College Master Plan for Building Development on Remnant Vegetation & Fauna Habitat in Lot 1 (DP 701512) & Lots 22 & 23 (DP 879582)* (UBMC 2000b); and

3) *Species Impact Statement York Road Bushland Lot 22 (DP 879582)* (UBMC 2000c).

Table 2: Land Lots Within the Larger York Road Bushland Site

Land Lot	Size (ha)	Zoning	Tenure	Current Land Use	Proposed Land Use
1	1.44	5(a) Special Uses (Hospital)	DOCS	Hospital	Educational
22	0.4857	5(a) Special Uses Educational	NSW Dept. Education Leased Moriah College	Vacant Land	Educational
23	1.07	5(a) Special Uses	CPMPT	Bushland / Open Space	Flora Reserve (SEPP-19)

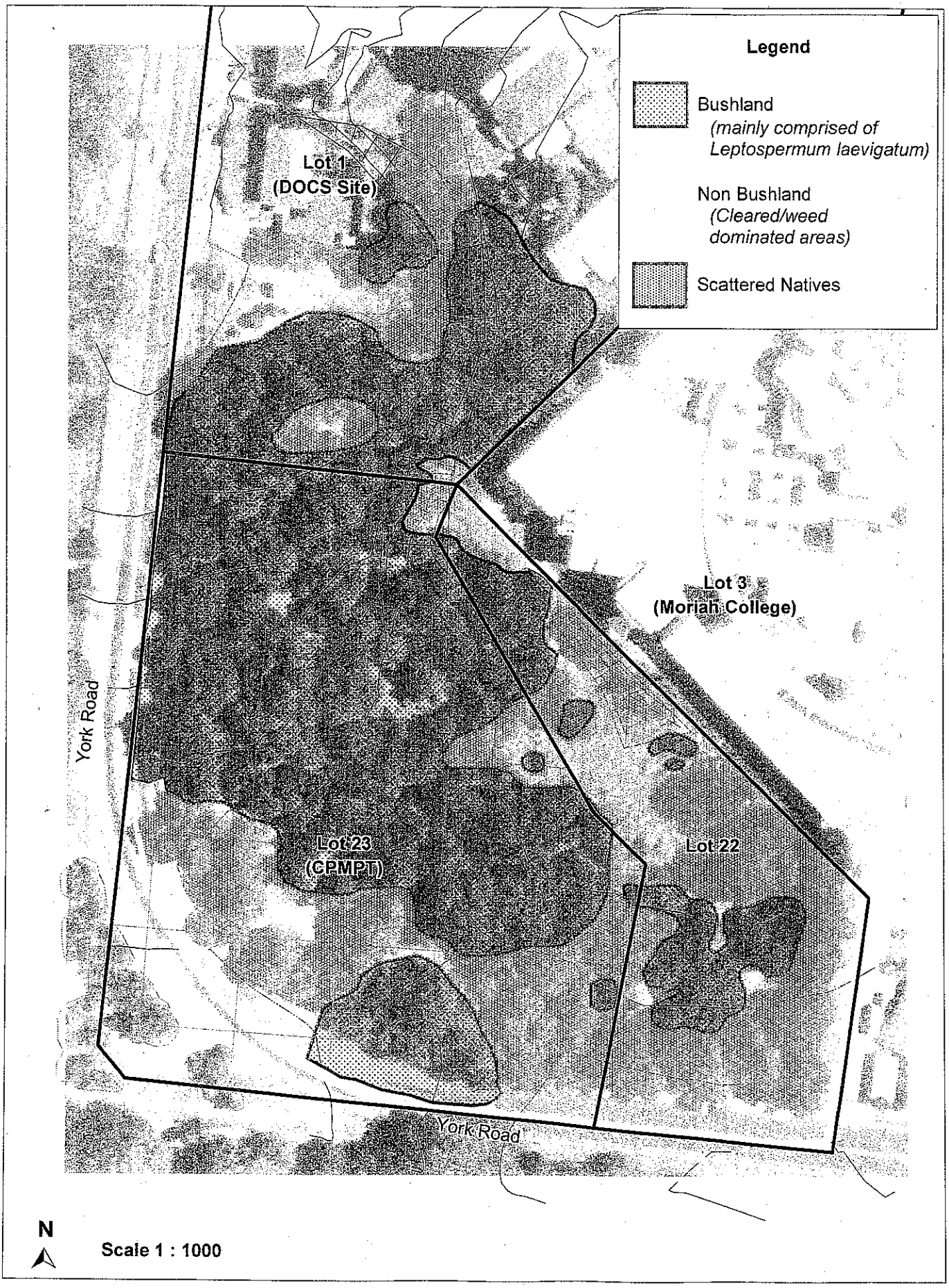

Figure 4
Bushland Boundaries, York Road Bushland

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3.2 The Physical Environment

3.2.1 Topography, Geology and Soils

The natural topography of the subject site is described as a rear-dune or coastal dune formation. Existing elevations within the larger York Road Bushland vary between 40 and 50 metres AHD, though the long-term use of the site has altered the natural topography considerably. Earlier land uses (eg horse riding, construction, waste disposal and vehicular access) have also significantly modified the condition and structure of the natural vegetation.

The geology of the area is mapped as Quaternary deposits, comprising medium to fine-grained 'marine' sands and podzols (Herbert 1983). Soils have been mapped as the Aeolian deposits of the Tuggerah Soil Landscape Unit (Chapman and Murphy 1989). The Tuggerah Unit is characterised by gently undulating to rolling coastal dunefields, with local relief to 20 metres, and slope gradients being generally 1-10%, but occasionally up to 35%.

Soils are deep podzols on dunes and podzol/humus, podzol intergrades in swales. The soils have been formed from fine to medium grained, well-sorted marine quartz sands, which have been wind blown. These soils are highly permeable, highly susceptible to wind erosion where vegetation cover is removed, and of very low fertility (Chapman and Murphy 1989).

As a result of earlier placement of fly ash over the parent sands, and the subsequent dumping of building refuse (particularly clay fill and rubble on neighbouring Lot 22), the original soil profile on that section of the subject site closest to the northern boundary (embankment) with Lot 22 has been partly overlain by imported soils and other debris (UBMC 1996a).

Table 3 summarises the geodiversity or physical characteristics of the subject site.

3.2.2 Hydrology

There is no flowing water anywhere on the site. However, a series of ornamental ponds is located in Centennial Parklands across York Road to the west and south of the site. As the sandy soils are known to be highly permeable (Chapman *et. al* 1989), and as site drainage is directed downslope into the Parklands, there is potential for activities on the York Road site to have some influence on water quality in the ponds.

3.2.3 Climate

The closest Bureau of Meteorology recording station is located at Centennial Park (066009). The annual mean daily maximum temperature is 21.9° C, with highest temperatures occurring in January and February. The annual mean daily minimum temperature is 12.2° C, with lowest readings occurring in July and August (Bureau of Meteorology 2001).

The site receives an annual rainfall of 1220 millimetres, with highest mean monthly rainfall recorded in April at 147.1 mm, and the lowest mean monthly rainfall in August and September at 72.25 mm (Bureau of Meteorology 2001). Peak rainfall periods (for coastal regions eg Randwick, autumn/winter) will determine optimal conditions for future planting programs.

Table 3: Physical Characteristics – Larger York Road Bushland Site

Characteristic	Represented in Study Area
Topography	Rear-dune or coastal dune formation. Existing elevations within the vary from 40-50 metres AHD (note altered landform due to past land uses)
Geology	Quaternary deposits, comprising medium to fine-grained 'marine' sands and podsols (Herbert 1983).
Soils	Aeolian deposits, with deep podzols on dunes and podzol/humus, podzol intergrades in swales. Earlier placement of fly ash over the parent sands, and the subsequent dumping of building refuse (clay fill and rubble on Lot 22 & northern boundary Lot 23)
Soil Landscape	Tuggerah Soil Landscape Unit (Chapman and Murphy 1989).
Hydrology	No flowing water on the site. Ponds in Centennial Parklands to west and south (sub-surface drainage connections to York Road Bushland likely)

3.3 The Biological Environment

3.3.1 Flora

Native Vegetation

Investigations for the larger York Road Bushland site (incorporating Lot 1, Lot 22 and Lot 23) have been undertaken over a number of years (SauveTerre 1995, ESP 1997, UBMC 1996a, 1999b, 2000a, 2000b).

The native vegetation conforms to the community described by Benson and Howell (1994) as 'Open-scrub: *Monotoca elliptica – Banksia integrifolia – Leptospermum laevigatum*' (UBMC 2000c). This community is considered to be a variant within the Eastern Suburbs Banksia Scrub descriptive (NSW Scientific Committee 1997, 2002).

The dominant plant form in the York Road Bushland is a large shrub – Coastal Teatree (*Leptospermum laevigatum*). Coastal Teatree grows to 8 metres in height and is commonly found growing in dense thickets near the sea, immediately behind the sand dunes (Robinson 1991). The Final Determinations (1997, 2002) state that thickets of Coastal Teatree may dominate a site after disturbance, although White Tick Bush (*Kunzea ambigua)* is also so identified (Burrell 1981, cited in Attiwell 1994).

Results of earlier investigations have been detailed in the documents listed in Section 3.1.4. A new flora survey was completed in October and November 2001 in order to update floristic information. Results of the most recent survey (UBMC 2001) provide the baseline data for the VMP. These have been included in Appendices 2 and 3. The results of the flora report are summarised below.

Definition of Terms

Bushland is defined in SEPP-19 (see Appendix 2) as:

> *...land on which there is vegetation, which is either a remainder of the natural vegetation of the land, or if altered is still representative of the structure and floristics of the natural vegetation.*

For the purposes of the VMP (and in accordance with UBMC 2000a), this definition was refined to be:

> *...any area that is dominated by locally indigenous, naturally occurring plant species.*

The term 'bushland' is a generic one. Plant communities named after their dominant plant form – usually a tree or shrub species., however the bushland in the subject site Lot 23, and in the locality generally is known as ESBS – to distinguish it from other coastal plant communities in the Sydney Region. Prior to clearing, the York Road site would have supported a number of locally indigenous coastal heath species, dominated by *Banksia integrifolia,* and supporting other large shrubs such as Coastal Teatree (*Leptospermum laevigatum*) occurring.

For the purposes of the VMP the term bushland is used interchangeably with ESBS, and the boundaries of the bushland are in fact, synonymous with the boundaries of the ESBS on this site. Bushland boundaries are shown on the site plan map prepared by Degotardi Smith & Partners (1997) and presented as Figure 4.

Survey Methodology

Survey methodology adopted a quantitative approach to allow for future statistical analysis. This involved placing a computer-generated grid overlay onto a coloured aerial photograph, which served as the site map. Grids were numbered sequentially. Non-random selection of quadrats ensured thorough investigation of all parts of the subject site.

All parts of Lot 23 and small areas of contiguous bushland in Lots 1 (DOCS site) and 22 (former TAFE site) were incorporated into the grid overlay. A system of 25 contiguous 20 x 20 metre quadrats was set up in the study area. Owing to the irregular shape of the study area, some areas occupied less than 20 x 20 metres. These were recorded as subsets of the nearest adjoining quadrat, and assigned the same quadrat number and a suffix (a, b or c).

Items recorded in each quadrat were:

- All flora species occurring;
- Indicative abundance/species, using an amended Braun-Blanquet system;
- Plant community structure based on Specht (1970); and
- Impacts on native vegetation.

Results

The field survey recorded a total of 92 species for the subject site Lot 23 and small areas of contiguous bushland on Lots 1 and 22. Of the total number of plants recorded, 32 (35%) species were indigenous species[7], and 60 (65%) were introduced (ornamental or weed) species.

Three additional species were recorded compared to findings of previous surveys (UBMC 1996a, 2000a), these being: Necklace Fern (*Asplenium flabellifolium)* (Quadrat 2); a sedge (*Cyathochaeta diandra)* (Quadrat 22a); and Kidney Weed (*Dichondra repens)* (Quadrat 24a). The identification of *Cyathochaeta diandra* was tentative owing to its small size and immature stage of development.

Mulga Fern (*Cheilanthes sieberi)* (vicinity of Quadrat 4), and Sweet Wattle (*Acacia suaveolens)* (vicinity of Quadrat 17) were not recorded during this survey, although they had been observed previously. It is possible that the above ground portion of Mulga Fern (*Cheilanthes sieberi)* may have suffered die back during the extended dry period preceding the survey.

Coastal Teatree *(Leptospermum laevigatum)* was again recorded in all quadrats surveyed, with densities varying from occasional immature specimens, to dense old-aged thickets (see Plates).

Other widespread and common species included Monterey Pine (*Pinus radiata),* Tree Broom-Heath (*Monotoca elliptica*), Sydney Golden Wattle (*Acacia longifolia),* Lantana *(Lantana camara),*

[7] Where 'indigenous species' means a species that occurs at a place within its historically known natural range, and that forms part of the natural biodiversity of a place (ANHC 2002).

African Olive (*Olea europa* var *africana*), Ochna *(Ochna serrulata),* Common Couch Grass *(Cynodon dactylon),* Panic Veldt Grass *(Ehrharta erecta),* and Ground Asparagus (*Protasparagus aethiopicus).*

Locally indigenous trees were restricted to the northern section of bushland. Most local shrub species were restricted to central locations, occurring in clearings or where breaks in the canopy had increased light levels.

Native herbs were generally very sparse or absent, with Longhair Plumegrass (*Dichelachne crinita),* Scurvy Weed *(Commelina cyanea),* Blue Flax Lily *(Dianella revoluta)* and Knobby Club-rush (*Isolepis nodosa)* being widespread, although occurring in small numbers. No naturally occurring vines were recorded.

Indigenous species recorded for Lot 23 and small areas of contiguous bushland (Lots 1, 22) and quadrat locations are listed in Table 4, below. The distribution of indigenous species recorded is shown in shown on Figure 5.

Table 4: Species recorded at York Road [8] / Quadrat

Botanical Name	Common Name	Quadrat No
Acacia longifolia *	Sydney Golden Wattle	1, 2, 4, 4a, 5, 5a, 6, 6a, 6b, 6c, 7, 8, 9, 9a, 10, 10a, 11, 12, 13, 14, 15, 16, 17, 19, 19a, 20, 20a, 21, 22, 23, 24, 24a, 25, 25b
Acacia ulicifolia *	Prickly Moses	9, 10, 10a, 11, 13, 16, 17, 19, 19b, 20
Asplenium flabellifolium	Necklace Fern	2
Astroloma pinifolia *	Native Cranberry	7, 8, 12, 14
Banksia integrifolia *	Coast Banksia	1, 2, 4, 4a, 5, 5a, 9, 9a
Banksia serrata *	Old Man Banksia	7, 12
Bossiaea heterophylla *	Handsome Flat Pea	15a
Bossiaea scolopendria *		12
Brachyloma daphnoides *	Brachyloma	7, 8, 9a, 11, 12, 13, 15, 15a, 25b
Commelina cyanea	Scurvy Weed	42, 5, 15a, 19b, 21, 24, 24a, 25
Dianella revoluta *	Blue Paroo Lily	6b, 9, 9a, 10, 11, 13, 14, 15, 16, 16a, 18, 19a, 19b, 25b
Dichelachne crinita *	Plume Grass	2, 4, 5, 9, 9a, 11, 15a, 16a, 19, 19b, 20, 20a, 21a,
Dichondra repens	Kidney Weed	24a
Dillwynia retorta	Parrot Pea	7, 12, 13
Isolepis nodosa	Noddy Rush	2, 6, 6a, 6b, 6c24, 24a, 25, 25b
Kunzea ambigua *	White Tick Bush	24
Leptospermum laevigatum *	Coast Tea Tree	All quadrats
Leucopogon juniperinus *	White Beard Heath	2, 3, 4, 5, 6a, 6c, 7, 25, 25b
Lomandra glauca		16
Lomandra longifolia *	Prickly Mat-rush	1, 6c, 7, 8, 10a, 21a, 22, 24a
Micrantheum ericoides		6b, 7, 8, 9, 10a, 11, 12, 13, 14, 15a, 22a
Monotoca elliptica *	Tree Broom Heath	1, 2, 3, 4, 7, 8, 9, 10, 10a, 11, 12, 13, 14, 15a, 21, 24, 25, 25b
Muellerina cedlastroides	Native Maidenhair	5
Persoonia lanceolata *	Lance-leaved Geebung	14
Pittosporum undulatum	Sweet Pittosporum	5
Wahlenbergia gracilis	Bluebell	5

KEY

The 16 species marked with * are listed by NSW Scientific Committee (Final Determination August 23, 2002) as characteristic of ESBS.

The Determinations also state "the total species list of the community is considerably larger than that given, with many species present only in one or two sites or in very small quantities'.

Results of the flora survey are presented in Appendices 3 and 4.

[8] Refer to Figures 4 and 5

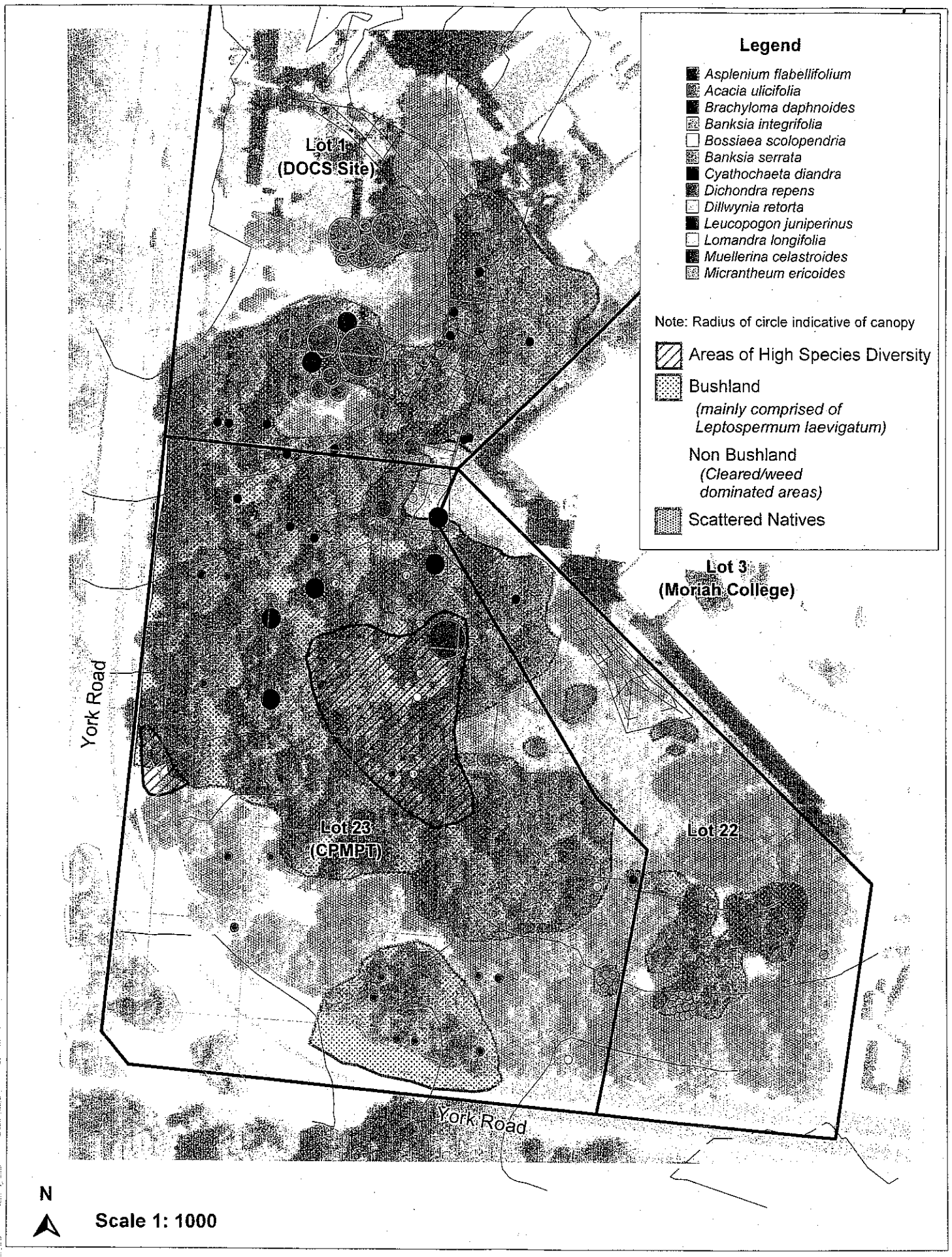

Figure 5
Approximate Location of Selected Native Species, York Road Bushland

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Introduced Plants

Almost 30% of the subject site had previously been mapped as 'non-bushland' (UBMC 2000c). This includes cleared or open areas of sand, weed thickets, and areas dominated by ornamental tree species. Introduced ornamental species and bushland weeds (environmental weeds) were recorded as 'common' throughout the site (UBMC 2000c).

During recent investigations (October and November 2001), weeds were again found to be very common in all quadrats. Monterey Pine was the only widespread tree species. Lantana, African Olive and Ochna were the main exotic shrub species.

Introduced herbaceous species were also common, widespread and locally dense, especially Wandering Jew (*Tradescantia fluminensis),* Panic Veldt Grass (*Ehrharta erecta),* Common Couch Grass (*Cynodon dactylon),* Red Natal Grass (*Melinis repens),* Kikuyu Grass (*Pennesetum clandestinum*), Ground Asparagus (*Protasparagus aethiopicus)* and Buffalo Grass (*Stenotaphrum succedaneum).* Rat's Tail Fescue (*Vulpia muralis)* was locally common in some open locations, such as Quadrat 17.

Four (4) introduced vines/scramblers (considered to be environmental weeds) were recorded in a few local concentrations. These were: Madeira Vine (*Anredera cordifolia)* (Quadrat 18), White Moth Plant (*Araujia sericifera)* (Quadrats 3 and 20); Morning Glory (*Ipomoea indica)* (Quadrats 22 and 24); and Japanese Honeysuckle (*Lonicera japonica)* (Quadrat 6c).

The distribution of introduced ornamental trees is shown on Figure 6. Keystone weeds (primary target species) for the site are discussed in Section 6.4.4.

Conclusions

The (new) Final Determination (Scientific Committee 2002) for ESBS provides a list of 63 indigenous species that are characteristic of the community (see Appendix 1b). Only 16 (25.4%) species of the 63 characteristic species listed in the Determinations were recorded for the subject site (see Table 4), although the Determinations state that the full list of species for ESBS is likely to be considerably larger than the one presented. Many of the species listed in the Determination and recorded in York Road, are those that commonly occur in other plant communities such as coastal heath, scrub and open woodlands on sandstone.

Notwithstanding the occurrence of some 32 indigenous species in the York Road remnant, the floristics and structure of the plant community have previously been noted to be generally 'highly simplified' compared to the description given in the Determinations (UBMC 1996a, 2000a, 2000b), and in comparison with other larger remnants in the Region (Jennifer Street, La Perouse). The results of the most recent (UBMC 2001) flora survey, and field investigation of other listed ESBS remnants (see Figure 7) confirm the previous description.

The updated Flora Report (UBMC 2001), including a list of indigenous, introduced and weed species, is presented as Appendices 3 and 4.

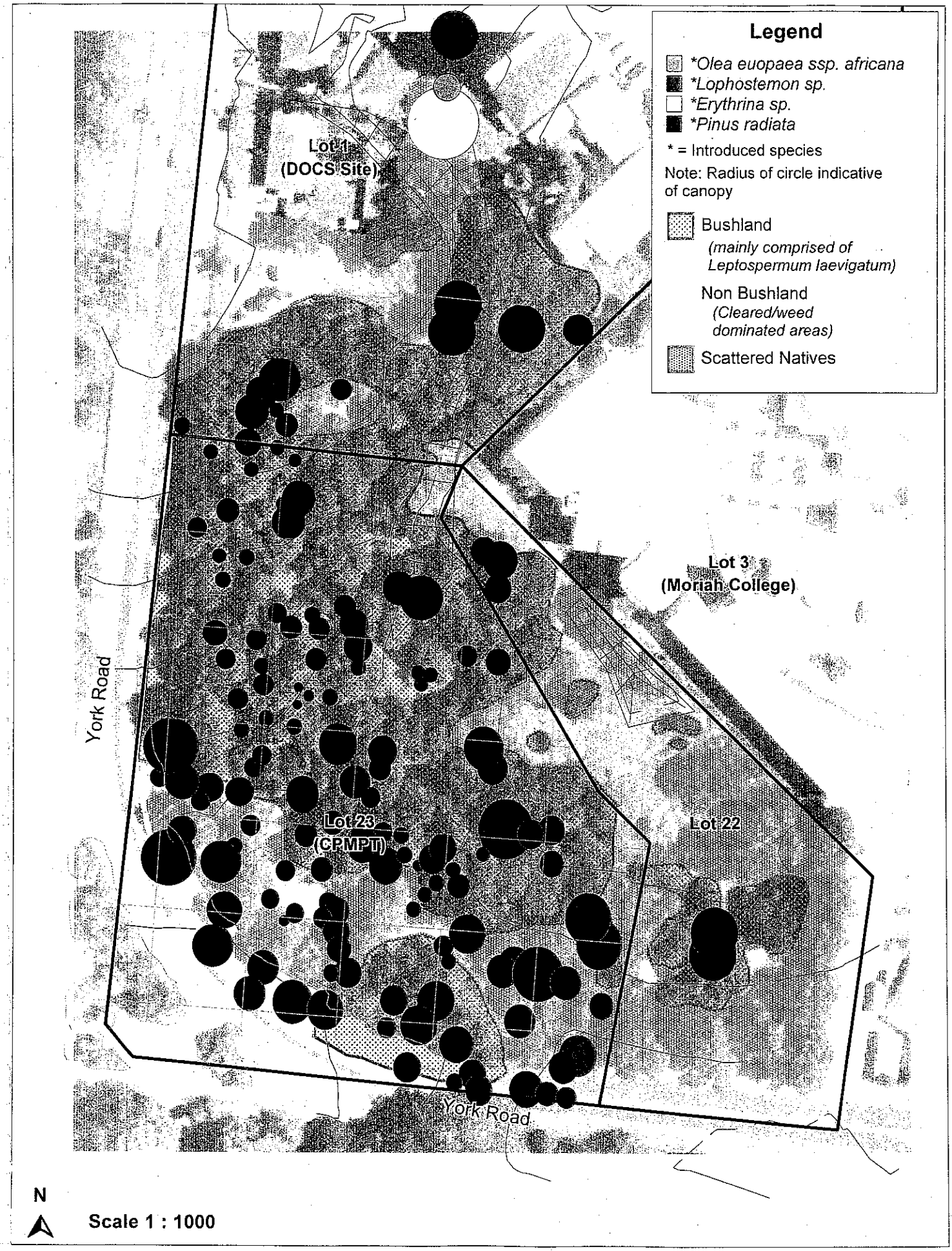

Figure 6
Approximate Location of Exotic Trees and Shrubs greater than 2m, York Road Bushland

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3.3.2 Fauna

Fauna investigations were carried out by LesryK Environmental Consultants for previous site investigations (UBMC 1996, UBMC 2000a), and replicated for the Species Impact Statement prepared for the proposed development on Lot 22 (UBMC 2000c). As there has been no significant change to existing habitats within the subject site, or on land adjacent to the site, it was not considered necessary to update fauna records. The following section summarises the results of fauna investigations prepared for the Species Impact Statement (UBMC 2000c) [9].

Survey Methodology

Survey techniques employed included habitat assessment, daylight searches, spotlighting for nocturnal species, hand searches within and under litter and logs, bird watching, ultrasonic detection for microchiropterans, call identification and identification of indirect evidence such as tracks, scratchings and scats. No limitations to the outcomes of the fauna survey were present and the conditions and times of the survey were conducive to the detection of fauna species present, particularly any likely to be of conservation significance.

Primarily, a single habitat type was identified for the subject site, this being a degraded scrub/woodland. On the subject site (Lot 23), the habitat type was assessed as being 'relatively healthy' (i.e. thickets providing a range of habitat sites), excluding the overstorey of exotic Pines and the presence of a large amount of wind-blown and dumped urban litter (UBMC 2000c). Also occurring were areas of introduced herbland/grassland, some small areas supporting native grasses and forbs, and areas of open sand.

Due to the size of the study area and the physical condition of both the site and the adjacent habitats, few native species were recorded. Species recorded for the larger York Road Bushland site (Lots 1, 22 and 23) were: 21 native birds; 1 native mammal; 6 reptiles, and 1 frog. With regard to the detection of these species:

- All birds were observed within, or traversing over the woodland habitat, or identified from their distinctive calls.
- The Brown-striped Frog *(Limnodynastes peroni)*, Michael's Oak Skink *(Cyclodomorphous michaeli)*, Three-toed Skink *(Saiphos equalis)* and Eastern Blue-tongued Lizard *(Tiliqua scincoids)* were all hand-captured while searching under and within urban refuse and leaf litter within Lot 23;
- The Grass Skink *(Lampropholis delicata)* and Garden Skink *(Lampropholis guichenoti)* were both observed while traversing the study area;
- The Weasel Skink *(Saproscincus mustelinus)* was hand-captured sheltering under some urban refuse within Lot 1; and
- The Grey-headed Flying-fox *(Pteropus poliocephalus)* was observed flying over the site during the spotlighting session.

While conducting the field investigations and assessing habitat values:

- No microchiropterans (micro-bats) were recorded or indicated;
- Predation of native birds by introduced predators was noted to be high;
- No trees with any suitable hollows were found;
- No caves or suitable cave substitutes were recorded; and
- No creeklines, drainage easements or any other aquatic environments were observed.

[9] Habitat descriptions in the VMP are presented for Lot 23 only, while fauna species have been recorded as occurring within the larger York Road Bushland.

Grey-headed Flying Fox (*Pteropus poliocephalus*)

Subsequent to the completion of the fauna working paper and Species Impact Statement, the Grey-headed Flying-fox has been listed as a Vulnerable species under both the NSW *TSC Act 1995* and the Commonwealth *EPBC Act 1999*.

However, during field investigations, no individuals of this species were recorded foraging or roosting within the study area (i.e. Lots 1, 22 and 23). Similarly, no historic or permanent roosting colonies were detected. Two permanent Grey-headed Flying-fox colonies are known to be present in the Region, these occurring within the Kurnell Peninsula and Royal Botanic Gardens, with Flying Foxes regularly utilising a variety of foraging resources available within urban landscapes and gardens (LesryK, author's field notes). For reference, a profile of the Grey-headed Flying-fox is provided in Appendix 5.

Based on a consideration of the habitats present in the York Road Bushland, combined with the results of previous field surveys, it is considered that the study area would not offer any resources significant to the occurrence of the Grey-headed Flying-fox. The proposed development of Lot 22, combined with the retention and enhancement of Lot 23 (particularly the replacement of exotic plants with native species), will provide foraging resources which the Grey-headed Flying-fox could potentially utilise on occasion.

The development of Lot 22 would not have an adverse impact on the local or regional occurrence of this species. The development of the area would not present any barrier to the movement patterns of this species or reduce the extent of available foraging resources. Therefore, the development would not have a significant impact on this species, thereby further threatening its presence in the Sydney Region.

Giving consideration to the assessment criteria listed under Section 5A of the of the *Environmental Planning and Assessment Act 1979*, (the 'Eight part Test'), and the lack of any significant reliance or occupation of the York Road site by the Grey-headed Flying-fox, it is considered that the development of this area would have not have a significant impact on this species, its populations, ecological communities or habitats.

From the perspective of the Grey-headed Flying-fox, it is not considered that any species-specific recommendations are required to increase the habitat value of the York Road Bushland for this animal. The rehabilitation of the natural vegetation, particularly the re-establishment of nectar and pollen producing plants, would meet the occasional foraging needs of this species.

Conclusions

In relation to the other fauna species recorded in the study area, these species are generally common to abundant, and most would be regularly recorded within urban environments. Of the fauna species recorded during the field survey, none (other than the Grey-headed Flying-fox) are listed under the Schedules of the *TSC Act 1995* or the *EPBC Act 1999*.

In addition to the species recorded within the York Road Bushland, a further 6 native mammals, 118 native birds, 21 reptiles and 15 frogs are known for, or expected to occur within the surrounding regions. Although this is the case, it is noted that a large number of these animals (eg water birds), have specialised habitat requirements that are not present within the study area: therefore they are unlikely to occur.

It should be noted that other species known for, or potentially present in the Region, have large home ranges, and the York Road remnant forms only a small, peripheral component of these home ranges. For these reasons, a large proportion of the animals previously recorded or expected for the Region, would not occur, or would not rely on the study area for any major component of their life cycle requirements.

A list of all fauna species recorded, expected or known from the region (as summarised from earlier reports) is provided in Appendix 6.

3.3.3 Corridors and Linkages

The subject site is part of a larger bushland remnant that spreads partially over adjoining land. - Lot 22 (former TAFE site) and Lot 1 (DOCS site). The York Road Bushland is separated from other vegetation and aquatic habitats found in Centennial Park by York Road. The bushland is also isolated from other local bushland areas, and it is unlikely that movement of plant material or fauna species other than highly mobile species (birds, insects) would occur.

Due to the proximity of densely populated urban areas to the north and east, no major regional fauna dispersal or movement corridors occur in the vicinity of the York Road Bushland. Therefore, the Species Impact Statement carried out for the proposed expansion of the Moriah College campus onto adjoining Lot 22 (UBMC 2000c) considered that the development would not destroy, disturb, or otherwise modify any significant regional fauna dispersal patterns.

The retention and rehabilitation of the bushland on the subject site Lot 23, as outlined in the VMP, will ensure that any local fauna movements within, or in close proximity to the study area are maintained and ensured. It is also anticipated that the retention and rehabilitation of this bushland remnant will ensure that the movement of any native species (particularly birds and other mobile species) between the study area and Centennial Parklands is retained.

3.4 Eastern Suburbs Banksia Scrub

3.4.1 Definition

The Botany Basin forms a complex geological and ecological system. Naturally defined by the sandstone ridges, along which European traffic was attracted in the early days of settlement, the huge catchment area once comprised wet and dry heaths, creeks, swamps springs, sand dunes, and ponds fed by ground water. This landscape supported a mixture of flora and a variety of faunal life, most notably birds (Ashton & Blackmore 1988).

The original vegetation of the area described is known as Eastern Suburbs Banksia Scrub (ESBS) – a community of sclerophyllous (hard-leaved) heath, scrub and low forest formed on the nutrient-poor Quaternary sands found between Botany Bay and Port Jackson (Benson & Howell 1990).

Commonly occurring shrub species include: Wallum Banksia (*Banksia aemula)*; Old Man Banksia (*Banksia serrata*); Tree Broom Heath (*Monotoca elliptica*); Pink Wax Flower (*Eriostemon australasius*); Wedding Bush (*Ricinocarpus pinifolius*), and Grasstrees (*Xanthorrhoea resinosa*). Small soaks and concentrations of organic matter in the sand formed locally wet habitats for Star-haired Goodenia (*Goodenia stelligera*), Crimson Bottlebrush (*Callistemon citrinus*), Button Grass (*Gymnoschoenus sphaerocephalus*) and other swamp heath plants (Benson & Howell 1990) [10].

3.4.2 Conservation Significance

The ESBS is known to be 'an endangered ecological community', listed under the *TSC Act 1995* and defined by the previous 1 Determination (gazetted 13 June 1997) and new Final Determination (gazetted 21 December 2001). The new Final Determination differs from the earlier Determination by the addition of a site on North Head, and the omission of a site on the Central Coast. It also provides a list of additional 'characteristic species'.

Fragmented by urban development and degraded by weed invasion and other impacts, the ESBS has been reduced to less than 1% of its former range. The NSW Scientific Community is therefore of the opinion that ESBS is likely to become extinct in nature unless factors threatening its survival cease (NPWS 1997).

The ESBS has also been listed by the Commonwealth *EPBC Act 1999* as a 'threatened ecological community', and is therefore considered to be of 'National' conservation significance (Environment Australia 2001).

[10] Note that the list of species occurring in ESBS is more extensive than the list offered in the Determinations.

3.4.3 *Regional Distribution*

Remnant ESBS in Waverley and Botany Local Government Areas has been the focus of previous investigations (SauveTerre 1995, 1997, UBMC 1997). Environmental Services & Planning (ESP 1997) lists some 32 ESBS remnants (see Table 5). The information summarised below has been taken primarily from these sources, and from the Determinations of the NSW Scientific Committee (see Appendices 1 & 1b).

However, it is understood that the NPWS has revised the list of ESBS sites and that a new map will be produced as part of the forthcoming Recovery Plan. The new map was not available at the time of writing, so that the original ESBS map prepared by the NPWS has been used in the VMP.

Originally covering some 7000 hectares in area, the ESBS has been reduced by clearing and urban development to some 70 hectares - approximately 1% of its former distribution (ESP 1997). With the exception of a small area on North Head (Sydney Harbour National Park), ESBS is restricted to the eastern and south-eastern suburbs of Sydney, being distributed between the local government areas of Botany, Randwick, Waverley and Woollahra (NPWS 1997).

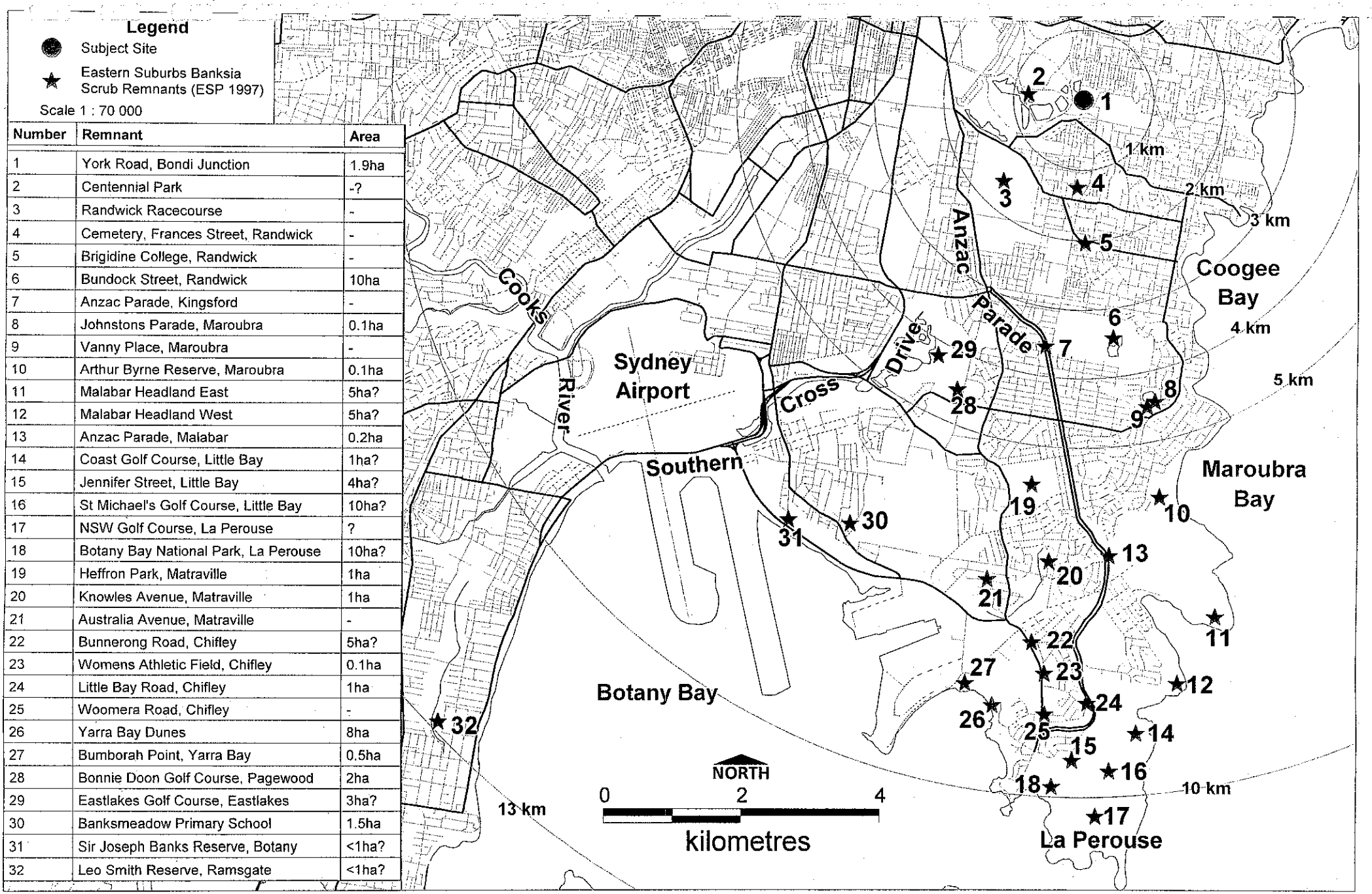
Surviving remnants of this specialised plant community may still be found at La Perouse and Jennifer Street (Botany Bay National Park), Eastlake and Bonnie Doon Golf Courses, North Head (Sydney Harbour National Park), Centennial Park (Benson & Howell 1996), and the subject site -York Road, Queens Park.

Isolated ESBS remnants (individual species or groups of plants) are found in other locations, eg. Botany Wetlands and Sir Joseph Banks Park, Botany, Banksmeadow Public School, Banksmeadow and Bunnerong Road, Chifley (UBMC 1996).

Apart from scattered individual trees and small areas of shrubland, remnant indigenous vegetation is largely absent from the local area. The ESBS remnant at York Road, which incorporates bushland in the subject site Lot 23, is the largest remnant in the Waverley Local Government Area. The York Road Bushland is located at the northern edge of the existing distribution of ESBS remnants (see Figure 7) south of the Harbour.

There are 2 large conservation areas in the Eastern Suburbs managed by the National Parks & Wildlife Service - Botany Bay National Park at La Perouse and North Head in Sydney Harbour National Park. Both Parks contain small areas of bushland which conform to the description of the ESBS contained in the literature.

Native vegetation consisting of coastal scrub, heath and woodland communities with similar characteristic species to ESBS (Coastal Teatree, Coast Banksia, and Tree Broom Heath) occurs along the coastal fringe from The Gap at Watsons Bay to the Royal National Park.



Number	Remnant	Area
1	York Road, Bondi Junction	1.9ha
2	Centennial Park	-?
3	Randwick Racecourse	-
4	Cemetery, Frances Street, Randwick	-
5	Brigidine College, Randwick	-
6	Bundock Street, Randwick	10ha
7	Anzac Parade, Kingsford	-
8	Johnstons Parade, Maroubra	0.1ha
9	Vanny Place, Maroubra	-
10	Arthur Byrne Reserve, Maroubra	0.1ha
11	Malabar Headland East	5ha?
12	Malabar Headland West	5ha?
13	Anzac Parade, Malabar	0.2ha
14	Coast Golf Course, Little Bay	1ha?
15	Jennifer Street, Little Bay	4ha?
16	St Michael's Golf Course, Little Bay	10ha?
17	NSW Golf Course, La Perouse	?
18	Botany Bay National Park, La Perouse	10ha?
19	Heffron Park, Matraville	1ha
20	Knowles Avenue, Matraville	1ha
21	Australia Avenue, Matraville	-
22	Bunnerong Road, Chifley	5ha?
23	Womens Athletic Field, Chifley	0.1ha
24	Little Bay Road, Chifley	1ha
25	Woomera Road, Chifley	-
26	Yarra Bay Dunes	8ha
27	Bumborah Point, Yarra Bay	0.5ha
28	Bonnie Doon Golf Course, Pagewood	2ha
29	Eastlakes Golf Course, Eastlakes	3ha?
30	Banksmeadow Primary School	1.5ha
31	Sir Joseph Banks Reserve, Botany	<1ha?
32	Leo Smith Reserve, Ramsgate	<1ha?

Figure 7
Regional Occurrences of ESBS
(Ecological Surveys and Planning 1997)

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3.4.4 Condition and Integrity of ESBS Remnants

Due to the small size and surrounding land uses of most remnants in the Eastern Suburbs (32 remnants listed by ESP 1997 [11]), all sites have been highly simplified and degraded by weed invasion and other impacts. Some of the remnants listed retain only trees and/or shrubs occurring singly or in very small numbers. Such occurrences, although containing species representative of ESBS (and other coastal plant communities) do not conform with the definition of 'bushland' provided by *SEPP-19* (see Sections 1.3.2 and 3.3.1), or to the description of ESBS provided in the Final Determinations (1997, 2002).

Bushland remnants in the City of Botany Bay were surveyed and mapped (SauveTerre June 1997) in support of a generic Remnant Bushland Plan of Management (UBMC June 1997). SauveTerre identified dozens of (mostly) small pockets of ESBS in many parts of Botany City, totalling some 9.5 hectares in size. Although the condition of most of the remnants was described as "poor", about 200 indigenous flora species were recorded (SauveTerre 1997).

The size of the Botany remnants varied greatly: the 8 largest remnants listed were between 0.4 and 1.0 hectares in size. Most of these sites occurred south and east of the Mill Pond system and adjacent to Eastlake Golf Course. Two remnants were listed for The Lakes Golf Course, and 1 remnant for Bonnie Doon Golf Course. Species listed for all the golf courses sites totalled 78 indigenous plants, although species numbers within each remnant varied widely, and most sites supported only single plants or groups of fewer than 5 individuals (UBMC 1997).

During preparation of the VMP for the York Road Bushland, all remnant ESBS sites within a 10-kilometre radius of the subject site were visited to seek out suitable reference sites, and to identify local seed sources. Investigations were made for 15 out of a total of 32 sites identified by SauveTerre (1997) and listed in the Determinations (1997, 2002) as 'remnant ESBS' bushland.

Initially, floristic survey was confined to remnants within a 1-5 kilometre radius of the subject site. However, as all remnants were found to be floristically limited and highly simplified, they were considered to be unsuitable as seed sources. Investigations were extended to another four (4) ESBS remnants located 5-10 kilometres distant from York Road. The results of that survey are set out in Table 5, and summarised below.

Most remnants within 1-5 kilometres of the York Road Bushland were considerably smaller and retained fewer species than the York Road Bushland. Some sites listed as 'remnant ESBS' (eg St Judes Cemetery, Frances Street Randwick) were observed to retain no local native species at all.

The only ESBS remnants south of Sydney Harbour considered to be both floristically diverse and structurally intact were La Perouse (Botany Bay National Park); Jennifer Street, Little Bay, and the Anzac Rifle Range Bushland at Maroubra. La Perouse is managed by the NPWS, as is the bushland at Jennifer Street. The Anzac Rifle Range is Commonwealth land currently leased to the NSW Rifle Association.

Each of the larger ESBS sites listed above is a coastal reserve with a distinctly maritime flavour. If these areas are used to collect seed and cuttings for use at York Road, care must be taken to avoid introducing species that are not normally found so far inland (such as Coast Rosemary - *Westringia fruticosa*, *Baeckea imbricata*, and Native Fuchsia - *Correa alba*) (as identified in the Final Determinations (1997, 2002).

[11] As identified by NPWS 1997.

Table 5: Eastern Suburbs Banksia Scrub Remnants (Source: ESP 1997)

No.	Remnant	Comments (ESP 1997)	Area	Distance from Site (Km)	No. Species Recorded	Comments (UBMC 2002)
1	York Road, Bondi Junction	Soils moderately to highly disturbed. Scrub species mature. Weed invasion moderate.	1.9 ha	n/a	32	Low native species diversity. Highly disturbed & simplified
2	Centennial Park	Bird Sanctuary and 3 other sites	< 1 ha (0.6)	1	12	Bird Sanctuary, mostly planted with some indigenous species. 3 other small sites with < 5 species each
3	Randwick Racecourse	2 sites. 1 clump each of *Xylomelum pyriforme.*	-	1	5	Small gully – mainly *Acacia* sp and natives grasses.
4	Cemetery, Frances Street, Randwick	Indigenous plants within and between grave sites.	-	2	0	No indigenous plants located. Non-indigenous trees on site. Maintained understorey.
5	Brigidine College, Randwick	Several *Xylomelum pyriforme*	-	2	5	Set in neglected garden beds. As ESP, plus several old *Banksia integrifolia* on eastern boundary (ex-site?)
6	Bundock Street, Randwick	Contains some relatively intact areas of ESBS east and northwest of the perennial lake.	10 ha	3	80	Dense weed understorey in most of site. Shrub & tree strata generally healthy on eastern embankment
7	Anzac Parade, Kingsford	Fenced area, western side of median strip between Broadbent and Fischer Streets. Contained *Allocasuarina diminuta* until 1995. Some natural regeneration of *Bossiaea* sp. is understood to have germinated in response to bush regeneration.	-	4	12	Contains few ESBS species with planted trees, shrubs & grasses. Vegetation in poor condition (senescent and damaged)
8	Johnston Parade, Maroubra		0.1 ha	4	5	Maintained understorey and many horticultural plantings present.
9	Vanny Place, Maroubra	Undeveloped private block.	< 1 ha	4	2	Highly weed infested understorey.
10	Arthur Byrne Reserve, Maroubra		0.1ha	6	19	Maritime species such as *Correa alba* and *Westringia fruticosa* present.
11	Malabar Headland East	Not yet mapped. Contains both areas of ESBS and heath on sandstone.	5 ha?	8	216	High species diversity and in good condition. A high maritime influence. Bush regeneration

No.	Remnant	Comments (ESP 1997)	Area	Distance from Site (Km)	No. Species Recorded	Comments (UBMC 2002)
12	Malabar Headland West	Not yet mapped. Contains ESBS on the east to south	5 ha?	9		work underway for past 10 years. Commonwealth land on Register of National Estate
13	Anzac Parade, Malabar		0.2ha	7	8	Embankment of mainly *Acacia sophorae.*
14	Coast Golf Course, Little Bay	Small areas of ESBS.	1 ha?	9	4	Some remnant stands within swales of golf course. Low species diversity.
15	Jennifer Street, Little Bay	Contains some of the most intact remnants of ESBS.	2.7ha	10	12	Highly weed infested understorey. *Banksia aemula*
16	St Michael's Golf Course, Little Bay	Contains relatively large, intact areas of ESBS.	10 ha?	10	7	Relatively healthy stands.
17	NSW Golf Course, La Perouse	Largely unsurveyed.	?	10	20	Adjacent to Botany Bay National Park. Some weed infestation, but relatively good condition.
18	Botany Bay National Park, La Perouse	Contains significant remnants of ESBS.	10 ha?	10	27	Relatively good condition. Some areas have high maritime influence.
19	Heffron Park, Matraville	Small, highly degraded remnant in centre of park and patches *Bothriochloa macra* throughout park.	1 ha	6	9	Highly degraded, with few ESBS spp.
20	Knowles Avenue, Matraville	Extremely degraded and weed infested.	1 ha	7	2	Only a couple indigenous individuals located. Mostly exotic grasses.
21	Australia Avenue, Matraville	7 clumps of *Xylomelum pyriforme* etc., and possibly 2 indigenous *Angophora costata.*	-	7	2	Maintained grassland dominated by horticultural plantings.
22	Bunnerong Road, Chifley	Substantial amounts of ESBS; slightly to extremely degraded.	5 ha?	8	13	Dense weed understorey.
23	Women's Athletic Field, Chifley	2 small sites, highly degraded.	0.1ha	8	5	Very dense weed understorey. Isolated ESBS spp.
24	Little Bay Road, Chifley	Highly disturbed and degraded remnant.	1 ha	9	7	Maintained grassland dominated by horticultural plantings. Few ESBS spp.
25	Woomera Road, Chifley		-	9	4	Very few ESBS individuals.
26	Yarra Bay Dunes	Mostly *Acacia sophorae* and *Leptospermum laevigatum.* Southern part more intact.	8 ha	9	13	Many horticultural plantings and landscaping.
27	Bumborah Point, Yarra Bay	Moderately disturbed, highly weed infested	0.5 ha	9	2	Highly weed infested understorey.

No.	Remnant	Comments (ESP 1997)	Area	Distance from Site (Km)	No. Species Recorded	Comments (UBMC 2002)
28	Bonnie Doon Golf Course, Pagewood	Unknown to ESP.	2 ha	5	40	Isolated remnants surrounded by fairways. Few shrubs, mainly herbs
29	Eastlakes Golf Course, Eastlakes	Degraded patches of ESBS.	3 ha?	4	73	As above
30	Banksmeadow Primary School, Banksmeadow	Moderately disturbed and weed infested.	0.69 ha	7	22	Small remnant in school grounds. Central core of bush with weedy surroundings. Good diversity
31	Sir Joseph Banks Reserve, Botany	Unknown to ESP.	<1 ha	7	17	Small dune area in landscaped park. Recently burnt (12/01).
32	Leo Smith Reserve, Ramsgate	Unknown to ESP	<1ha	13	?	
33	North Head, SHNP	Recent listing (2000)	~ 7 ha			New preliminary determination Dec 01 *Banksia aemula*

Area values of "-" indicate that the remnant is very degraded: usually consisting of scattered plants.

4 MANAGEMENT ISSUES

4.1 Management of an Endangered Ecological Community

4.1.1 *Conservation Significance and Legal Implications*

Eastern Suburbs Banksia Scrub has been defined as having a 'high' conservation significance by both the NSW *TSC Act 1995* and Commonwealth *EPBC Act 1999*, which means that it is considered to be 'endangered' at local, regional, State and National levels of significance. Both Acts are designed to ensure the protection of listed species, populations and ecological communities, although the legislation deals mostly with identifying negative impacts rather than prescribing remedial measures or offering incentives to landowners *to* conserve and manage land more effectively.

Under the terms of the *TSC Act 1995*, the NPWS is required to prepare Recovery Plans for species, populations and endangered ecological communities listed by the Act within 5-years of the Final Determination. Such Plans are designed to assist consent and determining authorities in the assessment of impacts on listed species, population or ecological communities, and for members of the public who are interested in becoming involved in the conservation activities.

The draft Recovery Plan for ESBS is currently in preparation and is not available for public comment. However, in common with other Recovery Plans prepared for endangered plant communities (eg. Cooks River Clay-plain Scrub Forest, draft February 2000, Cumberland Plain Woodland, in preparation) the primary objective of the Plan will be to promote the recovery of the ESBS community to a position of viability in nature.

Recovery Plans for other 'endangered ecological communities' in the Sydney area, are prepared according to a predetermined format. This is format provides:

- A summary of available information, including a floristic description, conservation status, and legal context, and identifies the location and condition of all known sites;
- A review the current level of understanding of the ecological processes [12] determining the ecological community,
- Identification of management issues and threatening processes operating on known sites,
- Identification of ameliorative measures and strategies for ecological restoration, and
- Consideration of the economic and social consequences that affect the success of the recovery program.

The VMP for the York Road Bushland adopts a similar format to that used by the Recovery Plans in providing a summary of available information and reviewing the ecological processes which determine community floristics, structure and function. Similarly, broad ecological goals and objectives, measures for impact remediation, and bushland rehabilitation strategies, as set out in Recovery Plans prepared for other endangered ecological communities, have been incorporated into the VMP.

4.2 Potential for Bushland Rehabilitation

4.2.1 *Impacts of Past and Current Land Uses*

The impact of past and current land uses on the remnant bushland has been considerable and these impacts extend over all of the area known as the York Road Bushland. Although official records extend only from the 1950s when the land was excised from Centennial Park and transferred to the

[12] Where 'ecological processes' means all the processes that occur between organisms, and within and between communities, including interactions with the non-living environment that result in existing ecosystems, and bring about changes in ecosystems over time (ANHC 2002)

NSW Department of Health, oral records and early photographs have allowed a site history to be prepared (UBMC 1996a).

Known impacts over the past 50 years or so have included: clearing of native vegetation; planting of exotic ornamental trees; alteration of land levels and the importation of fill to create building platforms; construction of a bitumen car park and access road, placement of fly ash and other substances to bind the sandy soils; suspension of the pre-development fire regime and other ecological processes; sand extraction; vandalism; dumping, and (latterly) illegal camping.

These impacts cannot but militate against the bushland rehabilitation process, particularly if this is to be achieved through purely 'natural' means, i.e. using traditional bush regeneration methods (i.e. weeding) as opposed to the restoration of the plant community by planting with local species. A discussion of some of these major impacts is presented below.

4.2.2 Condition and Integrity of Bushland Remnant

Species diversity for the subject site Lot 23 and for the larger York Road Bushland is generally limited, with only 32 native species recorded overall (November 2001). Of these, many are 'generalist' species found in other coastal heath communities.

The bushland is dominated by a single shrub species - Coastal Teatree, which is presumably the result of early clearing. It is possible that this species has been able to persist as a monoculture because ecological processes have been suspended (eg suppression of fire); because there have been fundamental changes to physical conditions on the site (light levels, soil profile, moisture and nutrient levels, weed invasion); and the incremental loss of other characteristic ESBS species through a steady depletion of the soil seed bank.

Structural integrity (representative strata) has been simplified, with large areas dominated by thickets of Coastal Teatree up to 8 metres in height. There is very little natural regeneration of other species occurring within these areas, but there is more diversity in other parts of the site where conditions are more conducive to the establishment of coastal heath. However, there are numerous Coastal Teatree seedlings growing in all open areas outside the scrub thickets, which indicates that this species is naturalising and can be expected to retain its dominance of the site in the absence of any other (larger) competing species.

The ornamental trees planted along York Road in the 1950s have naturalised and are now found throughout the larger York Road Bushland site. Dominants are Monterey Pine and Queensland Brush Box. Other introduced small trees/large shrubs include African Olive and Large-leaved Privet (*Ligustrum lucidum*), and well as a small number of non-indigenous native species (see Figure 6). The dense shade and heavy competition presented by these large trees is thought to be a significant factor in the suppression of indigenous understorey species.

Weed densities are high. Nearly two thirds (65%) of the total number of species recorded (November 2001) comprised exotic grasses or ruderal weeds (i.e. weeds of wastelands (see Table 9). Much of the shrub stratum in Lot 23 is dominated by Lantana, a woody perennial growing in thickets to 3 metres in height, which effectively prevents the establishment of light-demanding heath and scrubland species. The ground cover includes a range of exotic grasses, the succulent Wandering Jew *(Tradescantia fluminensis)*, and Ground Asparagus.

Note that Lantana, Green Cestrum (*Cestrum parqui)* and Pampas Grass (*Cortaderia selloana*), which have been recorded for the subject site, are listed as 'noxious weeds' for Waverley Local Government Area (*Noxious Weeds Act 1993*).

Weed invasion has not reached equilibrium. Monterey Pine and other woody weeds seedlings/saplings have been observed over time to be encroaching on small and highly vulnerable pockets of native species throughout the larger site. Some areas where native understorey species were recorded in earlier surveys (UBMC 1996a, 2000a) were noted (UBMC 2000c, 2001) to have been overtaken by Pines and/or Lantana, and as a result these species no longer occur as above ground biomass (although they are potentially retained in the soil seed bank, provided that that they had been established for a sufficient period of time to have matured and seeded).

4.2.3 Altered Soil Profiles

The York Road Bushland has a long with a history of disturbance. With the exception of a few large shrubs remaining at the Lot 23/Lot 1 interface (mainly Coast Banksia) the larger site was totally cleared in the late 1950s to facilitate the construction of the Eastern Suburbs Hospital.

The impacts of construction also extended onto adjoining land lots, with a construction huts and a bitumen car park located on what is now Lot 22, and access roads and tracks formed on both Lots 22 and 23.

Sand drift across York Road was a significant problem after vegetation clearing, so that fly ash and other material, possibly bitumen, was spread over most the site. Construction of Moriah College in the 1980s also inadvertently contributed to the degradation [13] of the soil profile through the introduction of fill material to create building platforms (note elevation of parts of Lot 1 and Lot 22 as compared to Lot 23), and the deposition of unwanted building materials (UBMC 1996a).

The bushland has since been used for a variety of purposes, including horse riding, unauthorised camping and trail bike riding, while anecdotal evidence suggests that for some years, part of the site was used as a waste dumping facility (UBMC 1996a, 2000a, 2000b).

Considering these major and long-term disturbances, it is possible that there is only limited potential for natural (*in-situ*) regeneration from the soil seed bank, other than for those species already present in the standing biomass and occurring as 'dominants' on the site (eg. Coastal Teatree). This applies particularly to those parts of Lot 23 where the natural sandy soils have been overlain with imported fill and rubble (eg northern boundary).

Site resilience is discussed in Section 4.3.2, while experimental works designed to investigate the (residual) potential of the soil seed bank have been described in Section 6.4.6.

4.2.4 Suspension of Ecological Processes

Changes in Fire Regime

One of the most important ecological processes determining the nature of coastal heath and scrubland is the *fire regime* – a term which incorporates the frequency, intensity and seasonality of fire events. Suppression of the bushland's 'natural' or pre-European fire regime is of course inevitable in developed areas, but it must be recognised that such changes have resulted in fundamental and widespread damage to bushland ecology: damage, which in many cases cannot be reversed.

Prior to urban development, bushfires (whether anthropogenic or naturally-occurring) periodically destroyed the standing biomass, reduced soil nutrient levels (Williams *et al*, 1994 Cheal 1996 in Watson 2001), and opened up the canopy to light penetration, thereby creating opportunities for the natural regeneration of the light demanding species typical of the nutrient poor sands of the coastal region.

Fire would have also checked the invasion of mesic (or soft-leaved) native species, and limited opportunities for the establishment of large trees, which if allowed to persist, promote a floristic shift from shrubland to woodland. Burrell 1981 (in Watson 2001), states that long-unburnt heath can be vulnerable to the proliferation (and eventual dominance) of shrubs such as *Leptospermum*, *Kunzea* and *Melaleuca*.

It has been suggested by many authors (Specht *et al* 1958, Benson 1985, Coops & Catling 2000) that firing at too frequent intervals may alter community floristics and structure by eliminating some species while encouraging others. Rhizomatous species such as Blady Grass (*Imperata cylindrica*) and Bracken Fern (*Pteridium esculentum*) are well adapted to frequent disturbance, including fire, and often occur on roadsides where annual fires are routinely set.

[13] Where 'degradation' means any significant decline in the quality of natural resources of natural integrity of a place, or the viability of an ecosystem, used directly or indirectly by human activities (ANHC 2002).

Too frequent burning also provides problems for obligate seeders (i.e. one that sheds seed after fire) such as Heath Banksia (*Banksia ericifolia*) and Dagger Hakea (*Hakea teretifolia*), which do not have soil-stored seed. As the adult plants are destroyed by fire, a second fire within a few years will destroy new seedlings and may result in local extinction (Siddiqi *et al*, 1976, Nieuwenhuis 1987, Bradstock *et al* 1997).

Similarly, re-sprouting species such as Broad-leaved Hakea (*Hakea dactyloides*), *Jacksonia scoparia* and Native Sarsaparilla (*Hardenbergia violacea*) will also decline in vigour as the result of frequent fires, and may also be lost over time (Watson 1999). Of the species listed above, 4 are represented in the ESBS community and occur in the remnant at York Road.

Conversely, suppression of fire over a long period of time may alter the community by encouraging the mesic shift described above, which comes about (at least in part), through a loss of reproductive vigour in adult plants and an incremental loss of seed from the soil seed bank. The impacts of the native tree Sweet Pittosporum (*Pittosporum undulatum*) in long-unburnt heath and woodland in the Sydney Region have been documented by a number of workers, including Benson (1989), and Rose (1997), and in Victoria by Gleadow & Ashton (1981).

Watson (2001), summarising research carried out by a number of workers, suggests that in coastal treeless heath and *Banksia aemula* woodlands (which are closely related to ESBS communities), fires applied at a range of intervals between 7-20 years (with an emphasis on intervals in the 8-12 year range), are necessary to maintain overall species diversity (Watson 2001).

The fire regime in the York Road Bushland has been dramatically changed, and apart from irregular small-scale spot fires, the bushland has remained unburnt for at least 50 years – and possibly longer. In the absence of fire, thickets of Coastal Teatree have persisted in densities possibly unknown in sites where a more 'natural' fire regime has been retained.

The planting of large (ornamental) canopy trees into the York Road Bushland has brought about major changes in light availability, soil moisture and nutrient availability. Alterations to soil chemistry brought about by the large number of Pine Trees may also be a factor in the suppression of native species. Over time, such impacts have made fundamental changes to site ecology inevitable. It is probable that the long-term suppression of fire in the bushland, when combined with the other man-induced changes described above, have acted to retard and eventually to virtually arrest the successional process in the York Road remnant.

Table 6 identifies the known fire response for genera and species recorded in the York Road Bushland. This information has been assembled from a range of sources, which are documented within the Table.

Table 6: Selected Indigenous Species Recorded at York Road Bushland: Potential Response to Fire Events

Botanical Name	Common Name	Response to Fire	References
Acacia longifolia	Sydney Golden Wattle	Adults killed but seeds germinate rapidly. *NB:* relatively low intensity fire will germinate seeds.	5
Astroloma pinifolium	Native Cranberry	Probably re-sprouts from rootstock	3
Banksia integrifolia	Coast Banksia	Adults generally killed, depending on age of plants and fire intensity. Root suckering not reported.	1
Banksia serrata	Old Man Banksia	Re-sprouts from epicormic shoots or from lignotuber (depending on intensity of burn). Juveniles 5-7 years are fire tolerant	1
Bossiaea heterophylla	Handsome Flat Pea	Variable response, some plants re-sprouting after high intensity fire and others killed. Seedling recruitment fire-related.	4
Brachyloma daphnoides	Brachyloma	Re-sprouts from rootstock. Seedlings recorded less than 1 year after fire.	3
Dianella revoluta	Blue Paroo Lily	Re-sprouts from rhizomes	5
Kunzea ambigua	White Tick Bush	Adults killed, re-establishes from soil-stored seed. Seedlings established within 6 weeks of high intensity fire. Capacity to regenerate after fire from encapsulated seed yet to be confirmed but some viable seed has been collected following burns.	2
Leptospermum lanigatum	Coast Tea Tree	Adults killed, with re-establishment from soil stored seed.	2
Monotoca elliptica	Tree Broom Heath	Re-sprouts from epicormic buds, though survival may be patchy. Most adults killed by high intensity fire. Seedlings appear to establish in long unburnt areas.	3
Persoonia lanceolata	Lance-leaved Geebung	Adults killed, re-establishes from soil-stored seed bank. *NB*: recruitment mainly after fire.	1

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Integrity of the Soil Seed Bank

The impacts of altered fire regimes on bushland in coastal heath and scrub have been described above. It has been suggested by a number of authors that these impacts include alterations to floristic composition and to structural complexity, due (in part) to a progressive loss of viable seed and other propagative material in the soil seed bank.

A fundamental tenant of the Bush Regeneration Movement (Bradley 1988) is the ability of the bushland to heal itself through a process of natural regeneration. In practice, this approach depends on the on-going viability of seed stored in the soil seed bank and vegetative reproduction. A range of methodologies and techniques has are used by bush regenerators (see Section 6.3) to stimulate this seed reservoir, with varying degrees of success.

Research into the viability of Australian native seeds and the retention of soil seed bank integrity over time has generally been related to fire ecology and the application of scientific research to fire management. Conclusions reached by a number of workers with relevance to the potential for natural (*in situ*) regeneration at the York Road Bushland are summarised below.

A number of studies have found that, although many species are seemingly lost from the community after fire, these may persist in the soil seed bank (Posamentier *et al* 1981, Gill & Bradstock 1995). However, after a number of years overall reproductive effort declines (McFarland 1990, Lunt 1994) and the aging vegetation loses vigour (McFarland 1990). Correspondingly the value of the bushland as habitat and as a food resource for native fauna is reduced, and birds and other animal species have been shown to move out of long unburnt vegetation (McFarland 1988b, Kingston 1997). This faunal exodus reduces the potential for pollination and/or seed dispersal, thus further simplifying the community. The impacts of frequent burning on fauna habitat are correspondingly dramatic, with the loss of ground-level shelter, food sources and hollow-bearing trees potentially resulting in the loss of some species from the area (Catling 1994).

Long-term fire exclusion may cause species to be lost, as plants that rely on fire for regeneration will eventually become old and die. If the area is not fired before the seeds lose viability, the species will then be lost to the community. Of particular relevance to the York Road Bushland is the modelling study of an obligate seeder *Banksia* species (Bradstock *et al* 1996), which found that senescence was the primary mechanism causing extinction.

Studies carried out by students from the University of NSW have been concerned with the stimulation of retained seed through applications of smoke water. Lesak (2000) reports that although trials proved moderately successful in glasshouse conditions, separate trials carried out in heath dominated by *Kunzea ambigua* and Coastal Teatree at Jennifer Street, La Perouse were disappointing, and were probably not economical to implement when compared to other methods used to rehabilitate bushland.

As the seed longevity of many of the ESBS species at York Road is generally not known, and the composition and viability of the seed soil seed bank has not been determined, the potential for regeneration from *in-situ* seed sources is subject to conjecture, although the length of time which has elapsed cannot but militate against the possibility that it has been retained intact. Nevertheless, experimental smoke water trials are proposed for the York Road Bushland (see Section 6.4.6.) [14].

Pollination Vectors and Seed Dispersal Agents

Some of the effects of inappropriate fire regimes on fauna and their habitats have been described above. Too much or too little fire may result in a loss of species, and if the bushland is a small, simplified remnant, isolated from other bushland areas, local extinction of some fauna species is possible. This is particularly true of those species that are non-generalists, that is, species that depend on the availability of a specific habitat type or food source (eg micro-bats, flying foxes).

[14] Smoke water trials will be carried out in the glasshouse and in the field, and will extend for a period of 2-3 years. Results of these trials will help to determine appropriate rehabilitation strategies to be used in the 2nd stage of the bushland rehabilitation program (years 3-5).

It is generally accepted that there has been an incremental loss of many birds, reptiles and non-arboreal mammals from urban bushland remnants as habitat values decline and these remnants are fragmented and degraded by a range of impacts. The York Road Bushland is no exception, with previous studies (LesryK for UBMC 1996, 2000a) recording only 29 native fauna species (see Section 3.3.2), with 21 of those species being birds observed to be foraging, perching or flying over the site.

Although it has not been well documented in the literature, it is reasonable to assume that a decline in vigour and/or the loss of fire-adapted species in long-unburnt bushland, will limit opportunities for flowering and fruiting. If this were true, there would be presumably be a corresponding decline in pollinating insects and birds. As many of the larger fauna responsible for seed dispersal have already left the remnant, or are thought to visit it only infrequently, this would have serious implications for the viability of the bushland as a self-sustaining ecological unit.

Table 7 summarises the pollination vectors and seed dispersal mechanisms known for the coastal heath and scrub species recorded in the York Road Bushland. Although many species are dependent on insects and other invertebrates to spread pollen and/or to disperse seed, many others rely on bats, birds and small mammals for their on-going survival. In the absence of some or most of these faunal vectors, other mechanisms (eg. re-introductions, replanting early with insect attracting species) may have to be explored.

Table 7: Selected Indigenous Species Recorded at York Road Bushland, Pollination Vectors and Dispersal Mechanisms

Botanical Name	Common Name	Pollination Vector	Dispersal Mechanisms	References
Acacia longifolia	Sydney Golden Wattle	Wind pollinated and insects (some flies) *NB*: Flowering June - November	Mainly ants, birds (Noisy Miner – *Meliphaga chryops*, *M. virescens*), birds	6, 7
Astroloma pinifolium	Native Cranberry	Insects (ants, beetles, possibly moths), small birds eg Spinebills *NB*: Peak flowering in August	Diaspore; fruit: dispersed by small mammals and/or birds Fruit eaten by soil organisms (millipedes etc), mice and/or rats	3, 8
Banksia integrifolia	Coast Banksia	Honeybees, native bees, butterfly, and Eastern Spinebill (*Acanthorhyncus tenuirostris*), honeyeaters eg. Fuscous Honeyeater (*Lichennostomus fuscus*), Flying Foxes. *NB*: synchronous flowering	Diaspore: gravity-dispersed, fire not essential for seed-shed as seeds released at maturity. Cockatoos use as a food source *NB*: Root suckering important for recruitment	1
Banksia serrata	Old Man Banksia	Native bees, Rainbow Lorikeet (*Trichoglossus haematodus*), Bell Minor (*Manorina melanophrys*), White cheeked honeyeater (*Phylidonyris nigra*), Grey Headed Flying Fox (*Pteropus poliocephalus*), Little Red Flying Fox (*Pteropus scapulatus*), Common Blossom Bat (*Syconycteris australis*). *NB*: peak flowering December	Diaspore; direct seeding via expulsion for short distances Seeds weigh 77.5mg +/-1.4, dispersed up to 4m with strong wind. Winged seeds released following fire.	1
Bossiaea heterophylla	Handsome Flat Pea	Native bee and the Honeybee (*Apis mellifera*) both visit the flowers for nectar. *NB*: peak flowering in April.	Diaspore; seed adapted for ant dispersal. Soil-stored seed bank.	4
Brachyloma daphnoides	Brachyloma	Insects *NB:* flowering August – December.	Diaspore; fruit, both vertebrate and ant-adapted dispersal.	3
Dianella revoluta	Blue Paroo Lily	Not known (possibly as for Epacridaceae)	Succulent fruit: birds & small mammals	8
Kunzea ambigua	White Tick Bush	Most significant pollinators are bees, flies, beetles and butterflies, with moths and wasps also acting as pollinators. *NB*: peak flowering November to December	Diaspore; seed, spread by wind or water, ant dispersed.	2

Botanical Name	Common Name	Pollination Vector	Dispersal Mechanisms	References
Leptospermum lavigatum	Coast Tea Tree	Ringtail Possum (*Pseudocheirus peregrinus*) feeds on flowers. *NB*: Mass flowering in September	Wind dispersed to a short distance, possibly ant – dispersed. Soil stored seed bank.	2
Monotoca elliptica	Tree Broom Heath	Insects (as for other Epacridaceae) *NB*: peak flowering August	Diaspore; fruit, probably bird-dispersed.	3, 8
Persoonia lanceolata	Lance-leaved Geebung	Native Bees & Long-tongue bees [*Leioproctus (Cladocerapsis) carinatifrons, L. incanescens, L. speculiferus*] other insect foragers are *Leioproctus (Hiiglossa)* sp., *Exoneura* sp., *Leioproctus filamentosa*	Diaspore: vertebrate dispersal of fruit eg. Currawongs. Seeds eaten by foxes; possibly dispersed by large mammals, kangaroos, possums: soil-stored seed bank, germination triggers unknown.	1

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4.3 Constraints to Ecological Restoration

4.3.1 *Template for Rehabilitation of ESBS*

There are no local ESBS areas available to provide a reliable template (or reference site) for bushland rehabilitation at York Road. Other local sites are very small in area and support only a few plants, while large areas that occur with a diverse ESBS community are located in predominantly marine influenced environments (see Table 5).

In the absence of a suitable template, decisions on issues such as species composition, densities and zonation must be extrapolated from known ESBS sites, even if these are further afield and/or recognised as variants (see Section 3.4). There will be differences of opinion about the floristic composition of the ESBS community in non-marine sites such as York Road, and as urban development has obliterated all but a few highly modified sites at some distance from the coast, irrefutable data is unlikely to eventuate.

Given the absence of suitable reference sites, the rehabilitation strategy proposed must adopt a conservative approach, and adopt a simple template to guide the rehabilitation process at York Road. This template will be based (primarily) on existing site floristics, information available in the literature, and on examination of coastal heath and scrub communities elsewhere in the Sydney Region.

In addition to guiding the rehabilitation process, templates are important for monitoring purposes. Changes in plant communities can be hard to monitor due to their dynamic nature and the number of variables that must be measured, although some of these variables are not practical or even possible to measure within the time span allocated to most bushland rehabilitation projects.

Monitoring the recovery process at York Road will be problematic without a defined template. Possibly extrapolation from existing (marine) remnants and other coastal communities will serve, provided that allowances are made for the differences in geographical location and minor floristic variations.

4.3.2 *Ecosystem Resilience*

Ecosystem resilience is defined as "the degree, manner and pace of restoration of the structure and function of the original ecosystem after disturbance" (Westman 1978), or more simply, as the ability of an ecosystem to recover from disturbance.

When assessing site resilience, key indicators will include the diversity and abundance of the standing biomass, the potential reservoir of propagative material (seeds, spores, rhizomes) in the soil seed bank (although the latter is difficult to assess without extensive trials), and connectivity to other bushland sites. Although site resilience is more correctly defined as *in situ* potential, in practice the potential for recruitment of plant material from nearby bushland must also be considered. ..

The resilience of the York Road site is expected to be low as a result of past land uses, changes to the soil profile and soil chemistry, suppression of the natural fire regime, dominance of the understorey by weeds, and the incremental loss of viability in the soil seed bank. Isolation from other bushland areas is also a major constraint to bushland rehabilitation, as gene flow and recruitment is no longer possible (see Section 4.3.3).

Species diversity and abundance in the 'above-ground' biomass throughout the larger York Road Bushland is low, and the site is largely dominated by a single species – Coastal Teatree - which has suppressed other light-demanding species characteristic of ESBS.

Although other indigenous species do occur, particularly in open sites away from the Teatree thickets, given the very small numbers/abundance present on the site, and the fact that these species often occur as immature saplings or seedlings, it is unlikely that large amounts of representative seed have accumulated in the soil seed bank over time.

The dense Teatree canopy and the long-term suppression of fire has not been conducive to the establishment and survival of coastal heath and scrub species, which require high light-levels and periodic fire episodes to retain the open conditions characteristic of these communities. Given that it has been more than 50 years since clearing for the construction of Eastern Suburbs Hospital, and that periodic disturbance events (clearing, earthworks, spot fires) have created suitable conditions, as the site has not responded with sustained regeneration of ESBS species, it is possible that the original soil seed bank may be exhausted or at least severely depleted [15].

Natural regeneration *is* occurring at York Road – although the diversity and abundance of species other than the dominant shrubs (Coastal Teatree, *Acacia* spp) is very limited. Seedlings present are representative of plants in the standing biomass, so that regeneration basically 're-cycles' the same limited number of species. Therefore rehabilitation strategies, which depend entirely on *in-situ* seed sources to restore a floristically diverse ESBS community, are possibly unlikely to succeed. Strategies must therefore be set in place to investigate site resilience, and to maximise the potential of the soil seed bank, but should this approach fail to achieve the program's stated goals and objectives, then alternative approaches must be considered (see Section 6.4.6 –Experimental Works Proposed).

4.3.3 Genetic Isolation

The York Road Bushland is isolated from other bushland and separated from open parkland to the west and south by York Road. Only 5 mapped bushland remnants are located within a 2.5 kilometre radius of the York Road Bushland. These are Brigidine College, Frances Street (St Judes) Cemetery in Randwick, small remnants in Centennial Park, and a small gully in the western part of Randwick Racecourse (see Table 5). Investigation indicates that these sites retain few species, usually occurring at very low abundance [16]. Given the distance between remnants and high-density urban development between these isolates, it is unlikely that exchange of genetic material between remnants is presently occurring, or is likely to occur in the future.

Fauna movements between York Road and other bushland remnants are similarly restricted, and would apply only to highly mobile species such as birds, bats, and some flying insects. Although there are some small areas of native vegetation in Centennial Park and Queens Park (see UBMC 1996b), Centennial Parklands is itself isolated within a highly developed urban environment, with only private gardens and street trees providing connectivity for highly mobile species.

Although it is likely that some genetic material is brought into the York Road Bushland by fauna movements (eg *Acacia, Pittosporum*), by wind currents (grasses such as *Dichelachne*) and by human action, this material is more likely to comprise horticultural or weed species transferred from nearby parks, gardens and other non-bushland areas (see Table 7).

4.4 Potential External Pressures & Influences

4.4.1 Moriah College Development on Lot 22

The Moriah College Masterplan Stage 1 Development Application proposes to develop the TAFE Site Lot 22 for the following facilities:

- Internal roadway and main entry;
- Car park with student play space over on concrete deck;
- Open play space; and
- Buffer zone planting to the Lot 22 / 23 boundary.

[15] There is anecdotal evidence that past disturbance events have resulted in the regeneration of a range of native species, however these are now (mainly) absent from the site, presumably as the result of shading and other factors. If these species occurred in sufficient abundance, and survived to maturity, there may be a valuable seed reservoir at York Road, but this will not be known until appropriate rehabilitation strategies are put in place.

[16] Species lists available for all remnant ESBS sites list only species 'occurrence' (i.e. presence/absence), and give no indication of species abundance or richness.

The development of site facilities on Lot 22 has been assessed as having the following potential for adverse impacts on the Lot 23 Bushland. These potential impacts are:

- Disturbance to the Lot 23 Bushland during the site clearing of Lot 22;
- Ingress of exotic plants from Lot 22;
- Ingress of wind borne litter from Lot 22;
- Shading by structures on Lot 22; and
- Ingress of storm water overland flow from Lot 22.

To counter these impacts, the development proposal includes for the following specific measures:

- Declaration of a structured site clearing strategy as part of this VMP;
- Provision of a landscape "buffer zone" to the Lot 22/23 boundary as part of the DA proposal;
- Treatment to the Lot 22/23 boundary fence for litter control as included within the buffer zone design declared as part of this VMP;
- Specification of the Lot 22/23 boundary fence to minimise bushland shading, as included in the buffer zone design declared as part of this VMP; and
- The design of storm water systems to divert water away from Lot 23 southward to York Road or eastward to Lot 3 as part of the DA proposal.

Given these specific measures, it is recommended that the potential impacts to Lot 23 should be managed by way of the undertaking within this VMP document, either arising from the DA proposal or any specific measures nominated in this document.

4.4.2 *Moriah College Development on Lot 1*

The Moriah College Masterplan Stage 2 is the relevant document outlining the development proposal for the DOCS Site Lot 1.

The Masterplan Stage 2 has only been developed sufficiently to allow for the successful rezoning of the site from 5a (Special Uses Health) to 5a (Special Uses Education). The Stage 2 design proposal currently does not allow for the retention of significant portions of the existing bushland identified on the site (see Figure 4).

Since the development of the Masterplan Stage 2, the significance of the York Road Bushland has been more fully understood. In accordance with an undertaking made to the NPWS, Moriah College has commenced negotiations with the NSW Government to identify and protect a portion of bushland within the DOCS Site Lot 1. Upon confirmation of these negotiations, the Moriah College Masterplan Stage 2 may be amended to address the agreed extent of bushland reserve.

Given this, the anticipated edge effects to the bushland along the northern boundary of Lot 23 will be negligible.

4.4.3 *Drainage Patterns / Stormwater Flows*

The whole of the York Road land block is situated in a natural sand valley where the substrate density is characteristic of sand with a wind blown nature. The sands are porous and free draining. Additionally, the water table is very deep (>3 metres), and the upper levels sands are generally dry (Douglas Partners 2000). Given this, the general surface drainage for the whole of the York Road site is very good and all open areas of ground provide high levels of soil permeability.

The levels of the larger York Road site has been heavily influenced by previous benching and other earthworks to create building platforms for the construction of the former Eastern Suburbs Hospital, and latterly for Moriah College. Arising from these platforms, the western center of the site has a major steep change in level from Lot 3 along the boundary to Lot 23 and Lot 1.

Following existing site levels, Lot 3 and Lot 22 tends to fall away to the south-eastern part of the site toward the Baronga Avenue / York Road intersection. Lot 23 and Lot 1 fall toward the western center of the site, with the low point sited on the DOCS site Lot 1, approximately at the existing car parking area.

Given each of the above, the existing site levels currently drain away from the core of Lot 23 and provide natural opportunities for any surface storm water management for future adjacent developments.

4.4.4 Edge Effects

Northern Boundary Interface With Lot 22

As the result of major earthworks during the 1950s and 1980s (UBMC 1996), there is a drop of 2-3 metres between Lot 22 and Lot 23. Although details are not know, it is thought that sandy soil from the surrounding area was mixed with imported fill to create a building platform on Lot 22, and that subsequently, during the construction of the current College campus, rubble and unwanted building material was deposited on what is now Lot 22 and (part of) Lot 23.

There has been some spillage of fill (or soil creep) downslope into Lot 23 and deposition of rubble and clay fill elsewhere (as evidenced by mullock heaps). The fill and rubble have been colonised by weed grasses and tall perennial herbs, by Wandering Jew, and by native species such as Coastal Teatree and Coast Wattle. The boundary between the 2 Lots runs through this area of disturbance (see Figure 4).

The proposed expansion of the College campus onto Lot 22 will remove all existing vegetation and scalp weedy soil from the site, so that weed invasion across this boundary will not be an issue. The embankment will be regraded and stabilised to prevent further soil creep, and it is anticipated that accessible mullock heaps and other debris inside the Lot 23 boundary will be removed at the same time as Lot 22 is cleared. If access is not possible without damaging native plants, weeds will be controlled, and the fill mounds replanted with locally indigenous species.

The creation of a buffer zone, to be cited wholly within Lot 22, and the raising of a low bund wall within the buffer will further ensure that edge effects at the Lot 22 / 23 interface are minimised. Landscaping within the buffer zone has been detailed in Section 6.8.7.

York Road Boundary

The VMP adopts the strategy that the retention of existing vegetation, exotic or otherwise, to the perimeter of the Lot 23 site will provide ongoing physical protection to the core areas of the site where ESBS is present or has the best opportunity of natural regeneration.

Given this, the proposed works schedule for the VMP will retain perimeter vegetation where this has a positive physical effect on the site core, and as such, can ameliorate any potential for traditional edge effects if the site was cleared of all non-ESBS vegetation.

Visual Impact

The removal of the large Monterey Pines and other ornamental trees along the York boundary will have a significant visual impact, particularly from Centennial Parklands. Although it would be more efficient and economical to remove these trees in a single operation prior to commencing bush regeneration, consideration of public opinion suggests that the removal of mature trees along the York Road frontage should be left until a substantial portion of the central or 'core bushland' area is restored.

Leaving these street trees will increase maintenance levels (eg removal of seedlings) and will significantly reduce light levels on edges sites (thereby precluding regeneration of ESBS species), but this is preferable to alienating some of the local community through wholesale removal of these significant landscape features. The street trees can be removed at a later date and without damage to the regenerating bushland behind, as they can be removed from the York Road frontage.

4.5 Potential Internal Pressures & Influences

4.5.1 Bushfire Hazard

A Bushfire Hazard Assessment has been prepared for the subject site (AVK Environmental Management 2000) with the dual purpose of re-establishing an appropriate fire regime for the ESBS remnant, and providing protection for the proposed expansion of Moriah College onto Lot 22. This report is summarised below. A copy of the Bushfire Hazard Assessment has been included as Appendix 7.

Investigations considered the subject site Lot 23 were carried out within the framework of the larger York Road Bushland. These investigations concluded that, despite its relatively small size and low surface fuel loads, a bushfire of sufficient intensity to cause damage to adjacent buildings could potentially occur on days of very high to extreme fire danger. However, given the easy access around the site and a plentiful water supply, it should be possible to control fires in the bushland in all but the most extreme conditions.

The Bushfire Hazard Assessment concluded that the bushland on Lot 23, and on surrounding Lots 1 and 22 currently present a medium-grade fire hazard, and that this would come from accidental of deliberately lit fires set on Lot 1 or Lot 23 to the west of the College campus. The Assessment also noted that any bush regeneration works on Lot 23 that (over time) substantially increase the density of the understorey, could also increase the fire hazard on the subject site. The potential for fires set by vandals was also noted, given the unsecured nature of the site and evidence that the site is not infrequently used for unauthorised camping.

The Bushfire Hazard Assessment recommended that a fire protection zone be established between the proposed and existing buildings in Moriah College, and bushland on Lots 1 (DOCS site) and the subject site Lot 23. The proposed fire protection zone would comprise a 10-metre wide 'fuel free zone' immediately adjacent to the buildings consisting of paved or gravelled roads, driveways or pathways, and/or mown lawn with access for fire brigade vehicles.

In addition, it is recommended that any native vegetation retained and/or planted within 15 metres of any buildings should not be more than 1 metre in height. Any proposed new buildings should be constructed to Level 1 specifications in Australian Standard 3959 - 1999.

These precautionary recommendations will necessarily restrict the choice of indigenous species that can be planted into the buffer zone along the College boundary. This will constitute part of the 'fuel-reduced' zone where shrubs <2 metres in height are maintained in a landscaped garden bed situation. However in general, this requirement to maintain a fuel reduced zone at the interface between Lot 22 and Lot 23, should not compromise the proposed bushland rehabilitation program on CPMPT land in Lot 23.

The layout of the future 'bushfire management zone' have been finalised (AVK 20 September 2002) and this is shown on Figure 8, below.

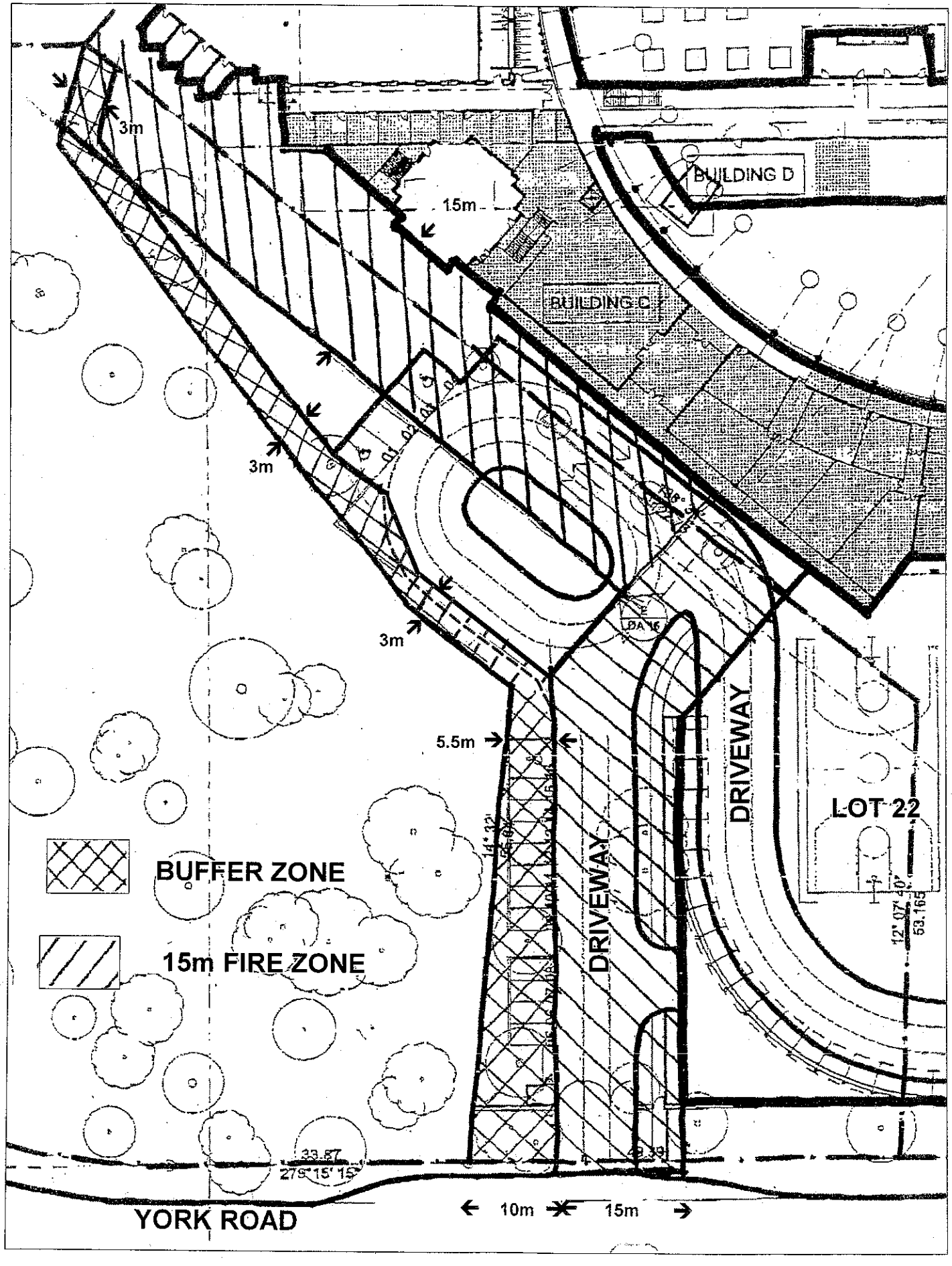

Figure 8. Location of Fire Management and Buffer Zones

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4.5.2 Impacts of Weed Clearing

In the short term, clearing the woody weed thickets, and removing up to 150 mature and semi-mature Monterrey Pines and other introduced trees will significantly increase light levels and potentially expose the sandy soils to scouring and soil erosion in heavy rain events. Tree removal and clearing woody weed thickets will also disturb the soil profile, stimulating regeneration of weeds and (potentially) native species. Weed clearance will reduce competition for water and soil nutrients between the weed and native species, as well as effecting sub-surface drainage patterns and levels of organic matter [17]. Removing the Pine Trees will also affect soil pH over time, as the ground cover is cleared of highly acidic pine litter, although this may also have a negative impact, as the Pine needles act to suppress weeds.

Soil scour and erosion is not anticipated to create a major problem as most of the site (other than embankment at the Lot 22/23 interface and the dune on the north-western corner), is flat. Where sloping land does occur, soil can be stabilised using cut brush or using mulch and/or placing erosion control fabric.

Initially the most dramatic effect will be the impact of increased light levels on the soil surface. A flush of weed growth can be expected in the short term, as the weed seed reservoir in the soil is likely to be high. Many understorey weeds are members of the grass (Poaceae) and daisy (Asteraceae) families, which are known to produce large numbers of long-lived seed. These will regenerate rapidly over a long period of time, and will need to be controlled. However, the seed longevity of weeds with succulent fruit (eg Lantana, African Olive[18] and Privet) is thought to be relatively short (Adamson & Buchanan 1974), so that control should be achievable within a single growing season.

Provided that weeds are monitored and controlled, the impacts of weed clearing will have beneficial effects on the rehabilitation process. With few exceptions, species characteristic of ESBS, thrive in open, high light conditions on free-draining, sandy soils low in plant nutrients. If the ESBS remnant at York Road is to be restored and maintained, these physical conditions must be re-established.

Removal of woody weed thickets (and site 'clean-up') will potentially impact on fauna occurring within the site by removing habitat. Precautions will include investigation of potential sites prior to removal of rubbish/debris, liaison with or on-site presence of WIRES (or similar) during initial site clean-up, progressive removal of weed thickets and timetabling large-scale clearing to avoid the spring breeding season.

4.5.3 Increased Public Usage and Visitation Rates

At only 1.07 hectares, the York Road Bushland is a small natural area in a highly urbanized setting, and as such is vulnerable to impacts such as trampling, vandalism, weed invasion, and incidents such as accidental fire. These could all conceivably result from an increased visitation rate.

However, the bushland remnant has been incorporated into an area designated as public parkland (Centennial Parklands), and it will eventually be opened for public use. The installation of a security fence along York Road, with gates that can be locked at night, and increased levels of surveillance should prevent inappropriate access and decrease current levels of vandalism.

A circular walking track system, with appropriate erosion control measures used in steep and/or potentially vulnerable sites (e.g. fixed steps, boardwalks) is proposed to direct visitors and prevent tracking through the central core bushland, thereby preventing damage to regenerating sites. Interpretative signage is also proposed.

Weed seed will inevitably be brought into the bushland on walkers' shoes and by maintenance vehicles. Weed seed will also continue invade through wind and animal dispersal and if fauna habitat is enhanced, there will be an increase in the amount of bird-dispersed seed reaching the bushland. As

[17] Culling dead/dying *Leptospermum* and creating light windows by lopping dead branches will result in a similar impact to light levels as clearing woody weed thickets.

[18] Research into the seed longevity of African Olive is underway at Mt Annan Botanic Garden.

many native and introduced birds are known to use ornamental plants such as Privet, *Cotoneaster* spp, African Olive and Sweet Pittosporum (*Pittosporum undulatum*) as a major food source, on-going woody weed invasion is probably inevitable. This factor must be taken into considering when allocating resources to long-term maintenance.

4.5.4 Vandalism / Dumping

Currently, site access is available along the entire length of York Road. The bushland is periodically used by homeless people, and is frequently used as a dumping ground. Ready access is also available from the informal parking area on the DOCS site. As the bushland is unsecured and is generally unsupervised, this has encouraged vandals to set spot fires without detection, and to use the site for illegal activities such as drug taking.

A secure perimeter fence is proposed for the length of the York Road boundary. This fence will be designed to minimise visual impact on the bushland. The York Road gate will be locked at dusk to prevent unauthorised access and inappropriate and illegal activities. As security is a major issue for Moriah College a 'man-proof' fence will be erected between Lots 22 and 23. Monitoring by security staff at the College, and increased surveillance by Park rangers will also assist to reduce incidents of vandalism.

5 BASIS FOR MANAGEMENT

5.1 Philosophical Basis for Management

Urban bushland is an important resource which much be preserved and carefully managed if it is to retain its inherent values. Bushland in a highly developed urban environment potentially provides a range of aesthetic, social, recreational, scientific and educational values to the community. However, bushland remnants in the urban environment are usually surrounded by a 'sea of development' and isolated from other natural areas. Remnants are generally fragmented by roads and tracks, and severely impacted by weeds, stormwater runoff, and subject to vandalism and other disturbances. Without active intervention, these remnants will continue to progressively degrade and their inherent values will be lost.

The management of remnant bushland (be it on private or public land) should be consistent with the provisions of *SEPP-19 - Bushland in Urban Areas.* That is:

> *.....to protect and preserve bushland within the urban areas, so as to provide representation of the original vegetation in its natural state, and enable the existing plant and animal communities to survive in the long-term* [19].

CPMPT is aware of its legal responsibilities in the management of remnant bushland and endangered ecological communities (*TSC Act 1995*, *EPBC Act 1999*, *Noxious Weeds Act 1993*). Based on current legislative responsibilities, community needs and expectations, and the need to preserve [20] the values and assets of remnant bushland, a series of broad management goals has been identified. These goals are set as follows:

- To conserve vegetation representative of the region's original vegetation communities (Eastern Suburbs Banksia Scrub, freshwater wetlands, estuarine and saltmarsh ecosystems);
- To manage remnant bushland in accordance with sound ecological principles and practices;
- To protect existing remnants from the effects of urban runoff, weed invasion, inappropriate fire regimes, the effects of feral and unrestrained domestic animals, from inappropriate activities and other forms of misuse;
- To rehabilitate degraded bushland areas to a condition where native plants are able to regenerate unassisted and (wherever possible) to re-establish a viable ecosystem;
- To extend and enhance isolated and/or degraded remnants by selectively replanting with material propagated from local seed sources;
- To provide corridors and linkages between small remnants to encourage the movement by birds and other fauna through the locality;
- To improve fauna habitat by removing weeds and providing/enhancing food sources and shelter;
- To provide a range of educational and scientific opportunities in order to increase knowledge and awareness of bushland values; and
- To involve the local community in a range of appropriate environmental management programs (Bushcare, Landcare).

5.1.1 Guiding Principles

The management of any remnant bushland area, including non-terrestrial systems such as freshwater wetlands, saltmarsh and estuarine swamps, should be guided by the following broad principles:

[19] NSW Department of Urban Affairs & Planning *Circular No B13. 17 March 1989*

[20] Where 'to preserve' means maintaining the biodiversity of a place at the *existing stage* of succession, or maintaining existing geodiversity. In the VMP, the term preservation is extended to mean 'protection' of existing values.

- To *protect* bushland remnants from the effects of existing and future development;
- To *rehabilitate* degraded remnants;
- To *enhance* species diversity in highly simplified remnants; and
- To *create* corridors and linkages between remnants to facilitate movement and to encourage the flow of genetic material.

These bushland management principles are often referred to as 'the 3 Rs'; that is:

1) *Retention*
2) *Regeneration*
3) *Revegetation*

These principles should always be applied in *descending* priority order. That is, bushland remnants should be retained and protected in the first instance, degraded bushland should be regenerated or rehabilitated through appropriate management practices, while revegetation should be used to supplement natural regeneration (if necessary) or to re-establish vegetation on sites where there is little or no potential for the regeneration of the plant community through regeneration.

Revegetation (commonly planting tubestock, but also inclusive of other methods – see Section 6.5.1) should not be used as a primary rehabilitation technique, but should be used to link fragmented or discontinuous patches of bushland or to enhance bushland where the major elements of the indigenous plant community has been lost, in whole or in part.

Bushland rehabilitation using planting or other revegetation techniques is commonly called Bushland Restoration (**hereafter 'restoration'**) and may range from supplementary planting to enhance local diversity or create habitat, to broad scale planting designed to fill gaps and create linkages.

In recommending appropriate bushland rehabilitation strategies, assigning management units and determining a sequence of works for the York Road Bushland, the VMP has adopted the principles set out above.

The strategies recommended for the (long-term) rehabilitation of the York Road Bushland are discussed in Section 5.1.2 and Table 8.

5.1.2 Management Strategies

The following recommendations, while generic in nature, represent management strategies fundamental to the protection, conservation and rehabilitation of remnant ESBS at York Road.

To Retain and Protect Bushland Remnants

- Identify the bushland remnant and prepare a vegetation management plan.
- Identify and acknowledge relevant regional bushland remnants.
- Education – ensure all grounds staff, contractors and volunteers are aware of location(s) of all bushland remnants, significant fauna habitats, and location of rare/vulnerable species.
- Assess current management practices for remnant areas (eg. mowing/slashing, burning, herbicide use, neglect) and suspend inappropriate practices.
- Restrict inappropriate access to prevent damage to vegetation and vandalism.
- Re-direct pedestrian traffic (via fencing, selective planting, erection of barriers/bollards).
- Construct boardwalks in sensitive areas where traffic cannot be re-directed, or where future visitation rates are anticipated (eg. high potential recreational/educational uses).
- Erect temporary fencing during regeneration program. Permanent fencing to be erected only if other methods cannot achieve adequate protection.
- Develop appropriate educational material and install interpretative signage.

To Rehabilitate and Regenerate Degraded Bushland Remnants

- Adopt and resource works recommended by the VMP for the York Road Bushland.
- Acknowledge associated regional bushland remnants in order to assess potential for linkages and increased gene flow.
- Begin rehabilitation process with a 'one-off' target-weeding program (see Keystone Weeds, Table 9), to control aggressive weeds and reduce impacts on regeneration sites.
- Maximise regenerative potential by commencing bush regeneration in areas with highest species diversity and representative community structure (see Figure 9).
- Guard against soil erosion. Where rehabilitation requires extensive clearing of grasses and other groundcovers, ensure that the soil surface is not left exposed (note highly erodible sandy soils).
- Ensure all stakeholders are aware that the rehabilitation of the remnant bushland will require a staged approach, and will not be achieved quickly, even if unlimited resources are made available.
- Liaise with other land managers (e.g. NSW Health, Waverley/Randwick Councils) to determine a co-operative noxious weed control program.
- Monitor and document all bushland rehabilitation actions, including success of weed control techniques, rates of natural regeneration/site, and revegetation and planting plans (e.g. location/species/numbers planted).

To Revegetate or Restore Bushland Remnants

- Identify areas within the remnant bushland where revegetation would enhance species diversity, re-establish structure and/or offer protection (perimeter sites, along tracks, open clearings, sites denuded by weed clearance, potential erosion sites).
- Determine planting requirements (species, numbers, planting aids): prepare Timetable of Works, and allocate resources at least 12 months in advance of needs.

- Establish an Indigenous Seed Bank (possibly using the Centennial Parklands' resources) and collect local seed for future revegetation work.
- Obtain appropriate seed collection permits and licences [21].
- Carry out enrichment planting as required. Note: planting to be carried out only after weed growth has been controlled, and resources for on-going maintenance have been established.
- Identify potential resources within the community (Moriah College and other local schools, special-interest groups such as Friends of Centennial Parklands, Australian Plant Society, Men of the Trees) to assist in planting and maintenance.

5.1.3 To Extend Bushland Habitat

The requirements of a basic revegetation program have been detailed above. These strategies also apply to the extension of bushland into areas where it currently does not occur (i.e. cleared areas). For such areas, considerable forward planning and consultation with a range of landowners may be required.

The following steps should be incorporated into the revegetation strategies detailed in Section 5.1.2 (above).

- Identify potential linkages and map all sites where selective replanting could be carried out over time (on both private and public land).
- Prepare a local Wildlife Corridor Strategy to link remnant bushland areas and to encourage movement of fauna through the suburbs (this will require co-ordination of appropriate planting in developed areas such as city parks, and as street landscaping).
- Liaise with all neighbouring landowners (including councils and government agencies) and undertake early consultation with the local community in order to gain acceptance and support for the corridor plan.

5.2 Commitment to Management

Bushland degradation, including a decline in species diversity and loss of understorey species, and the need to enhance and extend habitat for native flora and fauna have been identified as important management issues for the York Road Bushland (see Section 4).

The CPMPT has a moral and a legal responsibility to maximise the potential of all ESBS remnants under its control; to protect them from inappropriate uses, weed invasion and illegal clearing, and to ensure that they are properly managed and maintained. In managing remnant urban bushland, the wishes and needs of the local community must also be taken into consideration.

Contrary to the belief held by some land managers, bushland does not 'look after itself'; particularly in an urban environment where impacts and pressures continue unabated and many ecological processes have been suspended. There is no question that the effective rehabilitation of the York Road Bushland will require a substantial commitment of resources, and it should be stressed that the longer the situation is left unaddressed, the more expensive it will be to repair the damage.

The long-term nature of the bushland rehabilitation program, and the need for a firm and unqualified commitment from the CPMPT, Moriah College, Waverley Council, and the local community cannot be over-emphasised.

The primary aim of the VMP is to provide guidelines and recommend strategies for the protection, rehabilitation and on-going management of remnant ESBS on Centennial Parklands' Lot 23. The VMP will also provide a template for the management of other small bushland remnants within the Parklands (see UBMC 1996b).

[21] CPMPT has made an application for a Section 91 licence.

5.3 Establishing Goals and Priorities

A series of goals and priorities has been identified for the bushland rehabilitation program at York Road. These are set out in Table 8, below.

Table 8: Goals and Priority Actions over a 10-Year Period

Preparatory

Aims: *To alert the public of the proposed activities; Prepare Lot 22 for construction; Control access; Establish buffer zones.*

Actions	Management Unit (Fig 9)	Performance Indicators	Comments/Rationale
Exhibit and receive comments on Vegetation Management Plan Prepare an Information Program for Lot 23, ESBS bushland for community information	N/A	Public relations exercise completed (co-ordinated by Centennial Parklands) VMP on display (Centennial Parklands & Waverley Council) Comments received and where appropriate, suggestions incorporated into VMP	Good public relations. Alert residents to major visual changes such as tree clearing. Promote the project through Friends of Centennial Park and others Prepare media releases; information leaflet available at CP, carry out a letterbox drop to local community prior to start of Bush Rehabilitation Program
Survey and mark out property boundary Lot 22 / 23	3, 4, 6	Boundary line surveyed and pegged Boundary marked on property maps and construction drawings	
Salvage indigenous plant material from Lot 22	N/A	Salvaged material placed into nursery for maintenance	CP Nursery or contractor
Pines and other large ornamental trees removed from Lot 22 and from Lot 23 boundary/embankment	3, 4, 6	Trees removed from Lots 22/23 boundary without damage to native vegetation	Qualified arborist to carry out tree removal (only) Remove timber from reserve, grind stumps (as required)
Site Preparation Lot 22 Vegetation clearing and removal of rubble and other debris from site and (if possible) from existing embankment	N/A	Lot 22 cleared – all rubble and debris removed from site	Co-ordinate with clearing on Lot 22 for northern boundary area of reserve (note site access in this area will be unavailable after security fence is erected by College)
Protect ESBS vegetation on the Lot 22/23 boundary	6,4, 3	No damage to native vegetation	Fencing will require some removal.

Actions	Management Unit (Fig 9)	Performance Indicators	Comments/Rationale
Eret security fencing erected Lot 22 /23 boundary	3, 4, 6.	Security fence erected on boundary	Security fence the responsibility of Moriah College
Prepare Landscape Design for Lot 22 buffer zone and play space areas	N/A	Buffer zone and adjacent areas landscaped (as per Buffer Zone Design)	Landscape and creation of buffer zone the responsibility of Moriah College

Short Term – 0 to 3 years

Aims: *Prepare Lot 23 for Bush Regeneration Activities; Control Access; Removal of keystone weeds; Protection of existing biodiversity[22]; resilience testing; Identification of areas requiring enrichment planting, Set-up of Community Bushcare Group.*

Actions	Management Unit (Fig 9)	Performance indicators	Comments/Rationale
Initiate a general site 'clean up' prior to commencement of bush regeneration program (eg rubble, dumped rubbish and mullock heaps). If possible, co-ordinate with site clearing in Lot 22	3, 4, 6	Majority of mullock heaps, dumped rubbish and rubble removed.	Care must be taken to avoid destruction of fauna habitat. WIRES representative to attend site clearing
Erect temporary fence on York Road Boundary and place appropriate signage.	3, 2, 6, 5	Temporary (dismountable) fencing erected Bush Regeneration in Progress signs erected on fence	Incorporate removable panels to allow access for maintenance vehicles/rubbish removal.
Identify route of walking track system track and peg out to guide bush regeneration work. Close existing informal / eroding tracks.	To be determined.	Draft walking track route surveyed, mapped and marked out on the ground	Necessary to guide activities of bush regeneration/revegetation works
Experimental program to test site resilience and stimulate natural regeneration to be commissioned from UNSW (or similar).	Selected sites in all Management Units	Design completed: glasshouse trials underway Field trial set up and functioning Six monthly monitoring and assessment of results	Results assessed at end of year 2 and year 3 To help determine appropriate rehabilitation strategies.

[22] Where 'biodiversity' is defined as the variability among living organisms from all sources, and the ecological complexes of which they are part (ANHC 2002)

Actions	Management Unit (Fig 9)	Performance indicators	Comments/Rationale
Initiate a 'target weeding' program throughout the bushland (see Keystone Weeds – Table 9)	All Management Units.	>80% reduction of target species within 12 months of commencement.	Target noxious weeds and species with potential to suppress remaining understorey species. .
Cull/lop dead and senescent Teatree thickets to create light windows.	1, 2, 3, 4, 5	Series of light windows created with natural regeneration of light-demanding species occurring	Will need to be a regular program to maintain open conditions
Establish a bush regeneration program in core areas (see Figure 9).	1, 2, 3, 4, 5	Core bushland area substantially free of keystone weeds Natural regeneration of indigenous species occurring.	**Note** object is to re-instate diversity and restore habitat, not to encourage more *L. laevigatum*
Identify future planting requirements and set aside funds for works in Year 3+. Identify contractor to collect and propagate local seed	Mainly 6, possibly some others	List of species for planting agreed with BWG Sites for planting identified	Mt Annan Botanic Garden and/or Randwick Community Nursery both suitable for this project
Initiate a Community Bushcare group (Centennial Parklands volunteers)	All Management Units	Centennial Parklands Bushcare Group active in Lot 23 care and management	Complete these actions mid-way Year 3 (to allow for 6 months lead time for seed collection/propagation)
Allocate resources for park ranger supervision and routine maintenance activities (eg. rubbish removal, security).	All Management Units	Improved security and monitoring of activities in Lot 23 Site maintained: free of rubbish	

Medium Term Goals – 4 to 5 years

Aims: *Ongoing protection and enhancement of native diversity; Implementation of enrichment planting where required; Establishment of educational programs.*

Actions	Management Unit (Fig 9)	Performance Indicators	Comments/Rationale
Establish on-going management and maintenance program	All Management Units	Core bushland area substantially weed-free, showing natural regeneration of indigenous species.	
Prepare sites that have not responded to bush regeneration/experimentation for planting. Enhance natural regeneration by the planting of tubestock, and the implementation of brush matting and hand sowing.	To be determined, but probably 6, edge sites for	Sites identified, mapped and marked out (staked)	Will depend on results of program in years 1-3

Actions	Management Unit (Fig 9)	Performance Indicators	Comments/Rationale
	other M. Zones		
Revegetate chronically degraded areas completed in order to provide internal linkages, clearings and gaps planted.	As above	Existence of continuous canopy links between core bushland areas.	
Remove saplings and mature ornamental trees (eg Pines) from core bushland	1, 2, 3, 4, 5	All introduced trees < 3 metres in height removed from core bushland	Trees on Lot 22 boundary to be removed when Lot 22 is cleared Trees on York Road boundary to be left in situ for the time being
Remove remaining Pines from York Road frontage Note: in public areas (eg York Road) these may be replaced with appropriate indigenous species.	3, 4, 6, 5 York Road frontage	No large Pines remaining	Remaining Pines to be removed after core bushland has begun to recover to avoid visual impact No of trees to be removed depends on width of initial clearing
Maintain Community Bushcare Program (potentially expand activities beyond weeding, eg plant propagation, educational and/or monitoring activities)	All Management Units	Active Bushcare program underway (regular meetings)	
Rationalise internal walking track system Repair of degraded tracks and construction of steps and boardwalk (if applicable).	All Management Units	Track system completed, boardwalks etc incorporated	All introduced trees < 3 metres in height removed from core bushland
Improve public image of the bushland amenity	All Management Units	Bushland regenerated, provides attractive visual amenity. Vandalism and inappropriate activities cease. Lot 23 visitation rate increased.	
Establish an educational program with interpretative material developed by Centennial Parklands	All Management Units	School group / visitor guided tours underway.	Small size makes this site vulnerable to increased visitation. Small groups only Walking track system would facilitate these activities

Long-Term Goals – 6 to 10 years

Aims: *On-going protection and enhancement of native diversity; Enhancement of corridors and linkages; Further community involvement.*

Actions	Management Unit (Fig 9)	Performance Indicators	Comments/Rationale
Maintain bush regeneration program (enrichment planting, culling, weed control, routine maintenance).	All Management Units	Increased biodiversity in all bushland areas. Restoration of structural integrity (especially understorey stratum)	Work to be funded by CPMPT, but external grant monies may be available (eg Heritage Trust)
Incorporate resources for site maintenance incorporated into annual budget prepared by Centennial Parklands.	N/A	Annual budget for bush regeneration work incorporated into CP capital works budget	Decision to maintain and/or expand existing remnants an issue for CPMPT
Other bushland remnants in Centennial Park managed and maintained.	N/A	Bush regeneration/maintenance of all remnants established	A single generic management plan will serve for this group of tiny remnants
Enhance habitat corridor between Centennial Parklands and York Road Bushland (linkages restored), with potential co-operative arrangements with Waverley Council.	Edge sites for all Units, and York Road	Long-term planning for improved streetscape planting underway	
Establish York Road Bushland as an educational and recreational resource	N/A	Active educational/information program underway: printed information on ESBS available from CP	Small size makes this site vulnerable to increased visitation. Small groups only.
Monitoring and Reporting	N/A	Annual Program to be reported (as per VMP) Copies available as public documents (CP, Waverley Council, NPWS)	Documents should provide basis for 5-yearly review of VMP

5.4 Identifying Needs and Resources

The following have been identified as critical to the management of the ESBS remnant in York Road Bushland and are recommended for adoption are listed in chronological order of priority.

1. Moriah College to provide resources and funding over a period of 5-years within the budget limitations set out at Table 12 to implement Stage 1 of the VMP bushland rehabilitation work in Lot 23 York Road Bushland.

2. During the Stage 1 works, CPMPT may seek supplementary project funding through the National Heritage Trust (or similar) for Stage 1 or the commencement of Stage 2 of the program (years 5-10). The Trust may also seek sponsorship to fund on-going works and educational programs, or will commit resources (where funds are available).

3. Centennial Parklands will nominate a suitably qualified and experienced representative to manage the implementation of the Vegetation Management Plan and to supervise on-ground works and monitoring. Centennial Parklands will provide co-ordination between contractors and CPMPT, and ensure effective implementation of all guidelines and recommendations.

4. Centennial Parklands will provide practical support for general maintenance activities (eg rubbish removal, security, repair of infrastructure, signage).

5. Commitment by Centennial Parklands and all stakeholders to a long-term conservation of the ESBS remnant.

6. Periodic review of progress, assessment of methods and techniques should be carried out (annual Progress Reports with monitoring data to be provided to CPMPT, Moriah College, Waverley Council and NSW NPWS).

7. In keeping with local government policy to review all plans of management for bushland reserves identified as 'community land' on a regular basis (as per Local Government Act 1993), the VMP for the York Road Bushland should be reviewed and revised every 5-years.

6 IMPLEMENTATION

6.1 Policy and Performance

The policies established in this VMP provide a management framework consistent with the site's potential for rehabilitation and restoration (as determined by ecological constraints), the availability of resources necessary for on-ground and related works, and with stakeholder and community expectations.

The priority tasks outlined in Table 8, are subject to the availability of funds to employ trained and experienced bush regenerators, and may require modification should resources be curtailed (or conversely, enhanced).

6.1.1 Review

The VMP for the York Road Bushland is designed to cover a 5-year period (2002-2006) as this timeframe coincides with the funding commitment made to CPMPT by Moriah College. After that time, the VMP should be extensively reviewed, outcomes assessed, and changes made as necessary.

Actions have been identified which extend beyond the initial 5-year period. These have been identified in Table 8.

6.2 Work Priorities

In identifying a sequence of works for the Bushland Rehabilitation Program at York Road, the VMP gives *first priority* to protecting and regenerating those areas of highest species diversity. Work will then address areas of moderate to low species diversity, in descending order. This will be achieved using a 'traditional' bush regeneration approach (see Section 6.4), in combination with a range of experimental techniques designed to maximise the potential of the soil seed bank (see Section 6.4.6). This approach will be set in place for a period of ~ 3 years [23].

Selective supplementary planting will subsequently be carried out in areas of moderate to low diversity, and after these areas have been established, to extending bushland into areas where there are few or no native plant species and no natural regeneration following rehabilitation works (see Section 6.3.1). The need for, and extent of the restoration (planting) program will be determined by quantitative monitoring to assess the results of the combined bush regeneration and experimental programs. A comprehensive review of outcomes, assessed against identified project goals and objectives, is recommended at the end of Year 3 of the Program.

While experimental trials will be the responsibility of an external consultant (at this time, proposed as the University of New South Wales), it is envisaged that the results of those trials will be assessed in relation to the life form of each species regenerating on the site, in particular to species diversity, abundance, and densities.

6.3 Establishing Management Units

In order to identify priority work sites and to provide a staged approach to bushland rehabilitation, the bushland on Lot 23 has been divided into 6 Management Units[24] (see Figure 9). Each of these Units comprises a number of quadrats (see Section 3.3.1) - 20 x 20 metres in size (400 sq metres).

[23] The VMP had originally suggested a 2-year period of bush regeneration to promote natural regeneration prior to considering any planting. However, this period has been extended to 3 years at the request of the BWG.

[24] Excluding remnant bushland on the DOCS site in the first instance.

Management Units have been based on the floristic integrity and structure of vegetation in these quadrats, taken within the context of the bushland remnant remaining on Lot 23 (as determined by previous and recent flora surveys, UBMC 1996a, 2000a & b, 2001) [25].

Management Units are listed for work in *decreasing* order of priority; where Unit #1 has the highest level of (native) species diversity, and Unit #6 has the lowest level of diversity (or natives are absent).

The size of each Management Unit (in sq metres) can been determined by counting the number of quadrats within each Unit. This allows for accurate estimation of costs for on-ground works.

Management Units identified for Lot 23, York Road Bushland are illustrated in Figure 9.

6.3.1 Sequence of Works

The sequence of rehabilitation work in the York Road Bushland has been designed to maximise the potential for natural regeneration from the soil seed bank. By selecting priority work sites where some species diversity is retained, and where densities are moderately high, it is anticipated that some *in situ* regeneration from the soil seed bank will occur. By creating the conditions suitable for the germination and establishment (using a range of techniques), small nuclei of natives will be established in cleared or otherwise degraded areas. Over time, given the right conditions, plants in these nuclei are expected to spread, and in doing so, they will contribute to in-site recruitment.

Sites with less demonstrated potential for *in situ* resilience will possible require replanting (in whole or in part) and it is proposed these areas be treated at any time after more promising sites are regenerated and established.

Priority worksites have been discussed in Section 6.2 and a proposed timetable of works, designed to rehabilitate the bushland on Lot 23 over a 10- year period, is provided in Figure 11.

In preparing work strategies, the recommendations of the Species Impact Statement (UBMC 2000) have been considered, and where appropriate, these have been included in the VMP.

[25] Management Units do not necessarily coincide with the 3 zones identified Figure 10. The former represents areas of floristic diversity, while the latter indicates plant associations within the ESBS.

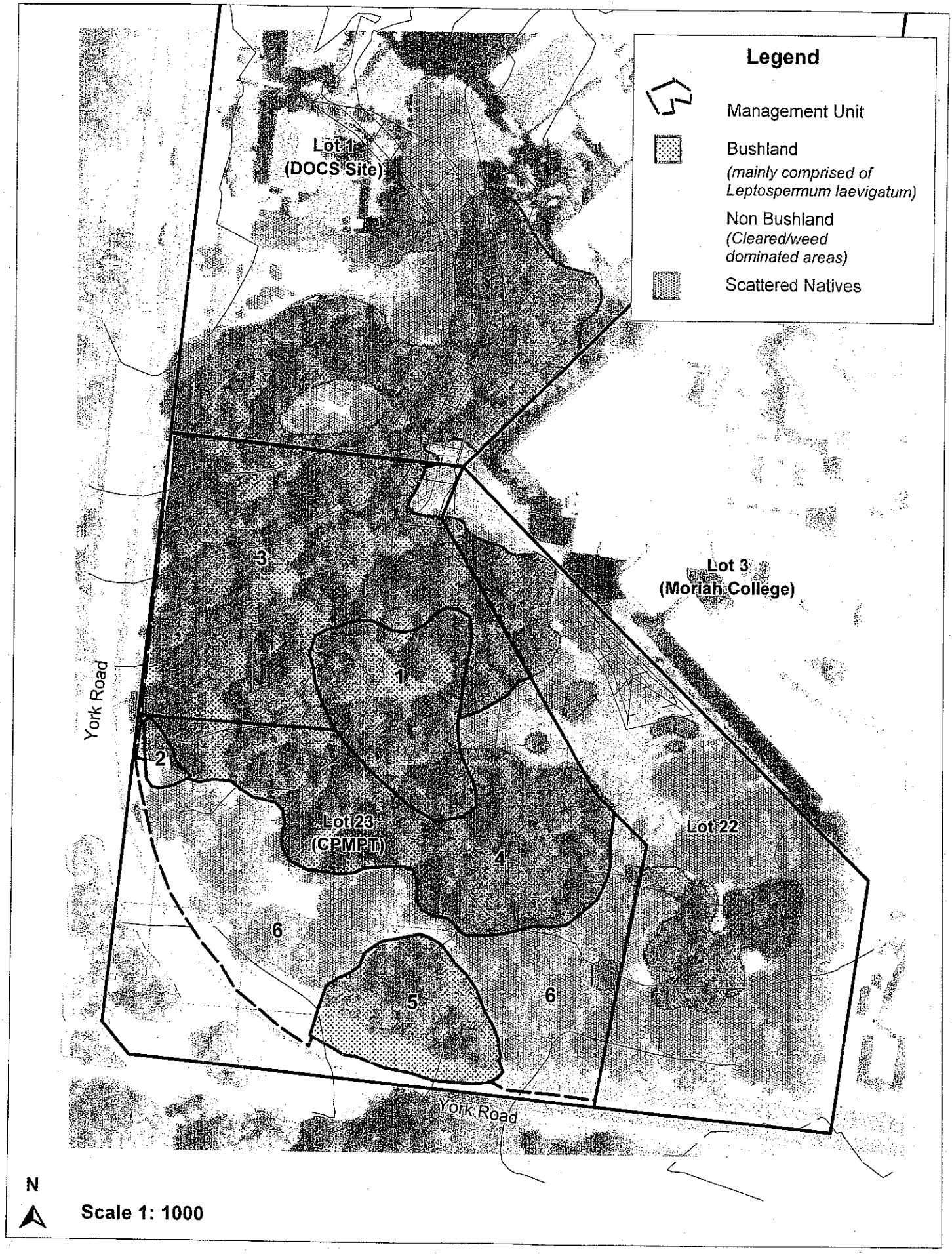

Figure 9
Management Units
York Road Bushland

URBAN BUSHLAND
MANAGEMENT CONSULTANTS PTY LTD

6.4 Rehabilitation Strategies

6.4.1 *Urban Bushland Management*

To be successful in terms of providing the greatest benefit for the least cost, the management of vegetation in the urban landscape - whether it involves contrived (landscaped), semi-natural or natural vegetation - needs to be cognisant of a number of principles which define both *what* can be done, and *how* it is to be done. Such principles are the aesthetic, the functional, the socio-political, and the scientific (Hitchmough 1994).

The bushland remnant on the subject site Lot 23 is surrounded by suburban development and subject to all the pressures that open space parkland in a densely populated area incurs. The challenge for CPMPT is to provide on-going management of this important bushland remnant in accordance with each of the principles listed above.

The information provided below, while generic in nature, is offered as an aid to the effective management of areas of natural vegetation in Centennial Parklands.

Definition of Urban Bushland

> *Urban bushland is land in or adjoining a city or town containing elements of the natural landscape, of which indigenous vegetation is an essential component. The vegetation may not necessarily be restricted to forest or woodland as heath, grassland and other natural plant communities are also valuable components of natural vegetation in urban areas* [26]

This definition, provided by the National Trust of Australia (NSW), applies to the whole bushland ecosystem, which encompasses not only the vegetation, but also to the surface and sub-surface soils, leaf litter, soil seed bed, and any rocks, stones or pebbles.

Urban bushland remnants are generally highly disturbed and degraded by invasion of weeds and introduced plants, by rubbish dumping, runoff from the urban stormwater system, fragmentation and genetic isolation, and by other forms of disturbance.

In order to determine whether a stand of vegetation may be regarded as 'bushland' in accordance with the legal definition provided by *State Environmental Planning Policy No 19* (see Appendix 2), it should exhibit all of the following attributes: These are:

1. Indigenous native species comprise the canopy (i.e. the upper stratum).

2. The understorey stratum (a natural characteristic of the bushland type), and the ground cover stratum, comprise indigenous native species, or if disturbed, will retain sufficient resources (seed or standing biomass) to re-establish those strata when disturbance is arrested or ameliorated.

3. The structure of the vegetation is recognisably a remnant of a natural bushland type, or is a regrowth form that has achieved a near natural structure, or is a seral stage towards that structure. The term 'structure' refers to the height and density of each stratum, and the number and relationship of these strata

6.4.2 *Bush Regeneration*

The most commonly used approach to the rehabilitation of native plant communities (bushland) is Bush Regeneration, which is defined by the Australian Association of Bush Regenerators as "the practice of restoring bushland by focusing on reinstating and reinforcing the system's on-going natural regeneration processes" (no date).

The bush regeneration approach (basically removing weeds and encouraging native plant regeneration from *in situ* seed sources) is suitable only for those sites the soil seed bank is intact,

[26] National Trust of Australia (NSW) Bushland Policy 1986

where native plants occur in sufficient numbers, and where there is adequate species diversity to restore the major structural components of the vegetation community.

Representative species of each stratum – the canopy, mid-storey and understorey – must be present or (potentially) be present in the soil seed bank for natural regeneration to function as the primary rehabilitation process. Such bushland is described as 'structurally intact', and conforms to the definition provided by *SEPP-19*. Regeneration of the native plant community from existing seed sources cannot occur where the potential for regeneration (site resilience) is absent.

The Bush Regeneration approach incorporates a number of methodologies, or strategies – the most commonly used are:

1. *Natural Regeneration* – which consists of removing weeds using a mixture of hand weeding methods and the use of selective herbicides, and caring for the native seedlings that subsequently colonise the site.

2. *Assisted Natural Regeneration* – which combines traditional bush regeneration methods (eg. weeding) with seed collection, propagation and planting of locally indigenous tubestock to supplement natural (unassisted) regeneration.

3. *Restoration or Reconstruction* – which is used where a native plant community has been completely lost, but where the biophysical attributes of the site (eg. soil type, soil nutrient status, hydrological regime) are still within levels which remain tolerable by the original plant community. Reconstruction techniques revolve around the planting of locally indigenous species in the proportions, range and densities similar to those present in the original plant community [27].

4. *Fabrication* – which is used where the original native plant community is no longer present, and where the site's biophysical attributes have changed to the point where the original plant community cannot be reconstructed or recreated (i.e. where site conditions have changed so dramatically that simply replanting with local native species is impractical). Fabrication of a new plant community will necessarily take place over a long period of time (up to and possibly greater than 10-years). The time frame required for fabrication will depend heavily on the feasibility of ameliorating site impacts and of course, on the resources available for on-ground works.

6.4.3 Selecting the Right Bush Regeneration Strategy

At the York Road Bushland, there are some small areas of moderate species diversity where the traditional bush regeneration approach (*natural regeneration*) would be applicable, but there are other, much larger areas with only a few native species remaining *in situ* where a combination of weeding and supplementary planting with local native species (*assisted natural regeneration*) will enhance the bushland rehabilitation process.

However, many parts of the remnant are highly simplified and/or badly degraded. Wholesale weed removal would effectively denude the site, leaving the soils open to erosion and reinfestation by weeds. If the large trees and weed thickets were removed *in toto*, well over 70% of the vegetation cover will be removed. If the conservative regeneration approach in these areas fails to provide adequate vegetation cover and recover species diversity within a reasonable timeframe, then extensive planting (*reconstruction*) with locally indigenous species, will be required.

In chronically degraded sites, such as mullock heaps and fill soil batters (eg on the northern boundary with Lot 22, existing soil conditions may preclude duplication of the pre-disturbance plant community – even by replanting with local species. In such areas, it may be necessary to plant species which are better able to tolerate these introduced soils (*fabrication*).

[27] Note that 'restoration' or 'reconstruction' (meaning planting to reintroduce species) is described as 're-instatement' by the ANHC (2002). The Charter also describes the bush regeneration process *in toto* as 'restoration'.

No matter what approach is used, it is essential that adequate resources be set aside for a considerable period of time to allow for follow-up and maintenance weeding and replacement of lost plants. Although each bushland remnant will respond differently in some degree, a period of at least 5 years will be required to re-establish the basic community structure and to enhance species abundance and richness. Possibly some pre-disturbance ecological processes (eg *in situ* recruitment, successional changes) will begin to occur without human interference within this timeframe. Thereafter, the remnant will require a period of intensive maintenance to maintain the bushland free of competitive weeds, and to ensure that these processes continue. A bush regeneration program of not less than 10-years in duration is proposed.

Therefore, with due consideration of the limited resources available to CPMPT for revegetation rehabilitation and future management, it is recommended that those Management Units with a higher species diversity be given priority in the short-term (see Figures 10). In cleared or degraded areas which fail to respond to a range of management strategies after a period of 3 years, planting using local native species has been recommended.

A staged, strategic works program, which addresses the rehabilitation of the remnant on a site-by-site basis, is preferred to a wide-ranging weed control program which removes standing weedy vegetation, but exposes the soil to erosion by over-clearing, and fails to replace vegetation cover by stimulating natural regeneration or planting.

Although a strategic, staged approach is recommended as a broad or 'umbrella' rehabilitation strategy, it is also essential to understand that 'target weeding' to eradicate aggressive keystone weeds in all sites must be one of the first tasks completed. Early weeding of keystone weeds will remove direct and urgent threats to native plants that occur, especially new seedlings. The need for and extent of target weeding within the rehabilitation site should be identified at the commencement of works, and reviewed at the start of each working year.

Ten keystone weeds have been identified for priority work in the York Road Bushland. These are listed in Table 9.

6.4.4 *Identifying Priority Weeding Tasks*

Keystone Weeds

Some introduced species pose serious and immediate threats to bushland areas. These are called 'keystone weeds' or 'primary target weeds', and they must be given priority in any bush regeneration program. A keystone weed may have a legal designation as a 'noxious plant' (*Noxious Weeds Act 1993*), or the species may be recognised as an 'environmental weed' in the local area - that is, a plant which naturalises readily in native bushland to the detriment of the native flora.

Commonly occurring keystone weeds in Sydney bushland include wood weeds such as Privet, *Lantana,* Bitou Bush (*Chrysanthemoides monilifera*), and African Olive" vines and scramblers such as: Ground Asparagus, Morning Glory (*Ipomoea indica*), and Turkey Rhubarb (*Acetosa sagittate*): succulent ground covers such as Wandering Jew, and perennial herbs such as African Love Grass (*Eragrostis curvula),* and some of the common turf grasses – Kikuyu (*Pennisetum clandestinum*) and Buffalo (*Stenopatorum secundatum*).

Because of their propensity to spread rapidly and affect water quality and habitat for aquatic fauna, water weeds such as *Ludwigia peruviana* (Cape Primrose), *Salvinia molesta*, and *Alternanthera philoxeroides* (Alligator Weed) are always designed as 'keystone' weeds. Although waterweeds occur in nearby Centennial Parklands, they are absent from the subject site.

Secondary Weeds

Not all weeds constitute a threat to the plant communities that they invade. Some annual weeds or herbaceous perennials may be naturalised in the plant community, and most are hardy pioneer species that establish in the early stages of recovery (succession). They are usually short-lived, and although they produce a copious amount of seed, these pioneering species will not survive once a shading canopy is re-established.

Because they are highly visible, often grow in dense thickets, and give an 'untidy' appearance to a rehabilitation site, secondary weeds are often targeted first – unfortunately to little benefit as they quickly recolonise the bare soil sites created by weeding. Unless unlimited resources are available, secondary weeds do not warrant early treatment in the weeding schedule, as there are other, far more environmentally damaging weeds to contend with in the first instance.

Introduced species, which pose a lesser threat to the viability of the plant community in the long-term, are designated as 'secondary target weeds'. Commonly occurring species include Fleabane *(Conyza* spp), Flatweed *(Hypochoeris radicata)*, Cobbler's Pegs *(Bidens pilosa)*, Pigeon Grasses (*Setaria* spp), and Purpletop *(Verbena bonariensis)*.

Table 9: Keystone Weeds the York Road Bushland

Botanic Name	Common Name	Status / Comment
Woody Weeds		
Cestrum parqui	Green Cestrum	W2 Noxious Weed
Lantana camara	Lantana	W2 Noxious Weed
Ligustrum lucidum	Large-leaved Privet	Noxious in other regional LGAs
Olea europa var. *africana*	African Olive	Small numbers, but invasive
Herbaceous Weeds		
Cortaderia selloana	Pampas Grass	W2 Noxious Weed
Nephrolepis cordifolia	Fishbone Fern	Small area, eradication possible
Parietaria judaica	Sticky or Asthma Weed	W2 Noxious Weed
Protasparagus aethiopicus	Ground or Fern Asparagus	Scattered throughout
Vines/Scramblers		
Acetosa sagittata	Turkey Rhubarb	Mostly in rubble & fill soils, large underground tubers
Anredera cordifolia	Madeira Vine	Very invasive, with underground and aerial tubers (persistent)
Ipomoea indica	Morning Glory Vine	Small area, but spreading rapidly through canopy at boundary of Lots 22 & 23.
Lonicera japonica	Japanese Honeysuckle	Small area, potential to eradicate
Tradescantia fluminensis	Wandering Jew	Small area, eradicate possible

6.4.5 Weed Control Methods

There are numerous methods used to successfully control weeds on private and public lands, but in remnant bushland areas, Bush Regeneration - which includes hand weeding, the careful use of selective herbicides, mulching and replanting - has become accepted practice. However, the use of machinery to scalp weedy topsoil, broad-scale application of herbicides (boom or aerial spraying), regular slashing or grazing, or the use of fire may be more appropriate on cleared or badly degraded land, or in rural situations. The most commonly used methods of weed control are discussed below.

Hand Weeding

Hand weeding is the preferred method for removal of herbaceous weeds growing among native plants and for removing woody weed seedlings (generally < 0.5 metres in height). Hand weeding methods can also be used to control/remove succulent ground covers such as Wandering Jew (rake and pile), White Moth Plant (hand pull roots), and exotic vines and scramblers such as Ground Asparagus, Balloon Vine and Morning Glory (dig out roots, tubers, corms).

Hand weeding is ineffective and/or uneconomical when dealing with dense weed infestations; on sites where no native plants are present; where weed thickets grow on fill or compacted soils, or for removing mature woody weeds. As hand weeding is highly labour intensive, it is not practical to use this approach on large areas, or to control dense weed infestations which could more easily (and economically) be treated using other means.

Hand weeding is recommended for control of small woody weeds and herbaceous weeds. Hand weeding will be standard methodology in the York Road Bushland, particularly in areas where natural regeneration is occurring and native seedlings must be protected. In some areas, hand weeding may be used in conjunction with other bush regeneration techniques such as the careful application of selective herbicides.

Chemical Control (Herbicides)

Woody weeds (eg. Privet, Ochna, Lantana, Blackberry) are difficult to control without the use of herbicide to achieve rootstock kill. Woody weeds have considerable regenerative potential in their fleshy tap and lateral roots, and even small portions of root dislodged or damaged will regenerate into new plants. For example, Tree of Heaven is notorious for its ability to sucker profusely up to 30 metres away from the parent plant if it is cut without poisoning the rootstock.

Herbicide may be applied to woody weeds via the 'cut-stump and poison' method (using loppers or a chainsaw to remove the top portion of the plant), via the 'tree injection' method (using chisel and mallet or a special tree injection gun), or via the stem-scrape and poison method (suitable for young plants with thin, smooth bark).

Given the relatively small size of the work site, and the ease of access for disposal of weed debris, the cut-stump and poison technique is recommended as a quick and economical way to control the majority of woody weeds present. Debris may be removed from the site for disposal at a landfill site, or stacked in situ for burning, provided that this does not in itself create a fire hazard. If pile burns are fired on a regular basis, the efficiency of the cut-stump method is greatly increased, as the natural regeneration of native species will be promoted.

In order to eradicate medium-sized woody weeds (eg sapling Pines or Privet) tree injection is by far the most effective and economical method of applying herbicide (systemic injection). There is no weed debris generated and after plant death, new plants may be placed between the dead plants. The dead weeds will provide some protection from weather the effects of heavy rain on both plants and topsoil. When compared to the time required to systematically dig out a single Privet, (30-35 hours) a single operator with a tree injection gun can treat up to 500 trees within the same time frame.

Similarly, scraping the stem and painting herbicide (or frilling) woody weeds saplings is both effective and economical, but will only work well on young woody weeds with a thin bark (eg Green Cestrum, Ochna) or on thick-stemmed vines (eg Madeira Vine, Honeysuckle).

At York Road, tree injection has limited applications, and will necessarily be confined to tree saplings and/or suckers. The large number of mature ornamental trees (> 150 individuals) planted into the site must be removed by a qualified tree surgeon. Although drilling and poisoning in situ will kill these trees over time, there is a significant public risk in leaving standing dead timber in public areas.

Foliar spraying is most frequently used to control herbaceous weeds and woody weed seedlings (eg. regrowth after clearing). It is also the preferred method of controlling weed thickets (Blackberry, Lantana) in open areas where not native plants occur. Foliar spraying is generally not advisable in bushland where native plants grow in close proximity to native species and are therefore likely to be damaged by spray drift or spillage. However, spraying grassy weeds or ground covers where no native plants occur, degraded edge sites or mounds of fill colonised by herbaceous weeds can be successful and very cost effective if carried out by a skilled operator.

There use of herbicide as a foliar spray to control extended areas of introduced grass and for isolated or discrete weed infestations where no native plants occur is strongly recommended. In weedy areas where only a few native plants occur, and the best use of resources indicates a foliar spray, natives can be protected by first hand clearing to create a small buffer zone and/or inverting a protective cover (bucket or plastic bag) over the plant before spraying.

Alternately, a selective herbicide can be used to target problem weeds, rather than using a general non-selective herbicide such as glyphosate (marketed as Roundup^{R} or Glyphosate 340^{R}). Fusilade may be used to control weed grasses without damaging native woody species, while Brushoff and Grazon can be used on a range of woody weeds (as listed on product label) without damaging monocots (grasses and flowering forbs).

Mowing and Slashing

Both methods remove the bulk (biomass) of the weed infestation and have the additional benefit of removing seed heads and reducing seed dispersal. However, both easy access and suitable topography (flat or gently undulating land) are essential ingredients for success. Slashing can also be useful in controlling young woody weed growth, provided that regular work is carried out in the growing season. Slashing as a method of weed control presents some problems, including the dispersal of weed seeds on machinery, and (generally) irregular application, which allows weeds to set seed and disperse before they are cut.

Because of the uneven topography, and difficulty of access, mechanical slashing is not appropriate. However, mowing turf or weed grasses on adjacent land using a whipper snipper or lawn mower may be appropriate depending on the maintenance program established on these neighbouring lands. Grass clippings should never be dumped into the bushland, or stored in the buffer zone.

Mechanical Removal

Mechanical removal of weeds is dependent on vehicular access and on flat or undulating topography where machinery can be used safely and effectively. This approach involves scraping or 'scalping' the weeds and weedy topsoil and is useful in treating chronically degraded areas. Scalping has particular application on fill soils where there is no opportunity for native plant regeneration. Weeds should be sprayed with herbicide before scalping.

Mechanical removal of weeds is unsuitable for already unstable areas such as creekbanks or steeply sloping land. It is also unsuitable for use on loose sandy soils where wind or water erosion could result after removal of protective vegetation. Gross disturbance of the soil profile by machinery will also promote invasion by opportunistic weeds. The disposal of the weeds and soil may also prove to be expensive.

Scalping could be used successfully to remove the weedy 'mullock heaps' and possibly to scrape some of the fill and other debris from parts of the northern boundary. However, access will be a problem, so that the decision to scalp will need to be made on a site-by-site basis.

Fire as a Management Tool

The use of fire to control weeds continues to be widely used, particularly in rural areas. This method of weed control can also be very useful in remnant urban bushland, provided that permission can be obtained from the relevant authorities (Environment Protection Authority, Council) and resources are available to allow for intensive follow-up treatment.

Many woody weeds re-sprout rapidly from rootstock after fire, often coppicing densely (Lantana, Gorse, Privet, Tree of Heaven). Herbaceous species (including many grasses), respond in a similar way, regenerating from growth buds on a network of robust underground rhizomes (Pampas Grass, Bamboo, Kikuyu Grass). Weed seed germination is usually prolific after fire, a response that necessitates prompt control measures, on-going monitoring and site maintenance (Gorse, Broom).

In bushland, burning may be used to stimulate native plant seeds in the soil. *Casuarina* (She-oaks), some Eucalypts, Wattles (*Acacia* spp.) and members of the pea family (Fabaceae) respond well to regeneration burns. However, the burnt area will also be open to weed invasion and must be carefully monitored. As with all weed control methods, follow-up control is essential.

If fire is used *prima facie* for weed control, pre-treatment of woody weeds will be necessary. Prior to prescription burning, mature woody weeds in the target areas should be treated to ensure infestations are root dead at time of burning. Chemical treatment of woody weeds may involve cutting and poisoning the stump (cut-stump), tree injection or spraying with an appropriate herbicide. Herbaceous weeds should be treated using a foliar spray.

Herbicide treatment should be carried out at least 6 weeks prior to the burn to ensure that the chemical has penetrated into the root system, achieved a total kill of all tissue, and the plant has had time to desiccate prior to burning. This will maximise removal of weed biomass during the burn. Disturbance of the treated weed (by mechanical means or burning) within this period may reduce the chemical's effectiveness, and regeneration from rootstock is likely to occur.

Following a prescription burn, a flush of weed seedlings can be expected on the exposed soil. It is essential to treat seedlings (either manually or using a foliar spray) before native plant seeds germinate.

As a rule of thumb, herbaceous (and some woody) weeds germinate rapidly in high light situations, so that it may be possible to treat the flush of weeds before any native seeds germinate. However, once native seeds have germinated, control options are reduced to careful spot spraying (using a protective cone nozzle sprayer) or hand weeding.

Woody weeds regenerating from rootstock must also be treated promptly. Re-cutting the stump and poisoning, drilling into the bole (junction of stem and root), or spraying new leaves when they reach approximately 0.5 metres in height is recommended.

Prior to and during the early years of European settlement, the Eastern Suburbs Banksia Scrub is likely to have experienced relatively frequent burning, and it is emphasised that most species characteristic of the ESBS have a range of mechanisms to promote regeneration following fire.

Burning is potentially a very useful strategy to promote regeneration at York Road but there are a number of contraindications. These include the need for a 'hot burn' (versus a cooler winter burn) to stimulate native seed, the lack of ground fuel, the danger of burning a highly flammable vegetation type (especially Teatree) close to developed areas. However, it may be possible to organise pile burns, using weed debris and dead Teatree as fuel, provided that these burns are strictly controlled.

Nevertheless, it is doubtful if such pile burns could achieve the high temperatures needed to stimulate members of the Epacridaceae or Fabaceae, although the Acacia and Leptospermum are expected to respond well. Spot burns are proposed as experimental strategies, however, it is worth noting that there was no evidence of any native seed germination following several small fires observed to have been set recently in the bushland.

Weed Matting and Mulches

Mulches and bush litter, provided that they are sourced from weed-free areas, are helpful in re-establishing native vegetation after planting. Mulching will be most appropriate in those areas where bush landscaping is used to replicate the native plant community (Bushcare sites), and where exotic gardens (encroachments) are removed as part of the bush rehabilitation program.

Mulches will be used to assist the planting program (see Section 6.6.2), and possibly in those areas where no native regeneration is anticipated (eg. fill soils). If large areas are denuded by weed clearance, it may be appropriate to use a 'living mulch' (nurse crop or annual grass) to hold the soil together prior to planting.

Biological Control

The Biological Control Unit of NSW Agriculture has developed, or is in the process of developing, a number of new bio-control programs. Most programs target weeds of agriculture or forestry and only occasionally does a bio-control program developed for the agricultural arena cross over into the environmental one.

Bio-control programs are underway for 'dual purpose' weeds such as Bitou Bush/Boneseed, Blackberry, Lantana, Broom, Alligator Weed and Bridal Creeper (*Myrsiphyllum asparagoides*) - all species are weeds of agriculture/forestry but are also destructive invaders of native bushland.

Biological controls are possibly not appropriate at this time as there are few species that would benefit from such an approach. The Lantana Beetle will not thrive in the Sydney climate and the small amount of Blackberry present can more easily be removed by digging and/or foliar applications of herbicide.

6.4.6 Experimental Works Proposed

The potential for *in situ* restoration (site resilience) at York Road is generally unknown; although there is some evidence which suggests that such opportunities are limited (Lesak 2000). In order to test this hypothesis, and to identify the most cost-efficient approach to bushland rehabilitation, a series of experimental trials is proposed. Trials are proposed over a period of 2-3 years.

The VMP recommends that the BWG and CPMPT invite biological science students from the University of New South Wales to design, implement and monitor a range of experimental strategies to test *in situ* site resilience and to encourage natural regeneration. Students from this institution have for some years been involved in testing resilience in other ESBS remnants (Lesak 2000). Funding provided by Moriah College will support expansion of the University's current research program (see Section 7)

It is proposed to test *in situ* resilience through a series of germination trials carried out in glasshouse trials, followed by extensive field trials. In the field, trials will identify suitable method stimulate germination of remaining seed in the soil seed bank. It is anticipated that treatments will include the use of fire (pile burns), smoke water, soil scarification, scraping to remove leaf litter, and promoting a change in light levels by culling dead plants and creating 'windows' or gaps in the scrub canopy.

Experimental design will be the responsibility of the research laboratory at UNSW and will be reviewed by the members of the BWG. It is anticipated that the bush regeneration contractor employed by Centennial Parkland to implement the VMP will assist the University in setting up and monitoring these trials.

6.5 Revegetation Strategies and Restoration Planning

6.5.1 *Assumptions About the Original Plant Community - Implications for Site Rehabilitation*

The existing vegetation has been said to relate to Benson & Howell's (1994) '*Monotoca elliptica-Banksia integrifolia-Leptospermum laevigatum* Open Scrub' (UBMC 1996a). This is stated to occur on Holocene Sands and is typically a plant community of fairly low floristic diversity. From the species that are indicated to be representative (NSW Scientific Committee, Final Determination 23 August 2002), it appears that the example given above is a maritime variant, and may not strictly apply to the bushland on the subject site Lot 23.

Some of the species present in the York Road Bushland are more usually associated with sandstone or shale-derived soils (eg Bearded Heath (*Leucopogon juniperinus*), Kidney Weed (*Dichondra repens*), and Necklace Fern (*Asplenium flabellifolium*) although their presence may simply reflect the greater distance from the coast, and proximity to other geology units. Hawkesbury Sandstone geology occurs about 900 metres north north-west of the site (Chapman & Murphy, 1984).

Other species are likely to have occurred at the York Road site prior to clearing and on-going disturbance. These species include: Rice Flower (*Pimelea linifolia*) (Benson & Howell, 1994), Sydney Red Gum (*Angophora costata*), Banksia (*Banksia aemula*), Bracken (*Pteridium esculentum*), and Woody Pear (*Xylomelum pyriforme*) (Chapman & Murphy, 1984).

However, previous surveys (UBMC 1996a, 2000a, 2000b) have not recorded these species within the site. It has been concluded that the existing structure and floristics of the native vegetation at Lot 23 have been highly modified from the natural condition.

Coastal Teatree communities appear to be generally related to long periods of fire exclusion (Benson & Howell 1994; NSW Scientific Committee 1998). For species that demand high levels of sunlight to survive, including many that occur within the subject site, it can be assumed that the York Road Bushland was previously affected by periodic fire that removed dense canopy species including stands of Coastal Teatree and Coastal Banksia.

It would be useful to re-establish such a fire regime in the bushland remnant, for both ecological and management purposes. In the event that this is not possible, it will be necessary to periodically control some species (via culling) that would otherwise cause the demise of others that comprise the greatest species diversity on site.

Owing to the genetic isolation and small size of the York Road Bushland, and changes to some of the natural processes such as the fire regime, this bushland remnant can no longer be considered to be a fully functioning ecosystem. This will not to be completely rectified by restoration work (i.e. planting), so that management strategies must be set in place to ensure that a balance is maintained between robust, generalist species (such as Coastal Teatree) and others that have specialised niche requirements.

Based on the above assumptions and conclusions, it is recommended that:

1. Existing floristic diversity be retained and enhanced by dividing the site into 3 management zones or sub-communities that conserve these separate and partly incompatible elements of the vegetation. The division of the site into these 3 zones (see Section 6.5.2) is based on the current distribution of the main occurrences of each of these elements (UBMC, 2001 – quadrat survey), and the need to avoid shading of small species by trees.
2. Bushland rehabilitation should largely comprise weed control, rubbish removal and (where appropriate) the planting of suitable species. The majority of species to be planted will generally be those recorded on-site. However, a small number of species from nearby areas are recommended to be planted, as their continued survival is

threatened in the local area and they are likely to have occurred in the York Road site previously.

Species considered to have once been present but now absent from the area include: Wallum Banksia (*Banksia aemula*), Bordered Panic (*Entolasia marginata*), Pomax (*Pomax umbellata*), Sword-sedge (*Lepidosperma concavum*) from the Bird Sanctuary at Centennial Park; Woody Pear (*Xylomelum pyriforme*) from Brigidine College, and Bracken Fern (*Pteridium esculentum*).

Any locally indigenous species that are re-introduced (or re-instated) into the site should be fully documented (including location on a site map) and only small numbers of these should be planted.

6.5.2 Zonation Within the Remnant

The York Road VMP incorporates different zones or plant associations that are defined by expected (future) soil moisture levels. Proposed works for each of these zones have been identified. These include bush regeneration, target weeding, and experimental work to determine the status of the soil seed bank, minor erosion control works, and revegetation.

Planting strategies are designed to achieve a representative and naturalistic zonation (albeit somewhat simplified). These are described for each zone / plant association. Zonation within the remnant is shown on Figure 10.

Zone 1 - Low Heath and Shrubland

Low shrubs and ground covers dominate this zone. There are groups of taller shrubs (mostly Coastal Teatree) throughout the zone. Tree cover is absent to sparse. The planting plan should aim to duplicate this association, using similar species and planting at similar densities and spacing. Coastal Tea Tree may need to be culled periodically in order to prevent loss of smaller-growing species by over-shading

As much of the existing Teatree shrubbery is senescent and collapsing, dead and dying plants should be culled or lopped where they threaten the viability of lower-growing shrubs (including parts of Quadrats 7, 8, 9a, 11, 12, 13, 14). A similar hardy pioneer species – White Tick Bush (*Kunzea ambigua*) - may be planted into the site, but it should be used only in areas of low species diversity in order to avoid a similar shading effect, thereby inhibiting the establishment of lower-growing shrubs and ground covers.

Rehabilitation through planting for Zone 1 is intended to recreate a mosaic of relatively diverse, low-growing species, with smaller areas of Coastal Teatree scrub.

Zone 2 – Woodland

This zone contains more trees than the others, and is dominated by Bangalay (*Eucalyptus botryoides*) and Coastal Banksia with a variable understorey and some ground covers. Again, the planting plan should aim to duplicate a woodland structure, with attention paid to retaining an open canopy to encourage the establishment of small shrubs and ground covers.

The understorey in Zone 2 should comprise a similar plant community to that existing and recreated in Zone 3 (Scrub), i.e. Teatree scrub with smaller areas of lower-growing heath vegetation. Coastal Tea Tree may need to be culled periodically in order to prevent loss of smaller-growing species by over-shading. Open locations that are likely to convert to scrub if left unchecked, should be planted with compatible species (i.e. shade-tolerant and/or tall-growing species) or left unplanted.

Zone 3 – Scrub

Coastal Teatree also dominates this zone. As a result, there is little in the way of understorey due to the dense shade cast by the tall shrub thickets. This zone should be planted with Coastal Teatree (although it is anticipated that this species will regenerate of its own accord). A range of more diverse plantings should be placed into the larger gaps. Gaps should be treated as described for the Zone 2 scrub understorey.

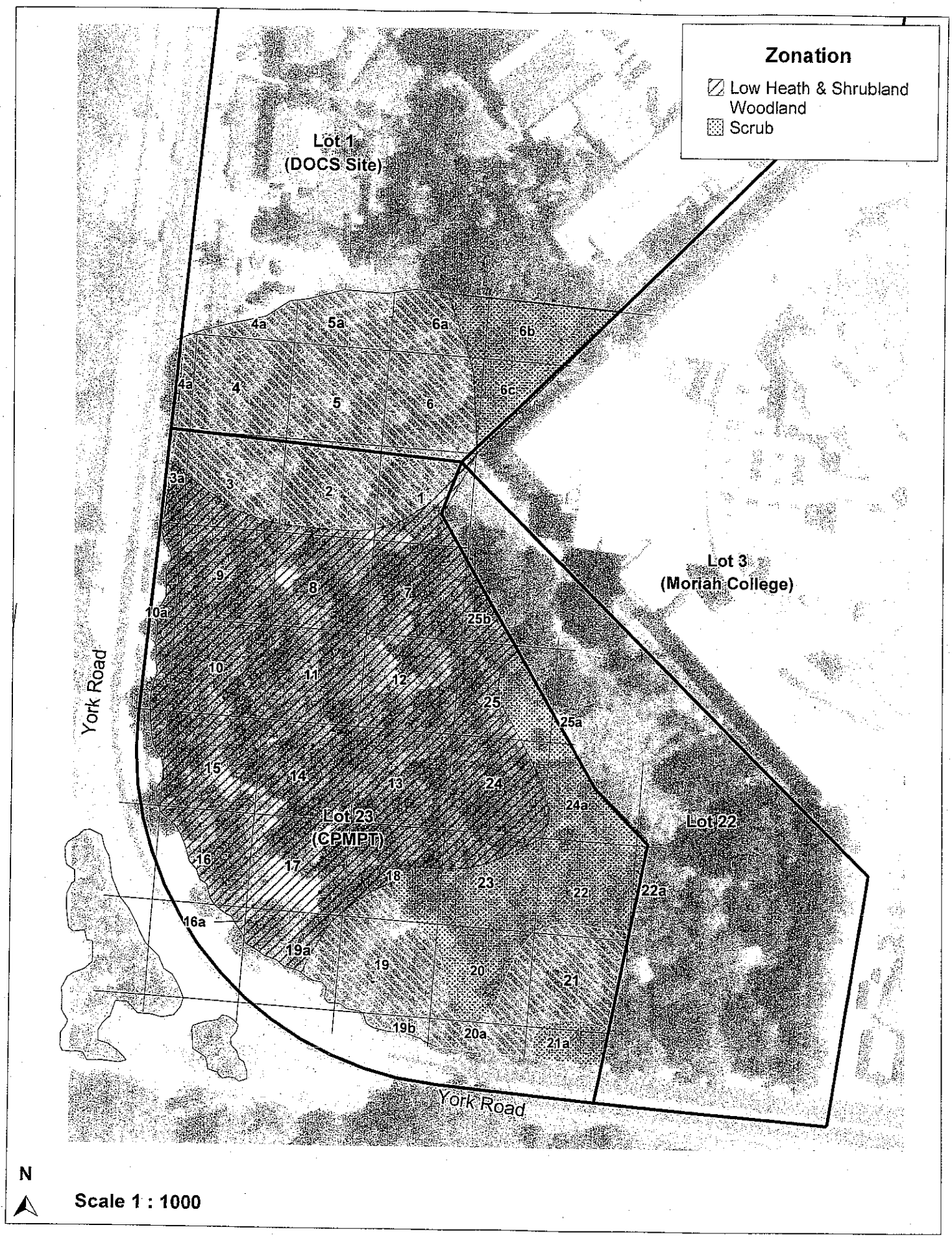

Figure 10
Zonation within the Remnant

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6.5.3 Floristics – Selection of Appropriate Species

A number of characteristic ESBS species have been recommended for planting in each of the 3 zones or sub-communities identified in the VMP (see Figure 10). Species have been selected on a number of criteria. These criteria require the species selected to be:

- Representative of ESBS as described in the NSW Scientific Committee's previous Final (June 1997) and new Final Determination (23 August 2002).
- Representative (as site conditions allow) of pre-disturbance site floristics;
- Useful for the creation of fauna habitat (shelter and food sources);
- Readily available from local seed sources (i.e. within a 5-kilometre radius);
- Easy to propagate and establish; and
- Require a low level of maintenance.

Species that are difficult to propagate, slow to establish and grow to maturity, or occur in the region as rare or threatened plants have not been recommended. Species with special habitat requirements and which should only be planted after a shading canopy has been established (eg 3-5-years) are noted in the recommended list.

Wherever possible, plant propagules should be collected from bushland within the Eastern Suburbs, although it is recognised that suitable seed sources do not occur within a 10-kilometre radius of the site (see Figure 7). Some species will be difficult to obtain, however, small amounts may be collected from known conservation reserves (under Licence from NPWS) and propagated in order to increase the diversity of species and broaden the genetic base at York Road. This action will also help to prevent currently inadequately represented (or absent) species becoming extinct.

A few species have been recommended for planting even though they have not been recorded on site. These species occur in nearby locations and could be expected to have previously occurred naturally in the subject site. They are also under threat of extinction in the local area.

Indigenous species recommended for restoration of ESBS in the York Road Bushland are listed in Table 10. It is not anticipated that all of the species listed will be used. Some species may be unavailable, or their provenance may not be acceptable. It may also be difficult to obtain sufficient quantities of local seed, plants may fail due to seasonal conditions, or some species used may not perform as anticipated. A wide range of species has therefore been selected in order to provide a range of choice.

Table 10: Recommended Species for Restoration Planting at Lot 23, York Road

Trees	Zone 1	Zone 2	Zone 3
Banksia integrifolia	NIL	O	O
Banksia serrata	C	C	O
Eucalyptus botryoides	R	C	R
Pittosporum undulatum	NIL	NIL	NIL
Xylomelum pyriforme #	R	R	NIL
Shrubs			
Acacia longifolia	V	V	V
Acacia suaveolens	O	R	NIL
Acacia ulicifolia	C	C	R
Astroloma pinifolium	O	NIL	NIL
Bossiaea heterophylla	O	NIL	NIL
Bossiaea scolopendria	O	NIL	NIL
Brachyloma daphnoides	V	O	NIL
Dillwynia retorta	C	O	NIL
Kunzea ambigua	O	C	V
Leptospermum laevigatum	NIL	NIL	NIL
Leucopogon juniperinus	C	V	O
Micrantheum ericoides	V	C	R
Monotoca elliptica	C	C	O
Persoonia lanceolata	R	R	NIL
Ground Covers			
Ferns			
Asplenium flabellifolium	NIL	NIL	R
Cheilanthes sieberi	NIL	NIL	NIL
Pteridium esculentum #	O	O	O
Angiosperms			
Commelina cyanea	R	O	O
Cyathochaeta diandra	O	R	R
Dianella revoluta	C	C	O
Dichelachne crinita	V	O	R
Dichondra repens	NIL	R	O
Entolasia marginata #	O	O	O
Isolepis nodosa	C	C	C
Lepidospermum ?concavum #	O	O	R
Lomandra glauca	O	NIL	NIL
Lomandra longifolia	C	C	C
Microlaena stipoides #	R	O	C
Pomax umbellata	R	NIL	NIL
Themeda australis	O	R	NIL

KEY

indicative frequency of planting

v = very common

c = common

o = occasional

r = rare

= species not recorded on site but within 5 km radius

6.5.4 Seed Collection

Collection Sites

In order to retain genetic integrity in planting, it will be necessary to collect indigenous seed and other propagative material from the site itself and from other remnant bushland areas within a 10-kilometre radius of the subject site (see Figure 7). Collection sites have been identified through examination of aerial photographs and maps, and verified by ground searches and through local knowledge. In particular, Botany Bay National Park offers opportunities for seed collection, as do some of the larger remnants listed.

Seed may also be collected from Lot 22 prior to clearing and other plant material salvaged as appropriate (see Section 6.5.1).

Seed Collection Guidelines

Seed collection, processing and storage should follow the Flora Bank Seed Collection Guidelines (National Heritage Trust / Bushcare /Greening Australia 2002). [28] Guidelines developed by UBMC (1990) are similar in nature to the Flora Bank document, and are appropriate for use in the urban bushland situation. This document - *A General Guide to Indigenous Restoration - Collecting, Processing and Storing Native Plant Seed* - have been included as Appendix 8.

Permits and Licences

Prior to undertaking any bushland rehabilitation activities, the landowner (Centennial Parklands) must seek permission to work in the endangered ecological community from the NPWS in the form of a Section 91 Licence. This Licence allows an individual or body 'to harm or pick a threatened species, population or ecological community, or to 'damage habitat'.

Because weed clearance and other activities associated with bush regeneration are considered by the Service to constitute 'habitat disturbance', Centennial Parklands must obtain a Section 91 licence for bushland rehabilitation work in the York Road Bushland. It is understood that the licence application has been made.

6.5.5 Site Preparation - Determining Site Characteristics

Soil Conditions

The success of any planting program is largely dictated by site conditions, and particularly the structure and chemical composition of the site soils. Prior to planting, a series of basic soil tests should be carried out. Soil tests must be carried out by a reputable chemical laboratory and should comprise:

- Emerson Aggregate Test (clay fill soils only)
- Available phosphorus (not total P)
- Soil pH
- Soil salinity
- Soil texture
- Cation Exchange capacity, especially Aluminium, Sodium, Magnesium, Calcium and Potassium

Results must be interpreted by a professional soil scientist, keeping in mind that the soil chemistry and structural traits required for plant establishment are different to those required for construction or other development activities (eg residential). Soil tests for the latter usually focus on the presence of soil contaminants (heavy metals, organophosphates etc), and do not consider the interaction between soil pH, soil moisture and nutrient availability, or soil texture.

[28] www.florabank.org.au

Indicative costs at time of writing are about $120/sample, plus GST. Enough samples should be taken to provide a clear picture of soil conditions across the site. Should results indicate that soil remediation is required to sustain vegetation; this should be carried out prior to sign-off. Should the soil prove unsuitable for revegetation purposes in some way, weed free topsoil (or a sterile re-constituted soil product) should be incorporated – despite objections from stakeholders who may not fully understand the fundamental role that the growing medium plays in the restoration program.

Soil depth, site drainage (overland flow and sub-surface drainage as it related to the re-contoured landform must also be identified and if necessary, adjusted before sign-off. If fill has been used, the nature and type of the underlying substrate must be made known.

Despite the costs involved of carrying out basic soil tests on each of the sites recommended for planting, the whole program could fail if the substrate is unsuitable for revegetation. Therefore these tests are considered to be fundamental to the restoration strategy.

Site Hydrology

There is no running water or ponded water anywhere on the site, but the slope of the land from the higher ground (north-east to south-west) results in surface runoff in heavy rain events. Observation during and after heavy rains shows that water scour occurs across the slopes and there is accelerated erosion on some of the steeper walking tracks.

The choice of planting sites must take this runoff pattern into account and unless site hydrology can be modified, obvious runoff channels should be avoided.

Similarly, if some areas are known to become boggy after extended rain, or to otherwise retain water, then these should be planted only with moisture tolerant species. There are several locations in Lot 23 where sedges such as *Juncus* sp. are found, suggesting (possibly) low-level runoff from surrounding higher ground. These sites are seen as 'micro-habitats' and should be planted accordingly.

6.6 Planting Program

6.6.1 Revegetation Methods

Tubestock Planting

Planting 'forestry tubes', hykos (small tubes) and/or advanced tubestock is the most reliable method of establishing woody plants (trees, shrubs) and may also be useful in establishing tussock grasses (*Themeda australis, Echinopogon* spp, *Poa* spp.).

Bushland rehabilitation in the York Road will generally rely on the placement of tubestock (i.e. restoration), supplemented by other methods of revegetation. Hand broadcasting of seed, brush matting, and transplanting may also be used to 'fill in the gaps' between planted tubestock.

Hand Sowing

Seed of hardy pioneer species such as *Acacia* may be collected from local bushland and scattered on bare (prepared) soil between tubestock plantings[29]. As hand sowing (or direct seeding) is wasteful of seed, seed collected from most other species should be propagated as tubestock.

If native grass seed is available, hand sowing between tubestock planting may also be used. Grasses such as Blady Grass (*Imperata cylindrica)*, Longhair Plumegrass (*Dichelachne crinata)*, Bordered Panic (*Entolasia marginata)*, and sedges such as Knobby Club-rush (*Isolepis nodosa)* and Sword-sedge (*Lepidosermum concavum)* would be suitable for hand sowing. However, grasses with more precise germination requirements such as Kangaroo Grass (*Themeda australis*) are best established via tubestock or transplanting.

[29] Acacia seed must be treated prior to sowing. ~ 50% of the seed should be treated by pouring boiling water over it. Seeds should be soaked for 1-2 minutes, drained and allowed to dry.

Brush Layering (Brush Matting)

The use of mulched timber as a soil cover and to provide microhabitat is a cheap and effective way of re-establishing vegetation if sufficient source material is available. If brush layering is to be used as a method of revegetation, then plants must bear ripe fruit/cones, and the branches must be cut and spread over bare (prepared) soil before the seed drops. The stress of cutting will release seed, so that cut brush cannot be stored for long period of time. Brush is best used on the day it is cut.

At York Road, the only material suitable for brush layering is the Coastal Teatree. The species is already widespread and culling and cutting light windows through the canopy will provide more than enough material to plug gaps and lay across track to prevent soil erosion [30].

If Coastal Teatree is used, great care must be taken not to overuse this species, as it is already dominant on the site, and it is known to suppress other desirable species through shading and direct competition (Burrell 1981, in Attiwell 1994).

Transplanting / Salvage of Plant Material

All remaining vegetation on the Lot 22 (former TAFE) site will be cleared to facilitate expansion of the Moriah College campus.

Although there are few native species remaining on Lot 22, the translocation of at least some of these seedlings into the subject site (Lot 23) is recommended. For example, there are a few *Dichelachne crinata* (a grass), some *Lomandra longifolia* (Spiny-headed Mat-rush), some *Isolepis nodosa* (a rush), and some of the smaller *Acacia* seedlings that could readily be transplanted and/or potted up for future use. However, translocation will only be possible if adequate notice of clearing is given to allow for preparation time, and if weather conditions are suitable (i.e. cool and preferably wet).

It is stressed that transplanting is usually only feasible for grasses, tussock herbs, or for very small woody seedlings. It is usually not possible to transplant native shrubs or trees as they suffer badly from transplant shock and die off. Most woody plants must be grown from seed or cuttings collected from the local area and placed as tubestock.

Densities and Spatial Arrangement

Planting arrangements should be based on likely natural configurations and densities in order to replicate the pre-disturbance plant community. Determining spatial arrangement and plant density must be considered on a site-by site-basis, as these may vary even within the rehabilitation area (eg zones or plant associations).

Variations within the site have been discussed in Section 6.5.1 and zonation is set out in Figure 10. Planting densities will depend very much on the number and type of native plants remaining and/or regenerating on the site after weeds are removed. If the site is effectively denuded after weed removal, and it is considered unlikely that natural regeneration will provide the desirable result, tubestock can be planted to replicate the pre-disturbance community structure.

Planting density should be based on the final size of the relevant species used. For example, small-sized plants (generally less than 500 millimetres in height) should be planted in groups at a density of 4 or 5 units per square metre. Larger species may also be planted in groups, but should be placed sufficiently close together to enable a dense cover to form (where this is appropriate, and will not suppress light-demanding ground covers).

The overall density can be reduced to a practical level over the entire site by separating dense plantings by planning for unplanted areas; and in Zone 2 (scrub areas only) and Zone 3 (scrub), by using larger-growing species.

[30] Teatree branches could be used effectively to block unwanted tracks or for soil erosion purposes, but they should not be used to promote the establishment of the species in areas where a native understorey is being regenerated.

6.6.2 *Planting Aids*

Nurse or Cover Crops

Nurse crops may be used to provide shelter (micro-habitat), protect the soil surface from climatic extremes, and retain soil moisture. Some form of cover crop is recommended when planting tubestock in harsh or exposed sites, or when broadcasting native plant seed (reduce sowing rates by 50% for the latter).

Although the most widely used species are introduced plants (Japanese Millet, Rye Corn), these grasses do not generally persist past the first growing season, especially in low-nutrient soils. If used according to recommended rates, they offer little competition for native seedlings. The creation of a microhabitat at ground level and other benefits provided outweighs what is a relatively low competitive factor.

Plant Fertilisers

A specially formulated native plant fertiliser (low in phosphorus) should be used when planting native tubestock on cleared or disturbed land. Possibly fertiliser is less important when planting in bushland areas with native or parent soils intact. Regular applications of dilute fertiliser should be used twice yearly (spring and early autumn) or when plants show signs of yellowing or spindly growth (at least until the plants become established and drought hardy).

As the sandy soil at York Road is low in plant nutrients and generally lacks organic matter, the use of a plant fertiliser is strongly recommended. This will promote plant establishment in the first 12-18 months of the planting program. As the vegetation cover is re-established and organic matter is re-cycled into the topsoil, there will be less need for supplementary nutrient input.

Complete native plan fertilisers are available in granular form or as tree tablets. Soluble fertilisers are preferable to granular forms, although tree tablets (or pellets) are useful at planting time.

Water Retaining Granules

Soil wetters such as Debco, Saturaid, Terracottem (or similar) should be used in harsh conditions and/or where post-planting watering may be problem, and they are particularly useful in free-draining sandy soils.

These products are inert, and do not react with fertilisers or herbicides. If used at planting time, watering times can be reduced by up to 50%. Experience using such granules in bush regeneration sites has allowed a greater survival rate than previously achieve[31].

Mulching and Weed Matting

Mulch is crucial to the success of most planting projects as it keeps the soil cool and moist and suppresses weed growth. Mulching around planted tubestock can utilise chipped eucalypt mulch (if this is available), or if costs allow, commercial 'leaf mulch' may be used.

Chipped or mulch from woody weed sources are never acceptable. All imported mulch will be of known provenance and free of weeds. Alternately, it is possible to foliar spray dense weed grasses with a selective herbicide (eg Fusilade) and to leave the dead thatch in place as mulch.

Mulch must be applied at the time of planting, after through soil wetting. When planting in large open areas, plants should be grouped to allow mulch to be applied around each 'planting island' or cluster. This reduces the edge effect (weed invasion, drying) and makes plant maintenance easier

Weed Matting – such as Jutemaster, Enviromat, coconut fibre or similar) is also useful for retaining soil moisture and suppressing weed growth. Individual weed mats may be used around each plant at planting time, or broad-scale weed matting can be placed over a large area. If the latter approach is used, the matting must be firmly anchored with long metal pins.

[31] Terracottem is a combined plant fertiliser and water retaining product.

Note that weeds will grow well in most types of mulch and on the surface of weed matting, but seeds beneath are prevented from germinating. Note also that some grasses and some bulb species have very sharp leading shoots (new growth) that can pierce loosely spun weed mats and grow up through them.

6.6.3 Irrigation

It may not be possible to water the planting sites over a long period, therefore the planting program should be planned to coincide with the period of maximum (and regular) rainfall. In most of the Sydney Region, optimal planting times are autumn and spring (respectively).

It is also important to ensure adequate watering at planting, applying 1-2 litres of water to each new plant. Additionally, the use of a water-retaining compound and some form of surface mulch are strongly recommended to retain soil moisture and decrease the need for on-going watering[32].

Plants should be soaked for at least 30 minutes prior to planting (before being removed from their pots), watered thoroughly at planting and thereafter, watered once each week for a period of 4 weeks (weather conditions dictating frequency). After this period, watering comprising 1 litre of water / plant each month will be required until the plants have established. If drought conditions prevail, the watering period may have to be extended to ensure plant survival. Watering is best carried out in the early morning (watering at dusk encourages fungal attack in some species).

6.6.4 Implementation and Timing of Works

The long-term nature of bushland rehabilitation projects such as the one proposed for the York Road Bushland is strongly emphasised.

Recommendations for action have been limited (in most cases) to a 5-year timeframe. This timeframe was chosen because Moriah College will not commit funds beyond this period of time.

As a rule of thumb, only rehabilitation sites which retain a diverse standing biomass and/or a known reservoir of seed, or those in close proximity to good quality bushland, can be expected to respond within 5-years or so. The rehabilitation and re-creation of bushland on highly degraded or cleared land will necessarily require commitment and resources for many years.

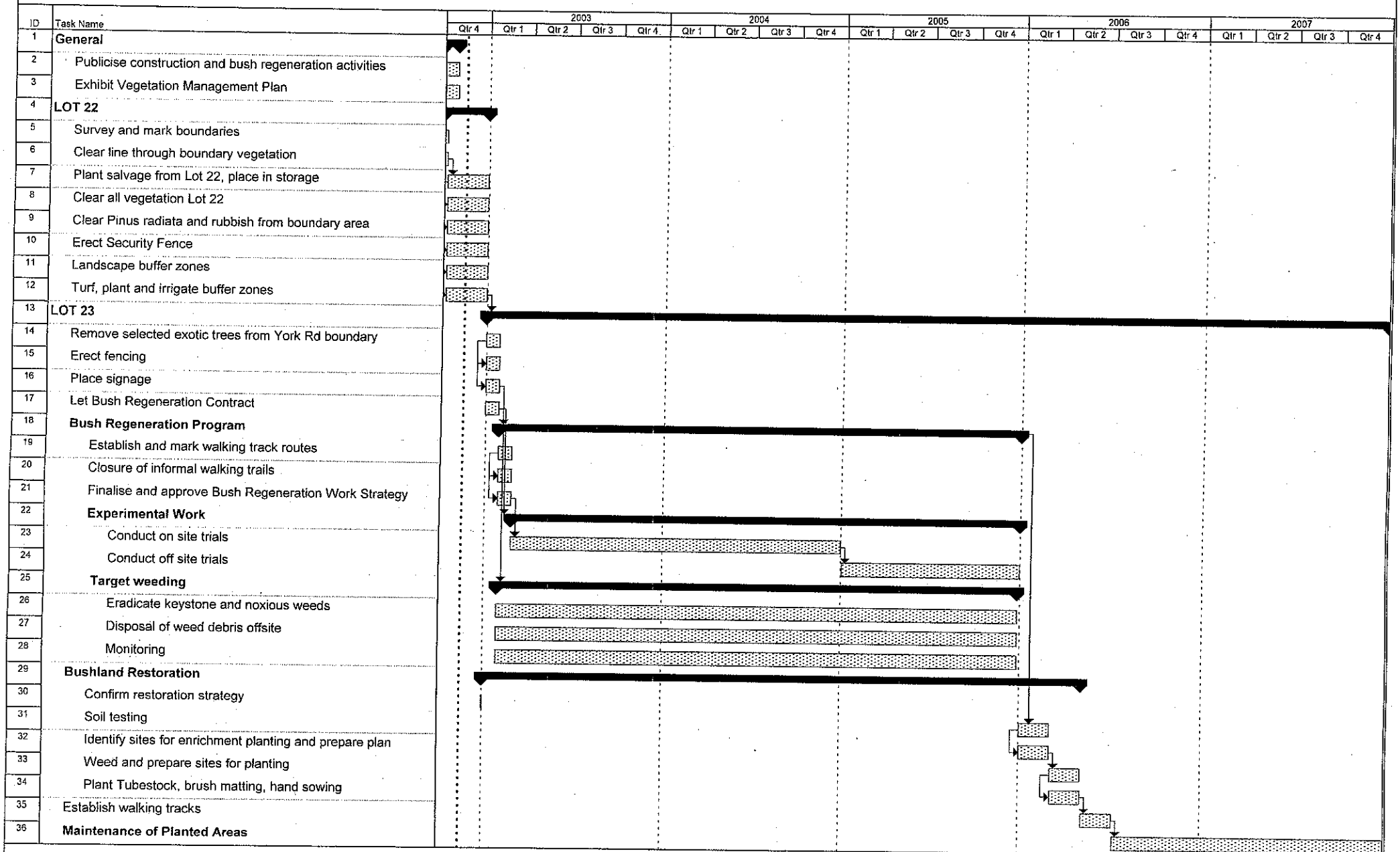
When bushland rehabilitation depends on planting (in whole or in part) to restore the plant community, it is important to understand that, in the early years of the program, only hardy pioneer species and fast-growing mid-storey species should be planted.

These pioneer species will tolerate the harsh conditions existing on cleared or exposed sites, and as they establish, they will help to stabilise the site, incorporate valuable organic matter (humus) into the topsoil, and help to suppress weed growth. Understorey plants and with more specific establishment requirements should only be planted after some degree of canopy is re-established.

Establishing a series of microhabitats within the planting site to facilitate successional processes will be crucial to the success of the bushland restoration program.

[32] Note that 'naturally occurring' coastal heath communities occur on free-draining sands, but organic matter in the soil retains soil moisture and makes it available to plant roots.

Figure 11. Timetable of Works*



* Figure 11 represents actions to be undertaken in the short and medium time frames. Durations shown are a general guide only.

6.7 Maintenance Program

A regular maintenance program will required for all bush regeneration sites and planted areas after the completion of initial works. After 5-years, bush regeneration work and routine maintenance will become the responsibility of Centennial Parklands.

Although an on-going bush regeneration program will be required to achieve the objectives of the VMP (see Section 2.2), regular weeding, enrichment planting, culling dead plant material to maintain site conditions and/or manage the fire hazard, and (latterly) the extension of habitat into cleared or fringing areas, will depend on the availability of funds and other resources. Generic specifications for the site maintenance program are set out below.

6.7.1 Weeding

The rehabilitation site must be kept free of competitive weeds. All keystone weeds must be treated as a matter of priority. Where secondary weeds (generally herbaceous annuals) are judged to be competing strongly with native seedlings or newly planted tubestock, weeds should be cleared in a 0.5 metre radius around each plant or group of plants.

A trained bush regenerator contractor should carry out routine inspection and weeding activities, at intervals to be determined by the Project Manager. After keystone weeds are removed and native regeneration is well underway, at least 4 sessions/year will be required, with a focus on weeding in the growing season. In planted areas, weeds must be removed from inside the planting bags and from under mulch mats.

6.7.2 Application of Plant Fertilisers

A periodic application of a low-phosphorus native plant fertiliser will be required to keep plants healthy and promote establishment, especially in low-nutrient soils. Application of a suitable plant fertiliser (Osmocote Purple, Thrive, Aquasol or similar) should be made every 3 months, following completion of planting. A fully soluble plant fertiliser is preferred to propriety granular brands.

6.7.3 Replacement of Failed Plants

At least 75% of the plants placed must survive for at least 12 months after planting, including any planting in Year 5 of the Stage 1 programme. If fewer plants survive within this period, plants should be replaced to maintain species numbers and densities. Replacement plants must be of known provenance.

6.7.4 Maintenance of Plant Bags and Stakes

Individual plant bags (or guards) and stakes must be maintained in good condition at all times. Damaged bags and stakes must be replaced, and if mulch mats are used, these must be kept securely fastened. As the subject site is highly visible from York Road and from parts of Centennial Parklands, it has a high profile in the local area.

The bushland will also be opened to the public after and possibly during rehabilitation work, so a high level of maintenance is essential.

6.7.5 Rubbish Removal

The bushland rehabilitation area must be kept free of rubbish and other debris. Pots, extra stakes and tree bags must be removed off site immediately after planting. All mulched surfaces must be kept in a clean and tidy condition. Leaving stockpiled weed debris and unused planting material on a public site often invites vandalism.

It will also be important to maintain the York Road frontage. Weed debris and wind blown rubbish must to be collected on a regular basis and taken off-site for disposal. Rubbish removal should extend to regular removal of wind-blow rubbish against the (proposed) perimeter fence.

6.7.6 Planting Plans and Documentation

Planting should only be carried out in accordance with a pre-determined planting plan; otherwise *ad hoc* planting may be at odds with rehabilitation objectives. Some of the most important environmental goals and objectives recognised are for the York Road Bushland are:

- The re-establishment of 'naturalistic' groupings or zonation within the remnant;
- The exploitation of specialist or micro-sites within the bushland to encourage habitat diversity; and
- The re-establishment of appropriate densities and proportionality between plant forms.

Such goals cannot be realised unless the restoration (planting) program is carefully planned and implemented. Prior to any on-ground planting, a planting plan should be prepared in accordance with the guidelines and principles set out above. Plant forms, species type, numbers and densities/micro-site should be fully detailed. Provenance material should be identified, and recorded in a special logbook. Each planting session should be fully documented, with species type and numbers used in each management unit / zone listed. Documentation must also include a clearly marked and scaled site map.

6.8 Other Works

6.8.1 Lot 22 Site Preparation

The Masterplan Stage 1 DA works are being completed in 3 key sub-stages, being Stages A, B and C. Stage A is complete and included for building refurbishments internal to the existing College campus on Lot 3.

The next stage, Stage B, includes for the internal roadway, car park and other buildings works that require the use of the Lot 22 land.

Ahead of the commencement of works to this stage, Moriah College will execute the lease for the TAFE Site Lot 22 and seek possession of the site.

For the possession of the site, an interim package of works is proposed which will clear the site, erect a fence, and prepare the surface as an open, turfed play space, with a planted buffer zone to the Lot 23 boundary.

In order to complete these interim works, the following sequence of key actions is proposed.

- Survey the Lot 22/23 boundary, to include:
  - Selected clearing of vegetation/bushland to effect survey sight lines; and
  - Pegging and ribbon tape to boundary line.
- Boundary vegetation assessment, to include:
  - Identification of ESBS Bushland, and other vegetation along the boundary line; and
  - Marking and tagging of vegetation to be cleared or retained.
- Boundary vegetation clearing, to include:
  - Clearing of tagged ESBS Bushland, and other vegetation by ecologist/vegetation consultant
- Boundary fence installation
- Site clearing
- Buffer zone installation and landscaping.

The extent of works, including the buffer zone design is included in the Appendix 9.

6.8.2 Removal of Pinus radiata

Prior to starting on-ground bush regeneration work, the majority of the mature and semi-mature (>3 metres in height[33]) Pines should be removed from the core bushland, as it may be difficult to access these trees at a later date. If these trees are left *in situ* until the site begins to regenerate (or is planted), removal will certainly damage native vegetation. The Project Manager will inspect the site with the tree removal contractor and mark all trees to be cut out.

Trees should be cut at the base and lifted from the site by crane to avoid damage to other vegetation and the stumps ground *in situ*. As Pine does not generally re-shoot after cutting, it will not be necessary to poison the stumps, however Indian Coral Trees will regenerate from cut timbers and/or rootstock, so Coral Tree stumps should be poisoned and all timbers taken off the site for disposal.

6.8.3 Fencing and Access

Security for the subject site Lot 23 site is required to prevent the ongoing invasive and detrimental activities of vagrants, illegal dumpers and destructive visitors. Any site fencing will be visually prominent along the exterior of the site facing of to York Road and, therefore, will need to be of visually lightweight appearance whilst providing good levels of security. Additionally, for the course of the 5-year bushland rehabilitation program and the ongoing development of the site, pedestrian and vehicle access will be required onto the site.

In consideration of the distribution of ESBS bushland on Lot 23, the VMP recommends that a single site access point be selected on the southern side of the Lot, adjacent to the Lot 22/23 boundary at York Road. The vegetation in this area is more heavily degraded, and will allow the provision of a vehicle access point with least detriment to the existing ESBS bushland. The detailed location of this access point would be selected in consideration of the adjacent vegetation. For other site access points, these would be provided a pedestrian exit gate (Building Code of Australia compliance) for safe egress from the site in case of bushfire or other emergency.

Upon commencement of the VMP works, the whole of Lot 23 will be fenced. The Lot 1/23 boundary line will be exempted for 12 months pending the outcome of Lot 1 land subdivision negotiations between the NSW State Government and Moriah College. In the interim and subject to the approval of the Minister of Health, the Lot 1 bushland will be temporarily fenced along the southern edge of the York Road carpark to complete general security to Lot 23.

Given the requirements set out above, all site boundaries will be fenced to the following specifications:

- Height: 2100 mm
- Type: chain wire, plastic coated, black.
- Gates: double vehicle gate & single pedestrian gates with egress handles.

A similar specification has been used for selected parts of the existing Moriah College perimeter fence, and has not been found to be visually intrusive.

6.8.4 Pathways and Boardwalks

The bushland remnant is dissected by a number of informal tracks, with no definite pattern. It is thought that some tracks date from the time the site was used to exercise horses. Some tracks are eroding badly, particularly those on the steep main dune at the north-eastern corner of Lot 23.

A circular walking track system through the bushland remnant is proposed. A suitable route will be identified by CPMPT and a Concept Plan prepared which will be incorporated into the VMP at a later date. The walking track should be designed to facilitate entry to all bushland zones (woodland, scrub), and the route should be clearly marked at the outset of works to guide bush regeneration and planting activities. To avoid track damage, construction should be delayed the bulk of heavy weed

[33] All trees above 3 metres in height must be removed by a professional arborist

clearance has been completed, however the route should be surveyed early in the program, and clearly marked to guide bush regeneration and/or planting activities.

Once the route has been defined, unwanted and/or eroding tracks should be closed. These tracks should be stabilise with brush matting (or similar), and revegetated using locally indigenous species. If planting material is not available in the short-term, chipped eucalyptus mulch or weed-free straw may be used to protect the soil surface from further erosion.

This steep main dune could be damaged if the track climbs this slope. Sturdy timber steps or a short section of boardwalk may be required on the steep dune and on badly eroded sites. The feasibility of incorporating one or more areas of timber stepping or boardwalk into the walking track system should be investigated.

6.8.5 Signage and Interpretation

Centennial Parklands will develop an innovative public education and interpretation strategy for the site that can be appended to the VMP. Interpretation of, and education about the site should be considered throughout the planning and management process and should be influenced by the VMP.

Interpretive elements should identify the remnant as ESBS, and provide a short description of its conservation values. 'Bush Regeneration in Progress' signs should be prominently displayed. Centennial Parklands will develop standard-issue interpretive signage in keeping with their corporate style to be displayed at appropriate locations such as the access gate(s) to the site.

As part of the interpretation strategy for the site, it is also anticipated that Centennial Parklands' Education and Interpretation Rangers will develop a range of materials, which can be used by visitors to the Parklands, and by educational, stakeholder and community groups. A strategy for distributing this material should be included in the interpretation strategy. Interpretive elements should not be limited to signage or text-based materials, and may also include Ranger-led activities, off-site outreach programs, web-based information and art or sculpture.

Where possible, the orientation of any walking track should be planned to facilitate and complement the proposed interpretive program. Any walking track should be clearly identified, with access gate(s) marked.

6.8.6 Buffer Zone Treatment

It is proposed to establish a buffer zone between the expanded College buildings on Lot 22 and the bushland in Lot 23. This zone will provide a buffer from the impacts of development and any potential adverse impacts arising from the educational activities on the Lot 22 site. Potentially adverse impacts have been identified as:

- Runoff from paved surfaces and garden beds;
- Invasion by weeds and/or garden escapes;
- Overshading by buildings and other constructions, and
- Movement of fill soils and other debris downslope from Lot 22.

Treatment of the buffer zone is provided in Appendix 9.

6.8.7 Landscaping on Adjoining Lot 22

A draft Landscape Plan has been prepared for the expanded College campus on Lot 22 (Site Image April 2000). The draft Landscape Plan is currently under review.

It has been agreed that the Landscape Plan will not use invasive species anywhere on the Campus, nor will it establish any lawn areas in the proposed buffer zone between Lot 22 and 23. It has been agreed that landscaping in the proposed buffer zone will utilise Australian native species, but in selecting appropriate species it will not seek to 're-create ESBS. No exotic or invasive native species

are to be used in the landscape design, and lawned areas are to be separated from the buffer zone by a physical root barrier and be of grass species that propagate by root only.

Site Image Landscape Architects prepared a draft Landscape Plan (29 April 2000) to accompany the original Development Application to Waverley Council. However, since that time discussions with Waverley Council and the NPWS have determined that the buffer zone between Lots 22 and 23 will require special attention. As the landscape treatment of the buffer zone was not included in the draft Landscape Plan, the landscape design has been revisited and revised in accordance with the recommendations made in the VMP (see Section 6.8.7).

Landscaping on Lot 22 must also consider the need to provide a fire protection zone between the bushland on Lot 23 and Moriah College buildings. The Bushfire Hazard Assessment (AVK 2000) includes a 10-metre wide fuel-free zone, measured outwards from the side of the proposed new buildings on Lot 22, and a further (5 metre wide fuel reduced area between the fuel free zone and the bushland (a total of 15 metres). Recommendations of the Bushfire Hazard Assessment are summarised in Section 6.8.8.

This Assessment recommendations that vegetation within 10 metres of the new College buildings on Lot 22 be restricted to mown grass with scattered shrubs, preferably of low flammability, with the density of the shrubs not exceeding 20% (canopy cover of mature plants). The choice of native species identified in the Landscape Master Plan will also be restricted to those no more than 1 metre in height.

This Assessment also recommended that highly flammable species such as Coastal Teatree and *Allocasuraina* species not be included in the Landscape Master Plan for the College campus extension.

Wherever possible, indigenous mesic or soft-leaved species should be used around the buildings and within the landscaped buffer zone. Indigenous species that have a high oil content in their leaves, or have fine, needle-like leaves should not be planted in close proximity to buildings.

Vegetation within the 5 metre fuel-reduced zone should also be restricted to indigenous species that will not grow to more than 1 metre in height, although there is no restriction on density.

6.8.8 *Management of Fire Hazard*

The potential risk to the College from bushfire originating in bushland contained in Lot 1 or Lot 23 has been discussed (see Section 4.5.1). The recommendations of the Bushfire Risk Assessment (AVK 2001) are summarised as follows:

- Retain a fuel-free zone of at least 10 metres in width between the expanded College buildings proposed for Lot 22; and the bushland on Lot 23;
- Retain a further fuel-reduced zone of at least 5 metres in width between the fuel-reduced zone and the bushland;
- Restrict vegetation within 10 metres of the new buildings to mown grass with scattered shrubs, preferably of low flammability, so that the density of planting does not exceed 20% (canopy cover of mature plants);
- Restrict vegetation within 15 metres of the new buildings to indigenous species that will not grow to more than 1 metre in height to reduce the fire risk to the College.

There is no perceived need for any fire hazard management (i.e. fuel reduction burns) on Lot 23 as long as the fire protection zone identified above is established and maintained between buildings in the College campus and bushland on Lots 1 and 23; and if a similar fire protection zone is maintained between buildings and the small area of bushland on Lot 1.

6.9 Labour and Resources

6.9.1 *Contractors*

The tasks listed below should be carried out by suitably qualified and experienced contractors and/or by qualified staff employed by Centennial Parklands. All external contractors must hold appropriate insurance policies, permits, certificates and licenses (as required). Any work in the bushland must be undertaken by qualified bush regenerators and supervised by an experienced bush regeneration supervisor and/or a Project Manager appointed by CPMPT.

Site Preparation

A thorough clean-up prior to commencement of bush regeneration work is required. This is to include removal of dumped rubbish, builder's waste, bitumen, cement and bricks, removal of small mullock heaps and (where appropriate) scalping of weedy topsoil.

Fencing

Site security requires the erection of man-proof fence with double access gates between Lot 22 and Lot 23, and the erection of a suitable perimeter fence with access gate(s) on the York Road frontage. The York Road perimeter fence should not be installed until such time as all debris, including Pines and other bulky vegetation is removed.

Signage

Interpretative signage incorporating site description, route of walking track is to be installed soon after the project commences. 'Bush Regeneration in Progress' signs also to be installed at appropriate locations, including at the access gate(s).

Removal of Ornamental Trees

There are approximately 150 Monterey Pines and 2 mature Queensland Brush Box to be removed from Lot 23. Tree removal will be undertaken in several stages (yet to be determined) and must be undertaken out by a qualified arborist. All timber and other debris are to be removed off site, and the stumps should be ground *in situ*.

Bush Regeneration

All bush regeneration activities, which include weeding, seed collection from other remnants, planting and site maintenance are to be carried out by a professional bush regeneration contractor employed by CPMPT. Bush regeneration and seed collection will be carried out under licence from the NPWS. The contractor's work may be supplemented by the efforts of the Centennial Park volunteers, and may from time to time, by volunteers from service clubs and local schools.

6.9.2 *Bush Regeneration - Professional Contractors*

Trained bush regenerators should be used to work in environmentally sensitive areas where threatened species or remnant vegetation could be harmed. A trained bush regenerator is one who has successfully completed the accredited Bushland Weed Control Certificate course offered by NSW TAFE (or interstate equivalent), and who has completed at least 350 hours in the field.

However, this is not to say that volunteers cannot play an important role in the bushland rehabilitation program. Many Councils and other land managers successfully use a combined contractor/volunteer approach to bush regeneration, and the joint effort undertaken by these groups have frequently achieved dramatic results within a relatively short time.

Long-term bush regeneration programs are more usually carried out on a contract basis. There are several dozen professional contractors operating in the Sydney area alone. Using professional bush regenerators to train and co-ordinate the work of volunteers and employed grounds staff improves the quality of work and allows the job to move forward far more quickly than would be the case if

only untrained volunteers are used. If grounds staff are assigned to work alongside the contractors, they can be instructed in appropriate herbicide techniques and specialised weed eradication methods (eg. cut-stump, tree injection, vine treatment), which can be applied to other aspects of park management.

6.9.3 Community Volunteers

Centennial Parklands has an active community volunteer movement in place, incorporating a range of activities. These volunteers provide invaluable help to CPMPT in their care and management of the Parklands. It is anticipated that groups such as The Friends of Centennial Parklands will take an active role in the bushland rehabilitation program proposed for the York Road Bushland. There is also some potential for students at Moriah College to have some input into the program, and although details have yet to be worked out. It is essential that these students be supervised at all times.

Volunteers must also be equipped with the right tools to carry out the work. The volunteers must have good on-site supervision and adequate back-up facilities (e.g. help with planning, access to expert advice, regular rubbish collection, supply of herbicides (if applicable) and replacement of tools and materials). Volunteers should never be set to work in chronically degraded areas or in sites with little potential for regeneration as the group will eventually lose its enthusiasm, and goodwill may be lost.

6.9.4 Unskilled Labour

There are a number of labour-market programs designed to secure employment for unskilled workers. Some of these programs provide workers to clear weeds and plant in bushland areas at low rates of pay. These teams are unskilled, but they usually include a supervisor with some training in horticulture or bush regeneration. Under constant supervision, these workers can make a valuable contribution. However, these workers are not trained in plant identification, bush regeneration methods, or the use of herbicides. Their input is meant to supplement, and not to replace trained bush regenerators.

It is essential that unskilled or untrained workers are not left unsupervised to clear vegetation, however degraded it may be. The use of power tools and herbicides by workers with no experience, and with only a very limited understanding of the potential dangers, poses a risk to the operator and to the environment, with the land manager (in this case, CPMPT) being held responsible. The likelihood of inadvertently damaging or destroying remnant native vegetation is also high. All workers, whether volunteers or paid professionals must be adequately insured at all times.

Table 11 sets out the various activities and tasks involved in the bushland rehabilitation project at York Road. It also identifies activities and tasks suitable to be undertaken by a range of stakeholders.

Table 11: List of Tasks and Responsibilities

Task	CPMPT staff	Bush Regeneration Contractors	CP Volunteers (Bushcare)	School Groups/ Service Clubs	Unskilled Workers (labour pools)	Other	Comments
Weed Control							
Removal of Pines etc							Arborist
Drill/poison large woody weeds (eg. Privet, Olive, Lantana,)	X	X			X *		* Under supervision
Cull Sweet Pittosporum		X	X		X *		
Remove small to medium sized woody weeds, dig out or cut-stump/poison (eg. Privet, Senna. Lantana)		X	X		X *		* Under supervision
Maintenance weeding - eg. hand pull weed seedlings		X	X	X *			Under supervision
Foliar spay herbaceous weeds eg. Ground Asparagus, Tradescantia)		X	X *				* After training and/or under supervision
Noxious weed control program (eg. *Cestrum*, Pampas, *Lantana* Blackberry, *Parietaria*)	X	X					
Rubbish collection & general site maintenance	X		X		X		To be undertaken under supervision
Remove weeds and other debris to a collection point	X		X		X		Clean up Australia Day – under supervision to minimise potential damage to fauna habitat
Site Maintenance							
Mow/maintain grass edges (where applicable)	X					Contractor	
Install hard edge to bush/grass	X				* X	Contractor	* Under

Task	CPMPT staff	Bush Regeneration Contractors	CP Volunteers (Bushcare)	School Groups/ Service Clubs	Unskilled Workers (labour pools)	Other	Comments
interface (logs or pathway)							supervision
Neighbourhood liaison and police dumping/vandalism	X			X		Moriah security staff	
Revegetation & Habitat Restoration		X					
Seed collection from local remnants		X	X			Community Nursery	
Propagate locally indigenous tubestock for restoration		X	X	X		Community Nursery or Contractor	
Site preparation (weeding, soil remediation, mulching)	X	X	X				
Supply planting materials (fertiliser, tree guards etc)	X				X		
Plant trees and shrubs in restoration areas		X	X	X			
Care of plantings		X	X	X			
Education & Interpretation							
Prepare interpretive material	X		X				Student project
Schools liaison	X		X				
Public relations & publicity	X		X				
Organise community working bees (Bushcare)	X		X				
Monitoring & Assessment		X	X			Consultant	
Other Tasks							
Install York Road perimeter fence & gates	X					Contractor	
Install security fence & gate to Moriah College (Lot 22)	X					Contractor	
Install signposts at access points	X					Contractor	

Task	CPMPT staff	Bush Regeneration Contractors	CP Volunteers (Bushcare)	School Groups/ Service Clubs	Unskilled Workers (labour pools)	Other	Comments
Determine route of new walking track system							
Mark out track (peg edges)	X				X*	Contractor	
Construct boardwalk and/or steps as required	X				X under supervision		
Experimental work		X				Consultant / University Student	

NB: It is not intended that all of the above-listed groups carry out multiple tasks. An entry next to a group's name means that they are capable of successfully carrying out these tasks, with direction.

6.10 Monitoring and Assessment

Monitoring [34] outcomes and results to assess the degree to which goals and objectives have been realised is good management practice. To be effective, a monitoring program must be set up at the outset of the rehabilitation program, and resources must be allocated to support this activity. Monitoring will provide an objective measurement of progress and record the slow and often subtle changes that occur at species, population, and community levels. Monitoring the results of different techniques used, experimental trials, and the response shown by different plant associations or micro-sites within the larger site will provide valuable information to guide other bush regeneration projects carried out in similar plant communities.

Monitoring procedures should be simple and straightforward, as well as inexpensive to implement. Monitoring should provide both qualitative (visual) and quantitative (statistical) assessment. Reports should present findings/data in a 'user-friendly' manner that can be readily interpreted by all stakeholders. Simple monitoring can be assigned to the bush regeneration contractor, or carried out by the Centennial Park volunteers or secondary school students (with some basic training). More complex (statistical) monitoring programs may require the assistance of a Rehabilitation Ecologist or a science-trained university student.

To monitor the success of establishment and successional progression of bushland rehabilitation program at York Road, 2 simple approaches are recommended: visual assessment (permanent photo-points), and quantitative analysis (transects/quadrats). These are described below.

6.10.1 Baseline Information

Successfully monitoring the recovery of an ecological community depends on the availability of comprehensive baseline data (eg. site floristics, community structure, soil types, hydrology, fauna populations, existing habitat and linkages). Previous studies (UBMC 1996, 1999, 2000a, 2000b, 2000c), and a recent floristic survey (November 2001) have provided information on species density, species richness, and species distribution.

It remains for the consultant ecologist commissioned by CPMPT to design a monitoring program that utilises the data to provide a clear and concise basis for comparison with the outcomes achieved during the term of the bushland rehabilitation project. Guidelines for a bushland rehabilitation monitoring program are set out in Section 6.10.4, below.

6.10.2 Reference Sites

The lack of suitable local reference sites (i.e. templates for rehabilitation) has been discussed (see Section 4.3.1). A list of species suitable for restoration work (i.e. planting) at York Road has been prepared, generally using larger, intact ESBS communities (eg La Perouse and Maroubra). However, these sites have a definite maritime influence, so that species that occur naturally only in the immediate coastal zone have been omitted (eg *Westringia fruticosa*, *Baeckea imbricata*, *Correa alba*).

None of the inland remnants listed by the NSW Scientific Committee (i.e. those within a 5-kilometres radius of the subject site) retain a wider range of species than the York Road Bushland. Therefore restoration work must be guided by a conservative extrapolation of the floristics and structure of these larger, more diverse sites. Knowledge of individual species' habitat preferences, pollination vectors and seed dispersal mechanisms will also help to determine which species are suitable for re-introduced to the York Road Bushland.

[34] Where 'monitoring' means on-going review, evaluation and assessment to detect changes in the natural integrity of a place, with reference to a baseline condition (ANHC 2002).

6.10.3 Performance Indicators

Performance indicators have been determined for each of the activities and tasks identified in the VMP. Such indicators serve as milestones or sign-off points during the life of the project and are useful in assessing whether or not goals and objectives have been met. Performance indicators are detailed in Table 8.

6.10.4 Monitoring Procedures

Quadrats and Transects

Permanent transects and quadrats are traditionally used to measure changes in plant community structure, densities and species diversity. Transects should established at measured intervals across the site, or they may be placed at random, but transects should always be placed to capture changes in site conditions and/or methods of treatment.

Transects should be 30-50 m in length. For a relatively small area such as York Road, it will be adequate to set permanent markers (stakes, star-posts) every 10 metres along each transect, and establish quadrats measuring at least 5 x 5 m. Large quadrats (up to 5-10 metres in size) are traditionally used for recording trees and large shrubs: 3 x 3 m quadrats are used for small shrubs; and 1 x 1 m quadrats are used to count grasses and ground covers.

The size and shape of the quadrats along a transect line will often be determined by site conditions (topography, physical features such as drainage lines or rocky outcrops) and by the density of the vegetation.

Permanent markers will also be used as photographic reference points (i.e. fixed photo-points). The location of transects, quadrats and photographic reference points should always be clearly marked on the site map.

The simplest way to record changes in the plant community is to count the numbers and types of seedlings regenerating in a measured plot over a period of time. This is a simple 'presence-absence' approach to monitoring incremental changes in a bushland rehabilitation site. Braun-Blanquet (as described in Chapman & Morrison 1988) provides a more sophisticated approach to monitoring incremental changes in vegetation cover. An area of set size (quadrat) is established and the % cover of vegetation within that quadrat is calculated. The % cover of individual species within that quadrat is also calculated. A number of quadrats are assessed (as above) and the results averaged. Results are entered onto a database, and are usually presented in tabular form or as a graph for reporting purposes.

Photographic Reference Points

Photographs are the easiest way to record changes in vegetation structure. A number of permanent photo-points are chosen and marked with a short wooden stake. Photographs should be taken from the same spot every six (6) months. The bearing/direction of the photograph from each reference point should be indicated. A photographic record captures the subtle changes that are often missed by workers in the field. Photographs are also useful in recording sequence shots at various stages in the project to illustrate the techniques used and the results obtained.

Flora and Fauna Databases

Updating Flora Lists on a regular basis is central to all bushland rehabilitation projects. The purpose of updating species lists is not to accumulate an ever-increasing list of new species, but rather to record the diversity and abundance of the *existing* plant community and to monitor any *changes* that take place as the project proceeds.

Flora lists should be updated every 6 months, with the location(s) of any unusual, rare or threatened species marked on the base map and the relevant authorities kept informed (National Herbarium, NPWS).

Other Data Worth Recording

Rainfall readings (monthly) and daily temperatures can be obtained from the local meteorological station. Local weather conditions in the 3-month period immediately prior to the monitoring session should also be recorded (to provide a point of comparison).

Duration of Monitoring Program

As many changes are not readily visible in the short-term, major assessments are required only once every 6 months. However, data should be collected over a number of years so that trends can be determined. The York Road Bushland project should be monitored for at least 5-years, with readings taken every 6 months for 2 years, and thereafter on a yearly basis.

As changes are often slow and hard to detect, site maps should be updated only once each year, but flora and fauna lists should be amended as new species are identified, and these lists completed updated on an annual basis. In this way, species gained as well as species lost from the site can be recorded. A monitoring program should assist the bush regeneration program, but not become an end in itself.

6.10.5 Reporting

The Bush Regeneration contractor appointed by Centennial Parklands (or members of its own staff, if available) will be required to keep a maintenance logbook and report in writing to the client and/or to the Project Manager on a monthly basis. All reports must be prepared in consultation with the Project Manager. The Project Manager should verify the contents of all reports before they are passed onto the client.

Monthly Progress Reports

Regular (monthly) should indicate the areas worked (in square metres), identify the type of work carried out (eg primary/secondary/maintenance weeding, spraying, planting/mulching), and the time taken (in person-hours) for each task.

The Monthly Progress Reports should also include mention of new or on-going problems such as soil erosion, vandalism or unexplained plant death, and items of interest such as the appearance of a new species, compliments paid by a visitor, fauna sighted, and so on. In this way, a record of successful work methods and rates of progress will be established and will help to provide a basis for future planning.

In addition, the Contractor will be required to produce and present with the first Monthly Report, a weed density map (condition of bushland) for the work site. This map will form the basis for reporting changes to weed density and native plant regeneration in annual and subsequent reports.

An Annual Report will also be required, as well as a substantial final (end of contract) report.

Annual Reports

The contractor will be required to provide the client with a comprehensive report at the completion of the first year's work. Information provided in the Annual Report should include:

- An overview or summary of all work completed during the past year;
- An evaluation of the project methodologies and techniques;
- Information about ecological site responses;
- Description of revegetation works (tubestock planting, seeding, brush matting etc);
- List of any tubestock planted (species, numbers, densities) and a location map;
- Any suggested changes to project priorities and/or directions;

- Before and after photographs (using permanent photo points);
- The results of quantitative monitoring (transects, quadrats);
- A colour-coded site map showing the (updated) condition of bushland; and
- Updated species lists (flora and fauna).

Final Project Report

At the end of the initial bushland rehabilitation project, (i.e. at the end of year 5) a comprehensive Final Report must be submitted to CPMPT. Moriah College, Waverley Council, NPWS and Environment Australia will also enquire copies of the Final Report, with an additional copy forwarded to the local precinct committee. After the Final Report has been accepted by CPMPT, the contractor and/or the Project Manager should prepare a formal presentation to the Trust and/or the BWG.

In addition to a summary of the material presented in the regular Monthly Progress Reports, the Final Report should include:

- An overview of the whole project, including background information (eg site history) and a site description (flora, fauna, geology and soils, hydrology), and project objectives;
- Assessment of project objectives and outcomes;
- Results of monitoring program (with conclusions) and experimental work carried out;
- A series of colour-coded maps of the before and after bushland condition from the beginning of the project;
- A description of the methods and techniques used and an evaluation of their success or otherwise, based on the monitoring results;
- Before and after photographs from all fixed photo-points; and
- Recommendations for future management of the bushland, including a site-specific maintenance program.

6.11 Viability and Long-term Management

The York Road Bushland is completely surrounded by urban development and has been isolated from other bushland areas for many years. Due to its small size and isolation, both physically and genetically, limited species diversity, and the impacts of past land uses; the bushland remnant will require on-going management and the expenditure of resources.

Although the bushland may acquire a greater degree of regenerative potential over time (as the result of natural regeneration and the introduction of new species via replanting), many of the ecological processes necessary to sustain coastal heath and scrubland may not be restored.

Among those ecological processes unlikely to be restored to the York Road site include the transfer/exchange of genetic material between other local bushland areas; natural (unassisted) transfer of pollen and/or seed from other bushland areas; periodic reduction of soil nutrient status via firing, and unassisted stimulation of the soil seed bank through animal activity or via physical processes such as bushfire and active soil erosion.

The use of fire as a management tool is unlikely to gain acceptance with either the local community or the authorities, so that other strategies must be set in place to encourage natural regeneration. Such strategies will include removing dead and/or dying shrubs, culling and lopping to create light windows, weeding to provide germination niches and other opportunities for *in situ* regeneration.

Some species may never be self-sustaining (for a variety of reasons, some of which may never be known), so if the enhanced floristic composition of the remnant is to be retained over time, it may be necessary to carry out (selective) enrichment planting every few years.

The York Road Bushland will possibly never be self-sustaining in the true meaning of the term, but the site can be managed in order to present a reasonable representation of the original vegetation communities of the local area. Once restored to a point where new plants are able to regenerate from *in situ* seed sources, and a mosaic of vegetation at different stages of development is re-established, fauna habitat will be substantially enhanced. With the return of available food sources, it is hoped that the bushland will once again be utilised by native fauna.

In effect, the York Road Bushland will need to maintained (at least in part), with clearing of dead and senescent native plants, and replanting of species which for some reason are not able to re-establish viable populations. This is not the most desirable situation from a management point of view, but it is a realistic prognosis. If the need for long-term care and maintenance is established at the outset, forward planning will ensure that adequate resources are made available to effectively manage the bushland remnant, in much the same way as other parts of Centennial Parklands are so managed.

7 PROJECT BUDGET

Table 12: Works Estimate – York Road Bushland (Lot 23)

Description of Works	Quantity	Budget	Responsibility
1. Preliminary			
Survey & Investigations Baseline Data & Analysis	Lump Sum	10,000	UBMC
Vegetation Management Plan Including consultation & liaison	Lump Sum	28,000	UBMC
Experimental Work (UNSW)	Lump Sum	10,000	UNSW
2. Implementation			
Remove Pine Trees / Bush Box	~ 125 units	40,000	Tree Contractor
Rubbish Removal & tipping fees (site clean up)	Unknown quantity	N/A	Land owner
Fencing		20,000	Land owner
Signage		5,000	Land owner
Bush Regeneration (1) ▪ Labour @ av. $30/hour (2)	1,470 hours pa	41,500 x 2 = 60,000	Bush Regeneration Contractor
Plants, including provenance seed collection (approximate only)	10,000 Units @ 2.50 ea	25,000	Specialist Contractor
Planting Materials ▪ Debco granules/soil wetter ▪ Low P fertiliser tablets	@ 0.20/unit	4,000	Bush Regeneration Contractor
Planting Labour @ av. $1.76 / unit	10,000 units	17,600	Bush Regeneration Contractor
Maintenance Program (3) ▪ weeding, watering, supplementary planting ▪ general site maintenance	1,335 hours @ $30/hour	40,000	Bush Regeneration Contractor TBD
3. Other Costs			
Project Management (over 5-years) @ av. 1 day / month, plus annual report	Lump Sum	40,000	Restoration Ecologist/Project Manager
Sub-total			**$299,600**
GST 10%			**$29,960**
Totals			**$329,560**

(1) Based on a team of 5 regenerators working 1 session/week (av. 42 sessions/annum) over 2 years and including planting labour.

(2) Hourly rate does not include CPI over a 5-year period.

(3) Based on a team of 5 regenerators working 1 session/month for 3 years (total 5-year project period).

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9 APPENDICES

APPENDIX 1: PREVIOUS FINAL DETERMINATION FOR EASTERN SUBURBS BANKSIA SCRUB

NSW SCIENTIFIC COMMITTEE

Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act has made a Final Determination to list the Eastern Suburbs Banksia Scrub as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. Listing of Endangered Ecological Communities is provided for by Section 12 of the Act.

Any submissions received following advertisement of the Preliminary Determination have been considered by the Scientific Committee.

The Scientific Committee has found that:

1. The Eastern Suburbs Banksia Scrub is the accepted name for a plant community occuring on nutrient poor sand deposits in the eastern and southeastern suburbs of Sydney.

2. It has the structural form predominantly of sclerophyllous heath or scrub occasionally with small areas of woodland or low forest, with, depending on local topography and drainage conditions, limited wetter areas.

3. The characteristic assemblage of vascular plant species in the community is:

Acacia longifolia	*Acacia suaveolens*	*Acacia terminalis*
Actinotus minor	*Allocasuarina distyla*	*Astroloma pinifolium*
Baeckaea imbricata	*Banksia aemula*	*Banksia ericifolia*
Banksia integrifolia	*Banksia serrata*	*Bauera rubioides*
Boronia parvifolia	*Bossiaea heterophylla*	*Brachyloma daphnoides*
Caustis pentandra	*Darwinia fascicularis*	*Darwinia leptantha*
Dianella revoluta	*Epacris microphylla*	*Epacris obtusifolia*
Eragrostis brownii	*Eriostemon australaisus*	*Eucalyptus gummifera*
Haemodorum planifolium	*Hakea teretifolia*	*Hardenbergia violacea*
Hibbertia fasciculata	*Hypolaena fastigiata*	*Kunzea ambigua*
Lambertia formosa	*Lepidosperma laterale*	*Leptocarpus tenax*
Leptospermum laevigatum	*Leptospermum trinervium*	*Lepyrodia scariosa*
Melaleuca squamea	*Monotoca elliptica*	*Monotoca scoparia*
Persoonia lanceolata	*Philotheca salsolifolia*	*Pimelea linifolia*
Pteridium esculentum	*Ricinocarpos pinifolius*	*Styphelia viridis.*
Xanthorrhoea resinifera		

4. The total species list of the community is considerably larger than that given in 3 (above), with many species present only in one or two sites or in very small quantity. In any particular site, not all of the assemblage listed in 3 may be present at any one time (at least above ground), seeds of more species may be present in the soil seed bank. The species composition of a site will be influenced by the size of the site and by its recent disturbance history. For a number of years after a major disturbance dominance by a few species (such as *Kunzea ambigua* or *Leptospermum laevigatum*) may occur, with gradual restoration of a more complex floristic composition and

ESTABLISHED BY THE THREATENED SPECIES CONSERVATION ACT 1995

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vegetation structure over time. The balance between species will change over the fire cycle, and may also change in response to changes in fire frequency.

5. The Eastern Suburbs Banksia Scrub is distinguished from the coastal heath which occurs along the eastern seaboard on soils derived either directly from sandstone, or, if aeolian of younger age than those of the Eastern Suburbs Banksia Scrub. Coastal heath is characteristically much lower than Eastern Suburbs Banksia Scrub and, although sharing many species with the Eastern Suburbs Banksia Scrub characteristically contains a more maritime element including *Baeckea imbricata*, *Correa alba* and *Westringia fruticosa*

6. The Community has been reported from areas of sand deposits in the local government areas of Botany, Randwick, Waverley and Woollahra.

7. The Scientific Committee noted that general information on the Eastern Suburbs Banksia Scrub is provided in Benson D & Howell J 1990. 'Taken for Granted - The Bushland of Sydney and its Suburbs'. Kangaroo Press, Kenthurst

The Scientific Committee has found that:

8. The Community, as defined by the proposal, satisfies the definition of an ecological community under the Act i.e. an assemblage of species occupying a particular area.

9. Less than 1% of the original area of the community currently exists in the form of a number of remnants.

10. Threats to the survival of the community include fragmentation, development, increased nutrient status, inappropriate fire regimes, invasion by exotic plants, grazing by horses and rabbits, erosion from use of bicycles, motorcycles and from excessive pedestrian use.

11. Although a small part of the surviving Eastern Suburbs Banksia Scrub is included within the Botany Bay National Park, this in itself does not ensure the survival of the community unless the threats to the integrity of the community are ameliorated. In view of the substantial reduction in the area occupied by the community, its fragmentation and the numerous threats to the integrity of the community the Scientific Committee is of the opinion that the Eastern Suburbs Banksia Scrub is likely to become extinct in nature in New South Wales unless the factors threatening its survival cease to operate.

12. In view of 9, 10 and 11, the Scientific Committee is of the opinion that the Community is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate. Accordingly, the Committee has made a Final Determination to list the Eastern Suburbs Banksia Scrub on Part 3 of Schedule 1 of the Act.

Dr Chris Dickman
Chairperson
Scientific Committee

Gazetted: 13/6/97

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APPENDIX 1B: NEW FINAL DETERMINATION FOR EASTERN SUBURBS BANKSIA SCRUB

NSW National Parks & Wildlife Service
nature & conservation

Threatened Species Conservation Act 1995
NSW Scientific Committee

Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act has made a Final Determination to amend Part 3 of Schedule 1 of the Act (Endangered ecological communities) by listing the Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion as an endangered ecological community and, as a consequence, to omit reference to the Eastern Suburbs Banksia Scrub in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. A Notice of Final Determination to list the Eastern Suburbs Banksia Scrub appeared in the NSW Government Gazette No. 62 on 13th June, 1997. The Scientific Committee considers that an amendment should be made to this listing following the receipt of additional information about the ecological community.

2. The Eastern Suburbs Banksia Scrub is the accepted name for the ecological community occurring on nutrient poor sand deposits in the Sydney Basin Bioregion.

3. It has the structural form predominantly of sclerophyllous heath or scrub occasionally with small areas of woodland or low forest, with, depending on local topography and drainage conditions, limited wetter areas.

4. The Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion is characterised by the following assemblage of species.

Acacia longifolia	*Acacia suaveolens*	*Acacia terminalis*
Acacia ulicifolia	*Actinotus helianthii*	*Actinotus minor*
Allocasuarina distyla	*Astroloma pinifolium*	*Baeckaea imbricata*
Banksia aemula	*Banksia ericifolia*	*Banksia integrifolia*

Banksia serrata	*Bauera rubioides*	*Billardiera scandens*
Boronia parvifolia	*Bossiaea heterophylla*	*Bossiaea scolopendria*
Brachyloma daphnoides	*Caustis pentandra*	*Conospermum taxifolium*
Cyathochaeta diandra	*Darwinia fascicularis*	*Darwinia leptantha*
Dianella revoluta	*Dichelachne crinita*	*Dillwynia retorta*
Epacris longiflora	*Epacris microphylla*	*Epacris obtusifolia*
Eragrostis brownii	*Eriostemon australasius*	*Eucalyptus gummifera*
Gonocarpus teucrioides	*Haemodorum planifolium*	*Hakea teretifolia*
Hardenbergia violacea	*Hibbertia fasciculata*	*Hypolaena fastigiata*
Kunzea ambigua	*Lambertia formosa*	*Lepidosperma laterale*
Leptocarpus tenax	*Leptospermum laevigatum*	*Leptospermum trinervium*
Lepyrodia scariosa	*Leucopogon ericoides*	*Lomandra longifolia*
Melaleuca nodosa	*Melaleuca squamea*	*Monotoca elliptica*
Monotoca scoparia	*Persoonia lanceolata*	*Philotheca salsolifolia*
Pimelea linifolia	*Pomax umbellata*	*Pteridium esculentum*
Restio fastigiata	*Ricinocarpos pinifolius*	*Styphelia viridis*
Woollsia pungens	*Xanthorrhoea resinifera*	*Xanthosia pilosa*

5.

6. The total flora species list for the community may be larger than that given above, with many species present only in one or two sites or in very small quantity. In any particular site, not all of the assemblage listed above may be present. At any one time some species may only be present as seeds in the soil seed bank with no above ground individuals present. Invertebrate species are poorly known but some species may be restricted to soils or canopy trees and shrubs. The species composition of a site will be influenced by the size of the site and by its recent disturbance history. For a number of years after a major disturbance dominance by a few species (such as *Kunzea ambigua* or *Leptospermum laevigatum*) may occur, with gradual restoration of a more complex floristic composition and vegetation structure over time. The balance between species will change with time since fire, and may also change in response to changes in fire regimes (e.g. fire frequency).

7. The Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion is distinguished from the coastal heath which occurs along the eastern seaboard on soils derived either directly from sandstone or, if aeolian, of younger age than those of the Eastern Suburbs Banksia Scrub. Coastal heath is characteristically much lower than Eastern Suburbs Banksia Scrub and, although sharing many species with the Eastern Suburbs Banksia Scrub, characteristically contains a more maritime element including *Baeckea imbricata*, *Correa alba* and *Westringia fruticosa.*

   Heathland with *Banksia aemula* has been recorded from the Central Coast by Benson & Howell (1994). These stands have a less dense shrub layer, a greater density of graminoids in the ground layer and differences in total floristics when compared with Eastern Suburbs Banksia Scrub in the Sydney Basin Bioergion as defined in this determination and are not regarded as part of this community.

8. The Community has been reported from areas of sand deposits in the local government areas of Botany, Manly, Randwick, Waverley and Woollahra which are all within the Sydney Basin Bioregion. On North Head, within Manly local government area the ecological community occurs on a sand sheet of similar age and composition to that on which the ecological community occurs further south.

9. The Scientific Committee noted that general information on the Eastern Suburbs Banksia Scrub is provided in Benson D & Howell J 1990. 'Taken for Granted - The Bushland of Sydney and its Suburbs'. Kangaroo Press, Kenthurst.

10. Less than 1% of the original area of the community currently exists in the form of a number of remnants.

11. Threats to the survival of the community include fragmentation, development, increased nutrient status, inappropriate fire regimes, invasion by exotic plants, grazing by horses and rabbits, erosion from use of bicycles, motorcycles and from excessive pedestrian use.

12. Although a small part of the surviving Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion is included within the Botany Bay National Park, this in itself does not ensure the survival of the community unless the threats to the integrity of the community are ameliorated.

13. In view of the above the Scientific Committee is of the opinion that the Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate.

Proposed Gazettal date: 23/08/02
Exhibition period: 23/08/02 – 27/09/02

Reference:

Benson, D. & Howell, J. (1994). The natural vegetation of the Sydney 1:100,000 map sheet. *Cunninghamia* **3(4)**, 679 - 787

APPENDIX 2: SUMMARY OF LOCAL PLANNING AND LEGISLATIVE FRAMEWORK

LOCAL GOVERNMENT REGULATIONS

A number of government acts and policies have relevance to the management of native vegetation within Waverley Local Government Area (**hereafter the 'LGA'**). The most significant of these are discussed below.

Waverley Local Environment Plan 1996

Waverley LEP 1996 controls the zoning of land within the Municipality, and determines the purposes of any buildings erected, or works carried out on that land.

Under the provisions of the *LEP*, land within the subject site Lot 23 is zoned 6(c) Open Space. Adjoining land - Lot 1 DOCS site (west) is currently zoned 5(a) Special Uses (Hospital), and Lot 22 former TAFE site (north and east) is zoned 5(a) Special Uses (Education Establishment).

In order to extend its existing facilities, Moriah College applied to Waverley to rezone Lot 1 from 5(a) Special Uses (Hospital) to 5(a) Special Uses (Educational Establishment). The Department of Urban Affairs and Planning on 14 December 2001 approved rezoning.

Waverley LEP 1996 also identifies heritage items within the Municipality. The York Road Bushland (the larger site) was recognised in the Waverley Heritage Study (Perumal Murphy 1993) as being a 'significant area of remnant bushland', having both historic and botanic values. The site is described therein as "remnant bushland on an old sand dune, partly degraded". The site is listed by the *LEP* as a local heritage landscape item, mainly for its rarity value.

Tree Preservation Order 1993

Waverley Council's Tree Preservation Order prohibits the pruning, cutting down, lopping, topping, ringbarking, removal or wilful destruction of any tree without the written consent of the Council, which may be subject to conditions.

The Tree Preservation Order applies to all trees:

- Over four (4) metres in height, or
- Four (4) metres in canopy width, or
- 30 cm in trunk width one (1) m above the ground, or
- Any tree listed in the Waverley Register of Significant Trees.

There are 125 introduced (or exotic) trees in the subject site Lot 23. These comprise 124 Monterey Pine (*Pinus radiata*) and a single Queensland Brush Box (*Lophostemon confertus*), which were planted as a landscape feature along the York Road frontage by the then-land managers -- NSW Department of Public Works (see Figure 6).

Monterey Pine, Brush Box and a number of Indian Coral Trees (*Erythrina sykesii*) were also planted on land now occupied by Moriah College. These trees have spread from their planting sites and are naturalised throughout the York Road Bushland (UBMC 2000a).

These trees are subject to Waverley's Tree Preservation Order, and their removal or lopping is subject to Council permission. It is understood that permission to remove these trees will be inherent in Council's Conditions of Consent.

STATE GOVERNMENT LEGISLATION

Threatened Species Conservation Act 1995

The *TSC Act 1995* aims to conserve threatened species, populations, ecological communities and their habitats; to promote their recovery; and to manage the processes that threaten or endanger them. The Scientific Committee established by the Act has listed a number of threatened flora and fauna species under Schedules 1 and 2, and plant communities considered to be at risk of extinction as 'endangered ecological communities' under Schedule 1, Part 3 [35].

The Act has made a number of consequential amendments to the *Environment Planning &Assessment Act 1979* and the way in which threatened species are considered in development and environmental processes. One such change was the introduction of Section 5A (the Eight-part Test), which is used to determine whether a development or activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats.

A 'modified form' of Eastern Suburbs Banksia Scrub occurs within the York Road Bushland (UBMC 1996a). As this plant community is listed under the Schedules of the *TSC Act 1995* as 'endangered', any proposal which has the potential to impact on the vegetation is subject to the application of the Eight-part Test.

The *TSC Act 1995* also lists a number of 'Key Threatening Processes' under Schedule 3 of the Act. These include predation by the European Red Fox (*Vulpes vulpes*), invasion of coastal communities by Bitou Bush (*Chrysanthemoides moniliferum*), high frequency fire, and the removal of bush rock.

The NSW Scientific Committee has also listed 'clearing of native vegetation' as a Key Threatening Process (21 September 2001). The Final Determination defines 'clearing' as:

> *.....the destruction of a sufficient proportion of one or more strata (layers) within a stand of vegetation so as to result in the loss, or long-term modification of the structure, composition and ecological function of stand or stand.*

Although the bushland rehabilitation strategy proposed for Lot 23 does not include any action identified as a 'Key Threatening Process', the Determination would have application to any future proposal to clear remnant native vegetation elsewhere within the larger York Road Bushland site.

State Environmental Planning Policy No 19 - Bushland in Urban Areas

SEPP-19 aims to protect and preserve bushland within the Sydney Metropolitan area, and in those other areas of the State which nominate for inclusion under the terms of the Policy. The application of the Policy is restricted to bushland in public ownership, that is, to land zoned as Open Space or Community Land. This zoning applies mainly to bushland in public reserves that are managed by local government authorities (local councils).

For the purposes of *SEPP-19*, urban bushland is defined as:

> *land on which there is vegetation, which is either a reminder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation.*

Clause 6 (1) of the Policy states that "A person shall not disturb bushland zoned or reserved for public open space purposes without the consent of Council" and Clause 7 (2) states that "A public authority shall not disturb bushland for a purpose referred to in Clause 6 (2) unless it has first had regard to the aims of the Policy".

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[35] See Appendix 1 for Final Determination (June 1997) and Appendix 1b for the (new) Final Determination (December 2001) for Eastern Suburbs Banksia Scrub.

Further, Clause 9 requires that where development is to be carried out on land which adjoins bushland protected by *SEPP-19*, the Consent Authority (usually council) must "consider the need to retain any bushland on the land", as well as the impact of the proposed development on any adjacent protected bushland.

Lot 23 (managed by CPMPT) is zoned as 5a (Special Uses) and is not designated as 'Community Land'. Therefore the provisions of *SEPP-19* do not apply. However, in the spirit of the legislation, and in recognition of the principle of Environmentally Sustainable Development, the aims and objectives of *SEPP-19* have been considered, and as far as practicable, these have been incorporated into the York Road VMP.

Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* replaced weed control legislation dating from the early part of the century (*Local Government Act 1919*), and is itself currently under review. The Act allows for the declaration of noxious plants in four (4) categories (W1 to W4), grouped according to the specific action(s) required to control them.

If noxious plants (as identified by the Act) are present on private land, the landholder has a legal responsibility to control them and to prevent their spread onto adjoining land. Similarly, noxious plants occurring on public land must be controlled and prevented from spreading, so local government and State government agencies are also required to abide by the requirements of the *Noxious Weeds Act.*

On land in the subject site Lot 23, only *Lantana camara* (Lantana) is declared in Waverley LGA. However, there are another two (2) listed noxious plants on the adjoining lots within the York Road Bushland, these being *Cortaderia selloana* (Pampas Grass) and *Cestrum parqui* (Green Cestrum).

Rural Fires Act 1997

Section 63 of the *Rural Fires Act, 1997* requires owners, occupiers, or public authorities managing lands, to take practicable steps to prevent the occurrence of bushfires, and to minimise the danger of the spread of bushfires.

A Bushfire Risk Management Plan has been prepared by the Eastern Suburbs District Bushfire Management Committee (draft 2002) in order to provide for the co-ordinated prevention and mitigation of bushfires in Sydney's eastern suburbs. This Plan identifies the potential fire hazard and anticipated fire intensities for the dominant plant communities in the region (i.e. dry sclerophyll forests, grasslands and open woodlands, and heath). Fire intensity is described as 'moderate' for short heath (< 2 metres in height), and as 'moderate to high' for tall heath (as occurs at York Road).

In preparing the Vegetation Management Plan for Lot 23, the bushfire risk to property on adjoining land and to bushland in the subject site itself has been considered through a Bushfire Hazard Assessment (AVK 2001). Although the risk of bushfire in the York Road Bushland has been assessed as 'relatively low' (see Section 4.5.1), this risk must be taken into account in managing bushland on Lot 23, particularly in relation to ensuring that surrounding developments are adequately protected.

Management of the potential fire hazard is discussed in Section 4.5.1, and a copy of the Bushfire Hazard Assessment has been included as Appendix 7.

COMMONWEALTH GOVERNMENT LEGISLATION

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *EPBC Act 1999* provides protection for matters of national environmental significance. It promotes Ecologically Sustainable Development (ESD) through formally requiring its principals to be taken into account when considering project approvals. The Act also requires Commonwealth agencies to report annually on how their activities satisfy these principles. The Commonwealth *EPBC Act 1999*, which came into force in July 2000, replaces the *Environment Protection (Impact of Proposals) Act 1974*; the *Endangered Species Protection Act 1992*; the *National Parks and Wildlife Conservation Act 1975*; the *World Heritage Properties Conservation Act 1983*; and the *Whale Protection Act 1980*.

Under the *EPBC Act 1999*, the Commonwealth Minister for the Environment must, by instrument published in the Gazette, establish a list of threatened species, threatened ecological communities and Key Threatening Processes. These lists originally contained only those species contained in Schedules 1, 2 and 3 of the *Endangered Species Protection Act 1992*, as in force immediately before the commencement of the *Act*. However, the Commonwealth *EPBC Act 1999* has increasingly listed species, populations and communities identified by the State as threatened and in danger of extinction.

The Commonwealth *EPBC Act 1999* has listed Sydney Eastern Suburbs Banksia Scrub as a 'threatened ecological community', while 'Land Clearance' has also been listed as a 'Key Threatening Process' (effective 4 April 2001). Therefore, any development, which has the potential to impact on the remnant bushland in York Road, must be referred to the Federal Minister for the Environment for approval.

This VMP document is subject to the approval of Environment Australia in respect of the Master Plan Stage 1 DA proposal, being a 'Controlled Action' under the EPBC Act 1999 Permission from the Minister is pending (@ 28.09.02).

OTHER RELEVANT LEGISLATION

There are a number of other legal instruments with relevance to the management of native bushland on both private and public lands in Waverley Local Government Area. These include:

- Catchment Management Act 1989.
- Heritage Act 1977
- Occupational Health and Safety Act 1983.
- Pesticides Act 1999 (replaces Pesticides Act 1978 as of July 1 2000).
- Protection of the Environment Operations Act 1997 (amends the Pollution Control Act 1970, Clean Waters Act 1970 and Soil Conservation Act 1938).

APPENDIX 3: FLORA INVESTIGATIONS FOR LOT 23, YORK ROAD BUSHLAND

(D. Thomas for UBMC, updated November 2000)

PREVIOUS INVESTIGATIONS

Investigations on the larger York Road Bushland site (incorporating areas now described as Lot 1, Lot 22 and Lot 23) have been undertaken over a number of years (UBMC 1996, 1999a, 1999b, 2000a, 2000b). A Species Impact Statement (UBMC 2000c) has been prepared to assess the impacts of the proposed Moriah College development on remnant bushland in Lot 22 and to identify potential impacts on bushland Lot 23 (the subject site).

UBMC (2000a, 2000b) mapped the vegetation in the subject site as containing:

- 7,333m² bushland;
- 3,139 m² non-bushland;
- 48 m² scattered natives; and
- 260 m² of non-mapped/developed areas (UBMC 2000c).

Areas identified as 'bushland' were determined to be where more than one (1) structural stratum was present (. i.e. canopy, sub-canopy, shrub, understorey or herb layers), which follows SEPP-19*. Areas identified as supporting only 'scattered natives' were present as:

- A single species, occurring in a scattered distribution or in small groups (i.e. typically fewer than five (5) individuals present); and/or
- A monotypic single species, occurring in only one (1) stratum (eg. *Leptospermum laevigatum* thickets).

The native vegetation in the subject site was found to conform to the community described by Benson and Howell (1994) as "Open-scrub: *Monotoca elliptica – Banksia integrifolia – Leptospermum laevigatum*" (UBMC 2000c). This community appears to be a variant within the Eastern Suburbs Banksia Scrub descriptive (as per Determinations 1997, 2002).

The dominant plant form within the study area is a large shrub - *Leptospermum laevigatum*. The Final Determination states that *Leptospermum laevigatum* is a species that may dominate a site after disturbance (*Kunzea ambigua* is also identified). The floristics and structure of the plant community was noted to be generally very simplified compared to the description given in the Final Determination (NSW Scientific Committee 1997. 2002). Refer to Appendix 1.

CURRENT INVESTIGATIONS

Methodology

In order to update existing information and to provide accurate baseline data to facilitate future monitoring of the bushland rehabilitation program, a supplementary flora survey was carried out in late 2001.

Field survey was undertaken by David Thomas (Cert. Marine Eng. Tech., Dert. Comp. Stem/Motor Ships (Class 1), Cert. Bush Regen., BSc. (in progress)), Judith Rawling (BA, Dip Ed, MEnvStud) and Adele Crane (BscHons) over a period of four (4) days in October and November 2001. Approximately 28 hours were spent on field survey.

Survey methodology adopted a quantitative approach to allow for future statistical analysis. This involved placing a computer-generated grid overlay onto the coloured aerial photograph

* For the purposes of SEPP-19, urban bushland is defined as:
....land on which there is vegetation which is either a reminder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation.

which serves as the site map. Grids were numbered sequentially. Non-random selection of quadrats ensured thorough investigation of all parts of the subject site.

All parts of Lot 23 and small areas of contiguous bushland in Lots 1 (DOCS site) and 22 (former TAFE site) were incorporated into the grid overlay. A system of 20 contiguous 20 x 20 metre quadrats was set up in the study area. Owing to the irregular shape of the study area, some areas occupied less than 20 x 20 metres (Figure 5). These were recorded as subsets of the nearest adjoining quadrat, and assigned the same quadrat number and a suffix (a, b or c).

Items recorded in each quadrat were:

- all flora species occurring;
- indicative abundance per species, using an amended version of the Braun-Blanquet system (Chapman & Morrison 1986);
- plant community structure based on Specht (1970); and
- impacts on native vegetation.

The modified Braun-Blanquet system used the following categories as indicators of species abundance. Abundance ranking was determined as follows:

1 = rare and less than 5% of quadrat
2 = occasional
3 = common
4a = very common
4b = 5-25% of quadrat
5 = 26-50%
6 = 50-75%
7 = more than 75% of quadrat

Plant nomenclature accords with Harden (1990-1993). except for the subsequent revision of *Tradescantia albiflora* to *Tradescantia fluminensis, Araujia hortorum to A. sericifera,* and other changes as published in *Cunninghamia.*

Due to the small size of the subject site, the relative ease of access to all parts of the site, and the availability of information from previous studies and reports, it is considered that there were no limitations to the flora survey.

Results

The vegetation throughout the subject site was observed to be a mixture of indigenous and introduced plant communities. These are described as:

- Coastal Teatree Scrub/Woodland, with variable Radiata Pine emergents[3], and
- Introduced Herbland or Grassland.

The distribution and density of plant species in Lots 23 and 1 are shown in Figure 5.

In total, 92 species were recorded in the subject site Lot 23. Of these, 32 species (35%) were native, and 60 species (65%) were exotic or non-indigenous native species.

Three additional species were recorded compared to previous surveys (UBMC, 2000,1999): These were: *Asplenium flabellifolium* (Quadrat 2); *Cyathochaeta diandra* (Quadrat 22a); and *Dichondra repens* (Quadrat 24a). The identification of *Cyathochaeta diandra* was tentative only owing to its small size and immature stage of development.

[3] Also referred to as 'modified Eastern Suburbs Banksia Scrub' (UBMC 1996a)

Cheilanthes sieberi (vicinity of Quadrat 4) and *Acacia suaveolens* (vicinity of Quadrat 17) were not recorded again, although they had been noted during previous surveys. The aboveground portion of *Cheilanthes sieberi* may have died back during the extended dry period which preceded the field survey.

Leptospermum laevigatum was recorded in all quadrats, although the density varied from occasional immature specimens to dense old-aged thickets.

Other widespread and common species included *Pinus radiata, Monotoca elliptica, Acacia longifolia, Lantana camara, Ochna serrulata, Cynodon dactylon, Ehrharta erecta* and *Protasparagus aethiopicum.*

Most of the smaller indigenous shrubs were restricted in distribution and relatively low numbers (eg. *Astroloma pinifolium, Brachyloma daphnoides* and *Dillwynia retorta.* An exception to this was *Micrantheum ericoides*, which occurred in moderate numbers, and was widespread.

Seven (7) indigenous species were limited to one (1) individual only within the study area. These were *Banksia serrata, Persoonia lanceolata, Kunzea ambigua, Asplenium flabellifolium, Cheilanthes seeberi, Wahlenbergia gracilis* and *Lomandra glauca.*

Locally indigenous trees were restricted to the northern section of bushland. Most local shrub species were restricted to central locations: a relatively large concentration at Quadrats 7, 8 and 12; and a small concentration at Quadrats 15/15a. *Acacia ulicifolia* was scattered through the western and southern sections of the site.

Native herbs were generally very sparse or absent, with *Dichelachne crinita, Commelina cyanea, Dianella revoluta* and *Isolepis nodosa* being widespread, although occurring only in small numbers.

No naturally occurring vines were recorded.

Weeds were very common in all quadrats. *Pinus radiata* was the only widespread tree species. *Lantana camara* and *Ochna serrulata* were the main exotic shrub species.

Introduced herbaceous species were common, widespread and locally dense, especially *Tradescantia fluminensis, Ehrharta erecta, Cynodon dactylon, Melinus repens, Pennesetum clandestinum, Protasparagus aethiopicum* and *Stenotaphrum succedaneum. Vulpia muralis* was locally common in some open locations, such as Quadrat 17.

Four species of vines, considered to be environmental weeds in Sydney bushland., were recorded in a few local concentrations. These were: *Anredera cordifolia* (Quadrat 18); *Araujia sericifera* (Quadrats 3 and 20); *Ipomoea indica* (Quadrats 22 and 24); and *Lonicera japonica* (Quadrat 6c).

Three noxious weeds were recorded, however, only *Lantana camara* was found to occur within Lot 23, while the remaining two (2) species - *Cestrum parqui* and *Cortaderia selloana* - were found within areas of contiguous bushland on Lot 1.

Appendix 4: Plant Species Recorded in Lots 23 and Part of Lot 1, York Road Bushland (Field Survey - October/November 2001)[1]

Plant Community: modified Eastern Suburbs Banksia Scrub

	Quadrat																																									
	1	2	3	4	4a	5	5a	6	6a	6b	6c	7	8	9	9a	10	10a	11	12	13	14	15	15a	16	16a	17	18	19	19a	19b	20	20a	21	21a	22	22a	23	24	24a	25	25a	25b
Canopy & Emergents																																										
*Acacia binervia					1																																				
Banksia integrifolia	1				2		2																																		
B. serrata												4b							4b																							
Eucalyptus botryoides		1	4b	1																																					
Leptospermum laevigatum	5	5	6	4b	5	4b	4b	5	7	4b	5	4b	7	4b	4b	5	3	6	2	5	5	4b	4b	4b	2	2	2	4b	3	4b	4b	4b	4b	4b	2	3	5	4b	4b	5	2	4b
*Lophostemon confertus					1																												1									
*Melaleuca quinquenervia																																										
*Pinus radiata	1	4b	4b	4b	1	4b				1		2	1	4b	4b	5	4b	4b	2	4b	2	4b	4b	4b	4b	2	4b	4b	4b	1	4b	4b	4b	2	1	1		4b	4b	4b	1	4b
Mid Stratum																																										
Acacia longifolia	1	2		1	2	2	1	2	1	2	2	1	2	1	2	2	2	2	3	2	1	2		1		2		1	1		2	1	1		1		1	1	1	2		2
Acacia suaveolens														2		1	2	1		1				1		1		2			1											
A. ulicifolia												2	1						2		1					1																
Astroloma pinifolia		1		2										1																												
Banksia integrifolia															1	1																											
Brachyloma daphnoides												2	2		2			2	3	1		1	2																			
*Celtis sp.										1																																1
*Cestrum parqui	1											2							1	1																					1		
Dillwynia retorta																																										
Ficus rubiginosa																															1											
Kunzea ambigua																																										
*Lantana camara		2		2	2	4b	4b	4a	2	4b	4b	1	2	1	2	3	3	2		2	2			4a	4b	4b	5	4b	4b	2	3	3	2	2	5		3	4b	4b	3		
Leucopogon juniperinus		2	2	2		1			2		2	1																												1		1
*Ligustrum lucidum			1									2	2	1					2	2																					
Monotoca elliptica	1	1	1	1											2	1	1	2	2	2	1		1									1										
*Ochna serrulata		2	2	2		2	3	3	2	2	3					2		1																							
*Olea europaea ssp. africana										1																																
*Oleander neriifolia																																										
Persoonia lanceolata																																										
Pittosporum undulatum		2	1			2														1																					
*Phoenix sp.																																										
Ground Cover																																										
Ferns																																										
Asplenium flabellifolium		1																																								
*Nephrolepis cordifolia															2							1																				
Dicots																																										
*Acetosa sagittata							1																																			
*A. vulgaris						1		1																																	3		
*Acetosella vulgaris							1																																	2		
*Ageratina riparium																																										
*?Artemisia verlotiorum					2																																	1			
Banksia integrifolia		1	1																																				4a	2		
*Bidens pilosa																																										
Bossiaea heterophylla																																										
B. scolopendria			1																1																							
*Bryophyllum delagoense			1	1																																						
*Cinnamomum camphora		1				2		2		2	2	1				2			1		1		1			1	1			3	1	2		1	3		2	2	2		
*Conyza albida																				1		1		1																		
Dichondra ?repens			2																																							
*Eriobotrya japonica																																										
*Gnaphalium sp.																																										
*Hypochaeris ?microcephala																2																										
*H. radicata		2	2	2	1	3		2		2	2	2	1		2		4a		2	1		2		2	2	3		2	2		2	1	2		2	4a		2		2	1
*Lagunaria patersonii			1																																						
Micrantheum ericoides										1		2	2		3			2	3	1	2		3																		
*Olea europaea ssp. africana	1	1	2		1	2		2	2																	1				1	2	1	1	3		1	1					

	1	2	3	4	4a	5	5a	6	6a	6b	6c	7	8	9	9a	10	10a	11	12	13	14	15	15a	16	16a	17	18	19	19a	19b	20	20a	21	21a	22	22a	23	24	24a	25	25a	25b
*Oxalis pes-caprae																																										
*Parietaria judaica																																										
*Petrorhagia nanteuilii																																								2	
Pittosporum undulatum						2																																			
*Plantago lanceolata																																									
*Polycarpon tetraphyllus					1			1			2			2																								2	2	2	2	
*Senecio madagascariensis				2	2	2							1		1			2																							
*Sida rhombifolia								1																					1		1										
*Silene sp.					1																																				
*Solanum nigrum				1	1												1												1												
*Sonchus oleraceus					1	1					2				1																										
*Taraxacum officinale	1																																	1							
*Tropaeolum majus																				1																					
*Verbascum virgatum																																									
*Verbena sp.																																						1			
Wahlenbergia gracilis						1																																			
Monocots																																									
*Agave sp.						1		1																																		
*Briza major						2																													2				2			
*Bromus catharticus																						2						3	2	2	2	3	2	3						1	
*Chlorophytum comosum																																		1							
Commelina cyanea				3			2																												3						
*Cortaderia selloana									1	2		1						1					2								1		1					1	2	2		
?Cyathochaeta diandra																																										
*Cynodon dactylon		2	2	4b	2	4b	2		3		2	3		1			4b	2		1	3	3		4b	4b	4b	4b	3	4b		3	3		3			1				
Dianella revoluta										1				2	2	2		1		1	1	3		1	3		2		1	3								2	2	2	4b	
Dichelachne crinita		1		1		1								2	1			2					1		3	2		2		2	2	2									2
*Ehrharta erecta	3	4a	4a	4a	3	3	4b	3	3	3	4b	2	2	4a		4a		3	3	2	3		3			3	4a	4a	2	3	4b	4a	4b	4a	4a	4a	4b	4a	3	4a		2
Eragrostis brownii																																										
*Eragrostis curvula	3							1		2			1																													
*Freesia refracta			2			2																																	3		2	
Isolepis nodosa	2							2	2	1	2																															
*Lolium perenne				1																																		1	2	1		1
Lomandra glauca																													1													
L. longifolia	1										1	2	1						3						1																	
*Melinus repens	2				3	2								1	4a		3					3	2	4b	4a	2			4a						1				1			
*Nassella neesiana	2			2													1																						3	2		
*Nothoscordum borbonicum	1																																				2		2		2	
*Pennesetum clandestinum											1																				2		2			1				
*?Phoenix sp.			1	1																							1	1		1				1			1			
Poaceae sp. (unknown grass)											1	1		2			2			1													1			1				
*Protasparagus aethiopicum		2	3	3	2	3	3				1	1	2	2	4a	2	3	2		2	2	4a	3	2	2	2	2		3	3	2	3	1	2				2			
*Sporobolus indica var capensis					2																																				
*Stenocarpus succedaneum		2	3	4a			2			2		2		2	3	2	3				2	3	2	2	2	2		4a		2	3		2		3			3	2	2		2
*Tradescantia fluminensis				1					2	1	2				1													1		2	2	1	2	2	4b		4b	4b	3			
*Vulpia muralis																	2								2			1		2									2			
*?Watsonia sp.																								1																		
*Yucca Sp.																																										
Vines & Mistletoe																																									
*Anredera cordifolia																																									
*Araujia sericifera			1																							1															
*Ipomoea indica																															1										
*Lonicera japonica											1																															
Muellerina celastroides						1																																				
Key																																									
1 = < 5% rare	2 = < 5% occasional							3 = < 5% common					4a = < 5% very common							4b = 5 - 20%					5 = 20 - 50%																		

1. The above table lists the species recorded during the field survey undertaken by David Thomas, Judith Rawling and Adelel Crane in October/November 2001. The species listed below were recorded in a previous survey of Lots 1, 22 and 23 by D. Hirschfield (5.1.2000

Eragrostis brownii, Cheilanthes sieberi, Cheilanthes sieberi, Danthonia sp., Pterostylis sp.

APPENDIX 5: PROFILE OF THE GREY-HEADED FLYING FOX (*PTEROPUS POLIOCEPHALUS*)

The Grey-headed Flying-fox utilises aural and visual signals, these animals having good eyesight and vocal communications. The Grey-headed Flying-fox is a canopy feeding frugivorous, blossom-eater and nectarivore of rainforests, open forests, woodlands, *Melaleuca* swamps and *Banksia* woodlands. Through its foraging activities within these habitats it plays an important ecosystem function by providing a means of seed dispersal and pollination for many indigenous tree species (NSW Scientific Committee 2001).

The Grey-headed Flying-fox also feeds on introduced trees including commercial fruit crops. The Grey-headed Flying-fox roosts and breeds communally with "camps" containing from 500 to 10,000 individuals (Churchill 1998). The camps are usually located in the branches of large trees in forests, thick scrub, swamps or mangroves.

The selection criteria of particular areas as roosting and breeding sites by Flying-foxes has not yet been identified but may include issues such as protection from strong winds, seclusion, occurrence of a particular topographical feature which assists in navigation, proximity to food sources and/or access to updraughts for flight (Eby 1995).

Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring. Foraging occurs opportunistically, often at distances up to 30 km from camps, and occasionally up to 60–70 km per night, in response to patchy food resources (NSW Scientific Committee 2001).

The Grey-headed Flying-fox is threatened through the clearing or modification of native vegetation (including both potential camp habitats and foraging resources), uncontrolled culling using destructive methods such as shooting and electrocution, by direct harassment via shooting at roosts and the destruction of camps (NSW Scientific Committee 2001).

In the vicinity of the study area, two Flying-fox camps are known to be present. The first of these occurs within the Royal Botanic Gardens, while the second is located on the Kurnell Peninsula, west of the Caltex Oil Refinery (refer to Figure 1). In addition, two other camps are known within the Sydney region, these being at Gordon and Fairfield.

In relation to the Royal Botanic Gardens and Kurnell colonies, these support around 8500 and 10000 individuals respectively (A. Leishman, Royal Botanic Gardens pers .comm. 15/5/2002, P. Eby, Researcher National Parks and Wildlife Service pers. comm. 21/5/2002). The Royal Botanic Garden's colony is generally a permanent camp (though some individuals do migrate north during the winter months) (A. Leishman, pers. comm. 15/5/2002), while the Kurnell Peninsula colony is more seasonal (P.Eby, pers. comm. 21/5/2002).

APPENDIX 6: FAUNA SURVEY

(Extract from Species Impact Statement, UBMC 2000c)

1 REQUIREMENT TO SURVEY

Description of Survey Techniques and Survey Sites

A fauna survey of Lot 22, York Road, Queens Park, was undertaken by Deryk Engel (B.Env.Sc. Hons) on the 26 August 1996, and by Deryk Engel and Mishy Mckensy (BSc.) on the 20 December 1999 and 1 February 2000.

Contact details for Engel and Mckensy are phone (02) 9523 2016, fax (02) 9544 1835, mailing (PO Box 1, Bundeena NSW 2230) and email (lesryk1@tpg.com.au).

During these field surveys:

- The diversity of native and exotic species present within both the site, and surrounding area, were documented.
- The conservation significance of the species recorded identified through consultation with the *Threatened Species Conservation Act 1995*, *National Parks and Wildlife Act 1974*, Randwick and Waverley Council's State of the Environment Reports, standard texts, and past ecological studies prepared both on the site, and in the surrounding region.
- The structure and diversity of the fauna habitats present were recorded.
- The value of the habitats present to be significant for the life cycle needs and, thereby support or be utilised by resident populations of species of conservation concern, as listed under Schedules 1 and 2 of the *Threatened Species Conservation Act 1995*, were determined.

Fauna identification techniques employed to identify the diversity of species present on, or adjacent, to the site were:

- Habitat assessment;
- Direct observation of fauna species;
- Spotlighting for nocturnal species and ultrasonic detection's for microchiropteran (insectivorous bat) species;
- Hand searches within, and under, litter and ground debris for reptiles and frogs;
- Bird watching;
- Call identification; and
- The identification of indirect evidence, such as tracks, scratchings and scats (as per Triggs 1996).

Due to the open nature of the site, the dates on which the various surveys were undertaken, and the conditions experienced during the field survey, no limitations to the outcomes of the fauna study were present. The conditions and times were conducive to the detection of the diversity of fauna species present, particularly any likely to be of conservation significance.

Documenting Survey Effort and Results

Times spent undertaking each activity is provided in Table A.6.1.

Table A.6.1: Description of Survey Effort – Fauna Investigations

Habitat Identification and Assessment	1 hour
Direct Observation	2.5 hours
Indirect Observation	1.5 hours
Spotlighting	1 hour
Ultrasonic Detection	1 hour
Ground Debris / Litter Searches	1 hour
Total Survey Effort	**8 hours**

Due to the open condition of the habitats present within and adjacent to the study area, visibility and access to all portions of the proposed development was high. While traversing the study area, the strategy employed for the field investigation followed an adaptation of the 'Random Meander Method' described in Cropper (1993), which has been modified to be suitable for fauna surveys. By undertaking a survey of the site using this strategy, all fauna habitats present within and adjacent to the study area were identified and investigated, and the majority of resident fauna species recorded.

Spotlighting of the stands of vegetation present with, and adjacent to, Lot 22 was undertaken on the 26 August 1996. The weather conditions experienced during the night survey were clear skies, mild to warm temperatures and slight breezes. During the nocturnal survey, all navigable paths and walking tracks were targeted, and a 100 watt hand held spotlight used. During the spotlighting sessions, efforts were made to target habitats considered suitable for nocturnal animals, particularly those species of conservation significance known or potentially occurring in the region. By the completion of the spotlighting session, a total of 60 minutes of spotlighting had been accumulated, with a total nocturnal survey effort of two (2) hours being established.

Ultrasonic detection targeting those microchiropterans potentially present within the study area was undertaken on the 26 August 1996. During the field survey, a detector was place at two (2) locations, the first being facing east, across the "car park" area, of Lot 23, and the second facing south along the former entrance to Lot 22.

During the ultrasonic session, which was undertaken a) just after dusk thereby targeting any individuals which maybe leaving roosting sites and b) around one (1) hour after dusk fall thereby targeting foraging animals, the detector was left in place for 30 minutes per site with any bat signals obtained being sent to FBN Bat Surveys, Newcastle for analysis.

During the spotlighting sessions, the identification of any distinctive calls, including frogs, owls and vocal mammal species, was also undertaken, with all calls heard being identified in the field.

The climatic conditions experienced during all diurnal field investigations were clear skies, warm temperatures and slight breezes.

Due to the size of the study area, and the physical condition of both the site and the adjacent habitats, few native species were recorded. Those that were recorded within, and adjacent to, Lot 22, were 21 native birds, one (1) native mammal, six (6) reptiles and one (1) frog.

In regards to the detection of these species:

- All birds were observed within, or traversing over, the woodland habitat, or identified from their distinctive calls.
- The Brown-striped Frog *Limnodynastes peroni*, Michael's Oak Skink *Cyclodomorphous michaeli*, Three-toed Skink *Saiphos equalis* and Eastern Blue-tongued Lizard *Tiliqua scincoides* were all hand captured while searching under and within urban refuse and leaf litter within Lot 23;

- The Grass Skink *Lampropholis delicata* and Garden Skink *Lampropholis guichenoti* were both observed while traversing the study area;
- The Weasel Skink *Saproscincus mustelinus* was hand captured sheltering under some urban refuse within Lot 1; and
- The Grey-headed Flying Fox (*Pteropus poliocephalus*) was observed flying over the site during the spotlighting session.

While conducting the field investigations:

- No microchiropterans were recorded or indicated;
- Predation of native birds by introduced predators was noted to be high;
- No trees with any suitable hollows were found;
- No caves or suitable cave substitutes were recorded; and
- No creeklines, drainage easements or any other aquatic environments were observed.

Of the species recorded during the field surveys, none are listed under the Schedules of the *TSC Act*. All species recorded are generally common to abundant and most would be regularly recorded within urban environments.

In addition to the species recorded, six (6) native mammals, 118 native birds, 21 reptiles and 15 frogs have been identified, or are expected to occur, within the surrounding regions.

Although this is the case, it is noted that a large number of these, for example, the water birds, have habitat requirements no components of which are present within the study area and would therefore not occur. Other species known or potentially present in the region have large home ranges, Lot 22 only forming a small, and peripheral, component of these. As such a larger proportion of the animals previously recorded or expected for the region would not occur or rely on the study area for any major component of their life cycle requirements.

Lists of fauna species recorded, expected or known from the region are provided in Appendix 5 of the Species Impact Statement (UBMC 2000c).

Of the species recorded for the region during previous studies, or expected to occur based on known distribution patterns, nine (9) are listed under the Schedules to the *TSC Act* (see Table A.6.2).

2 Assessment of Likely Impacts on Threatened Species and Populations

Assessment of Species Likely to be Effected

Based on the outcomes of the literature review, the field surveys and the habitat assessments it is not considered that any Scheduled Species would occur as resident populations within the study area. Similarly, none are considered to significantly rely on the poor quality of the fauna habitats present within Lot 22 such that, if these were removed, their populations, habitat and communities would be placed at risk of extinction.

Table A.6.2: Scheduled Species Known or Expected to Occur in the Vicinity of the Study Area

NAME	HABITAT REQUIREMENTS	CONSIDERATION OF IMPACTS
Green and Golden Bell Frog *Litoria aurea*	Water bodies which support a lack of well developed emergent vegetation, free of chemical contamination, presence of diurnal shelter, basking sites and refuge sites for hibernation over winter, feeding areas, aquatic breeding and spawning	**Likelihood Of Occurrence** Low. No suitable aquatic environments present within, or in close proximity to, the study area.

NAME	HABITAT REQUIREMENTS	CONSIDERATION OF IMPACTS
	areas and an absence of exotic fish, such as Mosquito fish.	**Likely Impacts** Low. No impacts on the regional occurrence of this species will arise if the development proceeds as planned.
Little Tern *Stern albifrons*	Breeds on undisturbed, unvegetated sites near estuaries and adjacent to freshwater and saline expanses of water. Only one population known for the area and this occurs on Towra Spit, Towra Point Nature Reserve.	**Likelihood Of Occurrence** Low. Site unsuitable for the life cycle needs of this species. **Likely Impacts** Low. No impacts on the regional occurrence of this species will arise if the development proceeds as planned. No oceans or estuarine areas will be affected.
Bush Stone-curlew *Burhinus grallarius*	Grassy woodlands or lightly timbered open country. Feeds on invertebrates such as beetles and grasshoppers. Nests on a scrape or small clearing on ground. Rare to extinct in closely settled areas.	**Likelihood Of Occurrence** Low. Unlikely due to the extent of predation observed and the proximity of urban areas. **Likely Impacts** Low. No impacts on the regional occurrence of this species will arise if the development proceeds as planned.
Regent Honeyeater *Xanthomyza phrygia*	Open forests, woodlands, timbered watercourses, and a variety of other habitat types. Constructs grass nest in trees or saplings. This species feeds primarily on four eucalypt species, Red Ironbark *Eucalyptus sideroxylon*, White Box *E. albens*, Yellow Box *E. melliodora* and Yellow Gum *E. leucoxylon* as well as heavy infestations of mistletoe (*Amyema* spp.).	**Likelihood Of Occurrence** Low. No significant stands of eucalypts present. May use trees during dispersing periods. **Likely Impacts** Low. Extent of similar and more diverse bushland within both Lot 23 and Centennial Park considered to provide a greater range of resources for this species. The development of the study area is therefore not considered to affect the regional occurrence of this species.
Common Bentwing-bat *Miniopterus schreibersii*	This species is the dominant cave-dwelling bat in south-eastern Australia. Occurs in a variety of habitats and roosts in caves, storm water channels, mines and roof cavities. Feeds on insects caught on the wing from within eucalypt woodlands and forests.	**Likelihood Of Occurrence** Low – high. Would not be using the site as a roosting area. May traverse over site during foraging periods. **Likely Impacts** Low. No caves or suitable cave substitutes were recorded, no individuals were detected during the field investigation, and no significant areas of potential foraging habitat will be cleared.
Eastern Freetail-bat *Mormopterus norfolkensis*	Confined to the east of the Great Dividing Range, this species is known to predominantly roost during the day in tree hollows. Emerging after dusk to feed on flying insects, the Eastern Freetail-bat hawks through the forest canopy, or in clearings at its edge.	**Likelihood Of Occurrence** Low – high. Would not be using the site as a roosting area. Likely to traverse over site during foraging periods. **Likely Impacts**

NAME	HABITAT REQUIREMENTS	CONSIDERATION OF IMPACTS
		Low. No trees with suitable hollows observed within study area. May forage within woodland habitat but more likely to occur and utilise habitats within Lot 23 and Centennial Parklands. No impacts on the potential occurrence of this species will arise if the development proceeds as planned.
Australasian Bittern *Botaurus poiciloptilus*	Shallow, vegetated freshwater or brackish swamps, usually dominated by tall, dense reed beds of *Typha* sp, *Juncus* sp and *Phragmites* sp. Nests on platforms of reeds and rushes, usually built over water in dense cover. Feeds on aquatic invertebrates, small fish and frogs, usually caught in shallow water or wet mud.	**Likelihood Of Occurrence** Low. No wetlands or other suitable aquatic environments present within study area. **Likely Impacts** Low. No impacts on the regional occurrence of this species will arise if the development proceeds as planned.
Black Bittern *Ixobrychus flavicollis*	Favours Casuarina-lined watercourses in which the Black Bittern builds it nests on a branch overhanging water within riparian vegetation. Foraging occurs in short marshy aquatic vegetation, where fish and invertebrates are fed upon.	**Likelihood Of Occurrence** Low. No watercourses or other suitable aquatic environments present within study area. **Likely Impacts** Low. No impacts on the regional occurrence of this species will arise if the development proceeds as planned.
Wallum Froglet *Crinia tinnula*	Originally thought to be confined to acid melaleuca swamps of the Wallum country, recent records for this species indicate that it is widely distributed in other areas of suitable habitat. The Wallum Froglet inhabits acidic wetlands, characterised by a dense sedge layer, and fringed by or including Broad-leaved Paperbark. At Botany Bay, as with other sites, these wetlands also contain dense stands of banksias.	**Likelihood Of Occurrence** Low. No suitable aquatic environments present within, or in close proximity to, the study area. **Likely Impacts** Low. No impacts on the regional occurrence of this species will arise if the development proceeds as planned.

Through consultation of Table 8 it is noted that those Scheduled Species previously recorded in, or expected for, the study region have specific habitat requirements on which they are dependent upon for their life cycle needs. Without these necessary habitat features, these species are not likely to occur in a particular area. Based on the findings of the field investigation, combined with the fauna species and habitats recorded, it is not considered that any of these necessary habitat features are present within, or in close proximity to, the study area.

Given that:

- The proposed development will generally remove mainly disturbed environments, and only a small portion of scrub / woodland;
- Within the subject site, no native trees are present;
- The main stand of scrub / woodland within the adjacent Lot 23 is to be retained and enhanced; and
- The proximity of Centennial Parklands and the diversity of fauna habitats available within this area;

it is not considered that any of these species will be significantly affected by the current proposal. No resident populations of any of these animals would occur within, or in close proximity to, the boundaries of the study area, and as such the works would not result in the extinction or displacement of any of these species.

An Eight-Part Test, as identified by the assessment criteria listed under Section 5A of the *EP&A Act*, was carried out and concluded that a Species Impact Statement for any of these species was not required. Therefore, based on the field survey results, a review of current literature and the outcomes of both the habitat and eight part test assessments, it is not considered necessary that any of these terrestrial threatened fauna species be further considered or addressed in this Species Impact Statement.

None of these species listed in Table 8 would occur within the site, and none would be further threatened if the works proceeded as planned.

DISCUSSION OF LOCAL AND REGIONAL ABUNDANCE

Discussion of Other Known Local Populations

No populations of any threatened fauna species were found on site. Therefore the development will not affect the regional status of any known local populations of threatened species.

Threatened species are known to be present within the conservation reserves of both Centennial Park and Botany Bay National Park. As these reserves are managed for the conservation and protection of native species, the long-term viability of these animals and their populations is considered to be guaranteed.

Discussion of Habitat Utilisation

During the field investigations, no threatened individuals were recorded within the subject site. No resident, transient, adult, juvenile, nesting or foraging Scheduled Species were recorded within, or adjacent to, the subject site. Given the quality of the habitats present, it is not considered that any threatened species would rely on the subject site such that their viability would be compromised if the development proceeds as planned.

Discussion of Corridors

Due to the proximity of urban areas to the north and east, no major regional fauna dispersal or movement corridors are considered to occur in the vicinity of the study area. The development of the study area will not disturb or modify any significant regional fauna dispersal patterns.

The retention and rehabilitation of Lot 23 is considered to ensure that any local fauna movements, those being within, or in close proximity to, the study area, are maintained and ensured. The retention and preservation of this woodland will ensure that the movement of native species between the study area and Centennial Parklands are retained.

ASSESSMENT OF HABITAT

Description of Habitat Values

Two (2) habitat types, that being a disturbed environment (grassland) and scrub / woodland are present within the subject site. Descriptions of each of these habitats follow, along with a consideration of its value for native species, particularly the threatened animals listed in Table A.2.1. Of these habitat types, the disturbed environment dominates the study area.

Habitats which surround the subject site, are a scrub / woodland to the west (of similar, better, structure to that described for the study area) and a developed area occupied by Moriah College along with its associated infrastructures to the east.

The disturbed areas within Lot 22 include, what is apparently, a former entrance to the site. This entrance has been cleared, levelled, contoured and, in parts, sealed through the placement of bitumen. The entrance has permitted the dumping and stockpiling of a large amount of construction and building waste,

and urban residential refuse. Stockpiles of bricks, rubble and other construction materials are common within this area.

Weed infestation and wind blown urban refuse is also high. Some exotic trees have established within this portion of the study area and these are up to 10 metres in height. While under taking the field investigations, no suitable hollows were observed within any of the trees present. Native and exotic shrubs were also present, these being of a medium distribution and to 3 metres in height. The ground cover is dominated by a high-density layer of exotic grasses and weeds to 0.5 metres in height.

The disturbed environments are not considered to be of value for any Scheduled Species. The level of usage and disturbance within these areas is considered to have displaced all but the most tolerant of urban associated native species. The further disturbance and modification of these areas will not result in the removal or loss of any unique habitats thereby threatening the presence of any native species, particularly those of conservation concern.

A small portion of scrub / woodland occurs within the subject site adjacent to York Road. This plant community also occurs within Lot 23, where it is the dominant habitat type. Within Lot 23, this habitat type is relatively healthy, excluding the overstorey of exotic Pines and the presence of a large amount of wind blown and dumped urban litter.

The scrub / woodland in Lot 23 generally supports trees to 10 metres in height, these predominantly being exotic Pines. Within those trees present and surveyed, no suitable hollows were observed. The understorey is a medium density layer of native shrubs and exotic saplings, these being to 6 metres in height. The ground cover is dominated by either exotic weeds or grasses, or, away from the ecotone with the disturbed environment, native forbs, saplings and grasses. Leaf litter is common, as are some sections of exposed sand, these corresponding with pathways and children's playing areas. Pine needles and broken branches are common around the base of introduced Pines.

The small portion of scrub / woodland which is present within the subject site is not considered to be of value for any of those Scheduled Species identified in Table A.2.1. The association of this patch, in relation to the more intact stands within Lot 23 is considered to be minimal and of little conservation value. The removal of the small patch of woodland from the subject site is not considered to compromise the value of the stands within Lot 23, or result in the die back or disturbance of these proximate vegetation areas.

DISCUSSION OF CONSERVATION STATUS

No populations or individuals of any threatened fauna species were found on site. Therefore the development will not affect or threaten the regional status of any known local populations or individuals of threatened species.

Two (2) habitat types available for use by native fauna species were recorded within the subject site. These habitats were a disturbed environment and scrub / woodland, of which the disturbed environment is the dominant community.

Neither of these habitats is considered to be critical to the life cycle requirements of those threatened species known for the region, nor are they critical for the species recorded during field investigations.

During the field investigations, no native species of conservation concern were recorded within or adjacent to the subject site. The subject site was noted to be highly disturbed, and was not considered to be important for the life cycle needs of any of the species recorded. The existing fauna habitats have all been modified and none are considered to be of sufficient structure to support resident populations of native species. Resident populations of native species would occur within Lot 23, due to the developed nature of the vegetation layers.

DESCRIPTION OF FEASIBLE ALTERNATIVES

As no populations or individuals of any threatened fauna species were found on, or adjacent to, the subject site, no mitigative measures or alternatives to the current proposal are required or recommended.

3 ASSESSMENT OF LIKELY IMPACTS ON ENDANGERED ECOLOGICAL COMMUNITIES

No endangered ecological communities of any threatened fauna species were found on or adjacent to the subject site. Currently no endangered ecological communities of fauna species are listed for either the Randwick or Waverley Local Government Areas under Schedule 1, Part 3 of the *TSC Act*. As such, the development will not affect any endangered ecological communities of fauna species.

ASSESSMENT OF ENDANGERED ECOLOGICAL COMMUNITIES LIKELY TO BE EFFECTED

No endangered ecological communities of any threatened fauna species were found on or adjacent to the subject site. As such, no endangered ecological communities of any threatened fauna will be affected by the proposed development.

ASSESSMENT OF HABITAT

No habitat important to the life cycle requirements and survival of any endangered ecological communities of any threatened fauna species were found on or adjacent to the subject site. As such, no habitats critical to the presence of any endangered ecological communities of threatened fauna will be affected by the proposed development.

DISCUSSION OF CONSERVATION STATUS

No endangered ecological communities of any threatened fauna species were found on or adjacent to the subject site. As such, no endangered ecological communities of any threatened fauna will be affected by the proposed development. The conservation status of any endangered ecological communities, which occur in the wider region, will not be compromised by the undertaking of the proposed development.

DESCRIPTION OF FEASIBLE ALTERNATIVES

As no endangered ecological communities of any threatened fauna species were found on or adjacent to the subject site, no mitigative measures or alternatives to the current proposal are required or recommended.

AMELIORATIVE MEASURES

Within and adjacent to the subject site, no threatened species, their populations, ecological communities, or habitats were recorded. As such no species or populations listed under the Schedules to the *TSC Act* will be affected by the proposed development. As such, no ameliorative measures specifically aimed at the presence of a threatened species or population are recommended.

4. CONCLUSIONS

Within and adjacent to the subject site, no threatened species, their populations, ecological communities, or habitats were recorded. As such no species or populations listed under the Schedules to the *TSC Act* will be affected if the development proceeds as planned.

LICENSING MATTERS RELATING TO THE SURVEY

Mr Deryk Engel B.Env.Sc (Hons)

- National Parks and Wildlife Service Scientific Licence Number: **A977**
- Animal Research Licence Number: ***AW95-003***
- Animals Care and Ethics Committee Approval Number: ***DGAC***

APPENDIX 7: BUSHFIRE HAZARD ASSESSMENT

Proposed Development of Lot 22 DP 879282 York Road, Bondi Junction

Introduction

This report has been prepared for Moriah War Memorial College by AVK Environmental Management. It evaluates the risks associated with Stage 1 of the proposed expansion of the College due to any bushfire hazard on, or surrounding, Lot 22. The proposed development involves demolition of some buildings on the existing college site, construction of new buildings on the existing college site, and car parking areas and roadways on adjoining Lot 22.

References

Bushfire hazard was assessed using the Department of Urban Affairs and Planning Circular C10, *Planning in Fire Prone Areas*. Bushfire protection requirements are based on the NSW Rural Fire Service document, *Planning for Bush Fire Protection*.

Site Inspection

The site of the proposed subdivision was inspected by Axel von Krusenstierna of AVK Environmental Management on 22 August 2001.

Site Description

The area proposed for development adjoins the existing college buildings to the east, and an area of bushland to the west on Lots 1 and 23. This bushland, approximately one hectare in area, has been described as a modified form of Eastern Suburbs Banksia Scrub, a plant community listed as an 'endangered plant community' in the Threatened Species Conservation Act, 1995 (UBMC 1996). The bushland on Lots 1 and 23 is dominated by *Leptospermum laevigatum* which forms a dense canopy at around 3 m to 4 m. The understorey is sparse, except in clearings where introduced grasses dominate. The bushland on Lots 1 and 23 is separated from Centennial Park by York Road.

Lot 22 is 4850 m² in size, is mostly cleared, and includes heaps of spoil and a section of bitumen pavement (see Plate 3 in UBMC, 2000). The vegetation on Lot 22 is dominated by introduced grasses, particularly Kikuyu (*Pennisetum clandestinium*), but also includes patches of scrub with *Leptospermum laevigatum*, *Acacia longifolia*, and *Lantana camara*. Lot 22 also includes scattered Pines *(Pinus radiata)* and Coral Trees *(Erythrina sykesii)*. The distribution of these species on Lot 22 is shown in Figures 5 and 6 of the Species Impact Statement prepared by UBMC (2000).

Bushfire Risk

Fine fuels on Lot 22 consist mainly of perennial grasses. Surface fine fuel loads in the bushland on adjoining Lot 23 are low (< 8 tonnes per hectare), however there is considerable fine fuel in the dense Tea Tree canopy. The fuels in the canopy are generally well separated from the surface fuels. It was noted during the site inspection that most of the surface fine fuels were needles from the introduced pine trees scattered throughout the area.

During the site inspection evidence of three recent fires was observed on Lot 23. These covered small areas in the order of 20 m² to 50 m² and appear to have either self extinguished or been quickly suppressed. There was no evidence of recent fires on Lot 22.

Despite its relatively small size and low surface fuel loads, it is considered that a bushfire of sufficient intensity to cause damage to adjacent buildings could occur on the bushland on Lot 23 on days of very high to extreme fire danger. However, given the easy access around the site, and plentiful water supply, it would not be difficult to control fires in the bushland, except in extreme conditions. The vegetation on Lots 1 and 23 approximates a Dry Heath (Coastal) fuel type as defined in Circular C10. Given an overall slope of less than 5%, and taking into account the small size of the bushland, the area would have a fire hazard score of 1.8, which is

classified as a medium fire hazard. It is possible that the fire hazard on Lot 23 could increase in the future, particularly if the density of the understorey was increased.

Given the risk of fire from the bushland on Lots 1 and 23, it is considered that the proposed development should include a fire protection zone between the proposed and existing buildings in the college and any bushland that will remain on Lots 1, 22 and 23. This would include a 10 m wide fuel free zone immediately adjacent to the buildings consisting of paved or gravelled roads driveways or pathways, and/or mown lawn. There should be access through the fuel free zone for fire brigade vehicles. In addition, vegetation within 15 m of any buildings should not be more than 1 m high and the proposed buildings should be constructed to Level 1 specifications in Australian Standard 3959 - 1999.

Long-term Management of the Bushland on Lots 1 and 23

Prior to, and during the early years of European settlement, the Eastern Suburbs Banksia Scrub is likely to have experienced relatively frequent burning, and it is noted that the species that characterise this community have various mechanisms for regeneration following fire. However, given the location of the bushland on Lots 1 and 23, any use of fire as a management tool would have to be limited and carefully controlled. Burning the area in a high intensity controlled burn would not be possible or advisable. Small fires could be used, with appropriate permits and with strict controls, to dispose of cut weeds or other vegetation and create ash beds to stimulate native seed regeneration, however bushland regeneration and management techniques that do not require the use of fire should be preferred.

Conclusion

a. The bushfire risk to the proposed redevelopment of Moriah War Memorial College is considered to be moderate, and to come from existing bushland on Lots 1 and 23 to the west of the college.

b. Management of this risk would require establishment and maintenance of a fire protection zone between the existing and future buildings, and the bushland on Lots 1 and 23. This fire protection zone would consist of a minimum 10 m wide fuel free zone immediately adjacent to the buildings. In addition, any vegetation within 15 m of any buildings should not be more than 1 m high.

c. There should be provision for fire brigade vehicle access through the fuel free zone.

d. Buildings adjacent to the bushland on Lots 1 and 23 should be constructed to Level 1 specifications in Australian Standard 3959 - 1999.

e. Long-term management of the vegetation on Lots 1 and 23 will have to be undertaken without the use of fire as a management tool, except for small carefully controlled burns.

Author: Axel von Krusenstierna
Principal, AVK Environmental Consultants
27 August 2001

References

Australian Standard 3959 - 1999, Construction *of Buildings in Bushfire-prone Areas.* Standards Australia, Sydney.

UBMC (1996) *Habitat Assessment, Lot 2, York Road, Bondi Junction.* Report prepared for State Property by Urban Bushland Management Consultants, Castle Hill.

UBMC (2000) *Species Impact Statement, York Road Bushland, Lot 22 DP 879582.* Report prepared for Moriah War Memorial College by Urban Bushland Management Consultants, Castle Hill.

APPENDIX 8: GUIDELINES FOR INDIGENOUS RESTORATION (SEED COLLECTION AND PROCESSING)

INDIGENOUS RESTORATION

CHOOSING RESTORATION SITES - SELECTION CRITERIA

The criteria used to determine which native plant species are suitable for use in a bushland restoration, rehabilitation or 'bush landscaping' project should include:

- the current distribution of species in nearby remnant bushland areas;
- availability of seed indigenous to the area;
- commercial availability of suitable seed/tubestock;
- the soil type(s);
- local and site-specific drainage patterns; and
- suitability of the species selected to the landscape's current function.

The choice of which species to use in an indigenous planting program will depend on what was growing on the site originally, whether any remnant vegetation is left on or near the project site and most important, if local seed or plant material is available to recreate the desired vegetation community.

In many urban areas obtaining sufficient quantities of suitable seed may be difficult, if not impossible. Either the required species are no longer available in the local area or there is so little bush remaining that seed collection would damage the remnant. In such cases, seed may have to be purchased commercially or collected further afield - there is often little choice.

Many native species may be adaptable to imported or disturbed soils (eg. clay fill, rubble or crushed sandstone) provided that adequate drainage is provided. However, some native plants will not survive on disturbed soils unless specific requirements are provided, even when natural soil materials have been used. Specialised requirements may be able to be recreated with proper planning and expertise.

Once the restoration site has been selected, a series of basic soil tests and a site drainage assessment should be carried out to identify any chemical or physical constraints. If soil and/or drainage problems are present, remedial measures should be undertaken.

PROGRAM OBJECTIVES

The prime objective of collecting locally indigenous plant material is to obtain propagation material from natural plant communities which are subject to the same environmental conditions as those where the restoration program is to take place.

By using material of known provenance, the restoration program will be better able to reflect local character and to complement and enhance existing habitat values.

Seed available through commercial sources are usually collected over a wide area, including interstate. The collected seed is bulked before sale so that provenance is unknown. While this may not be of great importance with many commonly occurring species, it is important to use local seed in conservation areas, or when unusual, rare or threatened species are present.

CONSERVING GENETIC DIVERSITY

The issue of genetic diversity is a controversial one, especially as it applies to the restoration of remnant bushland in urban areas. As most urban bushland areas are small in size, often linear

or fragmented and discontinuous in nature, collecting 'locally indigenous' seed is often problematic. Just "how local is local" when collecting native plant seed?

Man-made boundaries are not ecological boundaries. The seed collector must attempt to conserve local genetic integrity by collecting within specified geographical and natural boundaries, while at the same time, avoid collecting seed from a narrow and restricted genetic base - such as those often represented by small patches of remnant bushland.

While the aim of any bushland restoration program must be to conserve genetic diversity in the existing (local) plant community, collecting from a small area (eg. <2 ha), from individual plants or small stands or collecting material from only a few specimens in the remnant will ultimately degrade genetic variability and reduce ecological values.

If genetic variation in a seedlot is low, seeds may have reduced viability, shortened storage life and reduced vigour. Plants grown from seed with low genetic variation may also have reduced vigour and a limited ability to survive in the long term.

There is no hard and fast rule for determining the area parameters for indigenous seed collection. Recommendations from conservation groups and government agencies that deal in large-scale vegetation projects vary considerably. Restoration of remnants in urban bushland may specify seed collection over an area of <5 kilometres, especially if the remnant contains rare or endangered species.

If the collecting site includes a conservation area or a distinctive plant community, seed collection may be restricted to <1 kilometre from the site. Seed collection for the revegetation of roads or service corridors may extend over 50 kilometres or more.

For small site collections (eg. bush regeneration work, park or school plantings), match the existing vegetation community, soils, aspect and slope. For larger (regional) restoration projects, match the donor site to the restoration site for soils, aspect, elevation, slope, rainfall, annual temperature patterns, frost dates and associated plant communities.

PERMITS AND LICENCES

Laws protect a range of native flora. In New South Wales permits are required for collecting on public land such as council reserves, vacant crown land or road reservations. A special Class A collecting licence is required for work in Nature Reserves or National Parks.

For further information, contact authorities such as the local council, the Forestry Commission, Department of Land and Water Conservation, or the National Parks and Wildlife Service (NSW). If collecting seed on private land the permission of the owner must be obtained.

Most Councils, government agencies and some private landholders will require the seed collector to provide proof of appropriate insurance before permission is given to collect.

COLLECTING NATIVE PLANT SEED

When planning a restoration program which requires the collection of indigenous native plant seed, the following items require careful consideration.

PREPARATION AND PLANNING

Allow sufficient time to collect seed for a restoration project. Consider poor weather conditions and poor seasons that affect fruiting/seeding patterns. Plan a lead-time of at least one (1) years (18 months is preferable).

Survey the local area and identify likely seed collecting sites. Determine seeding times for the different species required and prepare a seed collection calendar.

Determine entry and access points to ensure minimal damage to native vegetation (eg. roads, tracks). Restrict vehicular access wherever possible.

Identify land ownership and obtain relevant licences/permission.

COLLECTING THE SEED

Avoid donor plants of unknown origin or specimens that are obviously planted (eg. park/street trees). These may be landscape specimens that do not grow naturally in the area. Trees planted in a straight line are often planted, as are trees that are all same size and age (although in some cases - eg. even-aged stands of Casuarina or Paperbark - they may be the result of a single fire event).

Avoid isolated specimens or small single-species stands - fewer than five (5) individuals represents a small sample. Avoiding lone specimens or small stands will help to avoid collecting from inbreeding plants.

Wherever possible, collect from undisturbed or intact bushland areas with good species diversity. Avoid monocultures or highly simplified plant communities.

Collect approximately the same amount of seed from each donor plant. Do not take all seed - 10-20% of the total amount is acceptable. If the reserve is small (eg. < 2 ha), take only a small amount of seed. Take a sample of seed from each plant but leave enough seed to allow for natural regeneration

Collect seed from as many different individuals of the same species as possible. Bulk (mix) the collected seed to obtain a diverse genetic mix. For large collections, sample 50 plants: for smaller collections sample at least ten (10) plants.

Widely space donor plants. If possible, move 100 metres from the first sample site before collecting from a second site. This limits the chances of inbreeding.

Collect only from strong, healthy plants, but at the same time, note that trees in stressful locations (eg. roadsides, suburban perimeters) often produce a bountiful supply of seed. Never collect from a diseased plant.

Collect tree seed soon after major storm events. Windfalls are easily collected after a storm but do not leave the seed lying on the ground for more than a few days as fungi and insect predation make the seed worthless.

Prune off small branches and extra leaves before bagging seed bearing branches-the leaves will sweat in the bag and encourage fungal attack.

If unsure of the species identification, place a leaf and/or flower sample into the bag for further study. Place a clearly marked label into each bag at the time of collection.

Collect only as much seed as you can process within a few days. Delay in processing seed after collection may lead to loss of seed through insect or fungal attack.

Work with clean, sharp secateurs, saws and other equipment. Do not damage vegetation unnecessarily when collecting seed and be sure not to spread disease by using dirty and/or contaminated tools.

SEED HANDLING - CLEANING AND PROCESSING

There are several textbooks available which detail the cleaning and processing techniques used to prepare Australian native plant seed. One of the most comprehensive texts is by Langkamp, published by the Australian Mineral Industries Research Association. Other useful publications have been produced by Greening Australia Inc and by groups such as the Society

for Growing Australian Plants (SGAP) and the Indigenous Flora and Fauna Association (IFFA). Two useful publications by Ralph (1994) have been quoted in this report.

Seed handling refers to the extraction of seed from the fruits and the subsequent cleaning of the seed. At all stages of seed handling care should be taken to avoid any damage to the seed, as this will reduce seed viability and longevity. The following recommendations are made to increase efficiency and to collect the maximum amount of undamaged seed.

In terms of seed extraction, seed collection is best carried out in the warmer months as drying will be easier and quicker and special equipment is usually not required. In warmer weather there is also less likelihood of fungal attack.

Some native plant species hold their capsules on the plant throughout the year and these may be collected at any time (eg. some *Eucalyptus, Leptospermum, Hakea, Casuarina).* Processing seed in the winter months may require the use of a special drying cabinet, a solar extractor or a glasshouse.

Most fruits and seed-heads will need to be dried to remove the seed, except for fruit with fleshy coverings (eg. berries, drupes). The drying process is used to open the fruits and loosen the seeds, although some careful handwork may be necessary to extract seeds from species such as Banksias.

Removing the seed will involve a variety of seed extraction methods (eg. manual extraction, shaking/thrashing abrading/crushing, soaking or heat extraction). Identify the method(s) applicable to the species collected and carry out the recommended treatment.

Once the fruit or seed-heads have been thoroughly dried, seed should be released easily. The amount of seed that drops when dry varies between species. Some species drop all their seed while others retain some seed in the capsule that must be taken out manually. If seed remains in the fruit despite all effort, the fruit may have been picked at an immature stage.

Process the collected seed as quickly as possible. Leaving seed in a plastic bag in hot or damp weather for a more than a few days may destroy the seed - especially in hot or humid weather. Do not collect more seed than you can process comfortably in a few hours.

Clean the seed by removing unwanted parts of the fruit, leaves, twigs and other impurities. Seeds may be cleaned by sieving through a wire mesh, winnowing or using a stream of air to separate the chaff from the seed. Seed must be clean and thoroughly dry before being weighted, labelled and stored.

STORING SEED

Store seed in a clean dry containers. Glass jars or metal containers with tight fitting lids are ideal: plastic containers are not recommended as they sweat in hot weather and moisture accumulates inside the container.

Moisture content should be kept low inside the container - about 6% moisture content is ideal. To maintain a constant moisture level, insert a small packet of silica gel into the container. The silica gel should be checked every few months and if replaced if necessary.

Ideally seed should be placed in special aluminium bags designed for seed storage. Bags are hermetically sealed and are waterproof. Silica gel is usually not considered to be necessary when using sealed aluminium bags. Aluminium bags may be bundled together and stored on a shelf or placed into a refrigerator or a cool room.

Large plastic "freezer boxes" or small cardboard boxes may be used to hold the foil bags, or individual bags may be placed directly onto the shelves.

Grass seed (or bulky items like rushes or sedges) may be stored in hessian, calico or paper bags provided they are kept in a cool dry place, away from direct sunlight.

Protection from insect attack is vital, and takes on added importance if lightweight bags or poorly sealed containers are used. Place naphthalene into the container or use one of the special insecticidal products marketed by the horticultural industry.

Fungal attack should not be a problem if the processed seed is dry when placed into the container and if the storage area is also dry. If desired, dust the seeds with a commercial fungicide before storing.

If using a cool room or a refrigerator to store seeds, adjust the temperature control to approximately 5°C. Storing seed in cool conditions will effectively double the lifetime of the seed. Do not allow the temperature to fluctuate. If necessary, ventilate the storage room.

Special refrigerated cabinets used to cool soft drinks are ideal storage items. Second hand "drinks cabinets" may be obtained from commercial outlets or through the local papers. The wide front doors and adjustable shelves allow for placement of bulky storage containers (including large bags)

The temperature may be adjusted in the cabinet, although the humidity is not always variable. The use or silica gel is recommended when the internal humidity is higher than the optimal 6%. The use of a wet-dry bulb thermometer to check the internal humidity of the cabinet at regular intervals is also recommended.

Label all internal storage bags and the larger external containers as well (if used). Include information such as: species name; weight; site location; date; soil type; aspect, and the collector's name. Other information may be added as desired.

Keep accurate records. If a computerised data bank facility is not available, use a simple card filing system and keep it up to date. When seeds are removed from or added to the seed bank, ensure that the records are adjusted at the same time.

SEED VIABILITY

As seeds age they lose vigour and viability. There is little information available on the seed life of most Australian plants, except for some of the most common species. Although it is known that some species are short-lived, most Australian native seed will remain viable for up to two (2) years and often longer when stored in dry conditions at room temperature. Storing seed in cool conditions (as described above) can effectively double seed life in most species.

Many species of native grasses will retain satisfactory germination for three-four (3-4) years: seed of *Callistemon, Eucalyptus, Leptospermum* and *Melaleuca* can retain a high viability up to ten (10) years, while some long-lived species such as *Acacia,* can remain viable up to twenty (20) years and beyond.

Also note that many native grasses, lilies and some other species have an "after ripening" period: and will need to be stored for between 3-12 months before they will germinate. Kangaroo grass (*Themeda australis*) and White Tick Bush (*Kunzea ambigua*) are thought to have such after-ripening periods.

TESTING THE SEED

When large amounts of seed are collected or when seed is to be stored for a considerable period of time, it is desirable to test seed for viability before storage.

Seed viability can be tested by a specialist laboratory. Batches of seed are tested individually and given a "certificate" which determines the germination test results. Test results are given as the % number of seeds germinated. On average, high quality seed should yield an 80% or greater germination rate.

If only small quantities of seed are collected, germination trials may be carried out by placing a known number of seeds from each batch onto damp filter paper or blotting paper. Place in a

light windowsill and keep the paper moist. The number of seeds germinating may be counted and the % germination rate calculated.

If seed is kept in a seed bank for long periods of time (eg. >2 years), regular germination trials should be carried out to ensure that seed viability does not decline beyond acceptable levels.

Information on quality control and seed testing may be obtained from the International Rules for Seed Testing Association in Switzerland. Contact with the IRSTA may be made through any commercial seed merchant, or through the NSW Institute of Horticulture.

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APPENDIX 9: BUFFER ZONE DESIGN

INTRODUCTION

It is proposed to establish a buffer zone between the expanded College buildings on Lot 22 and the bushland in Lot 23. This zone will provide a buffer from the impacts of development and any potential adverse impacts arising from the educational activities on the Lot 22 site. Specifications are set out as follows.

LOCATION

The vegetation buffer zone to the Lot 22/23 boundary is intended to provide a buffer to adverse impacts from the educational activities on the Lot 22 site. The buffer zone is proposed for:

1. The area located between the western edge of the proposed internal roadway, extending north from York Road and the Lot 22/23 boundary line to the Lot 22/23 boundary; and

2. The area along the northern portion of the Lot 22/23 boundary, extending eastward 3 metres in from the boundary line.

KEY ELEMENTS

The buffer zone varies in width across the 4 key areas:

- York Road boundary - 10 metres.
- Internal Driveway north - 5.5 metres.
- Internal Driveway turnaround - 2 metres.
- Northern play space - 3 metres.

The buffer zone design will feature the following key elements.

Ground conditions

- Existing sand soils.
- No imported topsoil.

Surface Conditions

- Earth berm 600 mm high.
- No imported mulch.
- Mulch from existing vegetation species.
- Fence of open character (to avoid shading ESBS on Lot 23).
- Fence treated with litter mesh to 1200 mm.

Plant Species

Native plant species (although not necessarily indigenous to the ESBS) have been chosen to be:

- Tolerant of sandy soils and low nutrients.
- Low species aggression (root and seed transfer).
- Shrub character species to 2 metres high or less.
- Ground cover species to 600 mm high.

- Low flammability, in accordance with the Bushfire Hazard Assessment and Fire Management Plan prepared by AVK (2002).

OBJECTIVES

The buffer design responds to the objectives in the following way:

Ground conditions

▪ Artificial soil nutrient transfer	Retention of existing soils.
▪ Ground water transfer	No fixed irrigation proposed.
▪ Imported soil transfer	No imported soils.

Surface conditions

▪ Surface stormwater transfer	Earth berm and design levels.
▪ Litter and debris transfer	Fence mesh and ground cover.
▪ Landscape mulch transfer	No imported mulch.
▪ Exotic or aggressive plant transfer	Suitable species selection (non-invasive).

Above surface conditions

▪ Litter and debris transfer	Fence mesh to 1200mm.
▪ Exotic or aggressive plant seed	Species selection.
▪ Flammability	Suitable species selected

Given the varied buffer zone widths available, the design responds to these widths by providing an earth berm (common in height and width) along the boundary line. This minimum width will be supplemented by flat buffer zone areas (as available) along the boundary (see Figure 9).

ZONE SPECIFICATION

As an initial development of the buffer zone design, the specification for the zone will be as follows:

Groundworks

- Clear existing topsoil to 100 mm (scalp weedy topsoil and dispose off-site).
- Remove all weeds, ornamental trees.
- Reinstate topsoil with clean sand fill extracted from the site works.
- Construct a continuous earth berm to 600 mm high.

Boundary Fence

- Erect a 2.4 metre high chain wire mesh fence on boundary alignment (colour black).
- Place 1200 mm high, minimum 50% permeable shade cloth.

Planting

- Shrub species 1: Grevillea x hybrid "Honey Gem" @ 1 unit/3 sq metres
- Shrub species 2: *Banksia ericifolia* (Heath Banksia) @ 1 unit/3 sq metres
- Shrub species 3: *Doryanthes excelsa* (Gymea Lily) @ 1 unit/ 3 sq metres

- Shrub Species 4: Grevillea Sandra Gordon @ 1 unit/3 sq metres
- Ground cover species 1: *Callistemon citrinus* (Bottlebrush, dwarf variety) @ 2 units/sq metre
- Ground cover species 2: *Angiozanthus falvida* x hyrbid (Kangaroo Paw, Gem Series) @ 2 units/sq metre
- Ground cover species 3: Grevillea Royal Mantle (hybrid) @ 2 units/sq metre
- Soil stabilisation species 1: *Lomandra longifolia* @ 3 units/sq metre
- Soil stabilisation species 2 : *Carborotus glaucescens* (Pigface) @ 3 units/sq metre

Ground Conditions

- Soil as existing from site.
- No fixed irrigation.
- No fertilisers.
- Mulch as chippings from existing native plants from cleared site.

APPENDIX 10 - GLOSSARY

Aeolian	Wind blown or transported by wind, as in aeolian sand dunes
Aquifer	Porous soil or geological formation capable of being permeated by water, which holds and yields ground water.
Assisted Natural Regeneration	Bush regeneration approach combining traditional weeding methods with supplementary (or enrichment) planting
Biodiversity (biological diversity)	The variety of all life forms, comprising genetic diversity (within species), species diversity and ecosystem diversity. The variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems) and the ecological complexes of which they are part.
Biological control	The control of weeds and pests through the use of other organisms (predators, herbivores, parasites and disease-producing organisms).
Biomass	Total living matter in a specific area.
Blow-out sites	A depression caused by wind erosion. May result in the exposure of the lower soil horizons.
Buffer	An area of land between two conflicting land-uses, for example a nature reserve and an intensive development.
Bushland	Land on which there is vegetation that is either a remainder of the natural vegetation of the land or if altered, is still representative of the structure and floristics of the natural vegetation (As defined in *SEPP-19*). For the purposes of the VMP – any area which is dominated by locally indigenous, naturally occurring species.
Bush regeneration	The practice of restoring bushland by focusing on reinstating and reinforcing the system's on-going natural regeneration processes.
Catchment	The land area drained by a river and its tributaries.
Community land	Land that is classified as community land under Division 1 of Part 2 of Chapter 6 of the *LG Act 1993*. There are two classifications of public land (land under the control of the council) under the *LG Act 1993* – community and operational. Areas classified as community land are kept available for use by the general public and cannot be sold (except in limited defined circumstances). They cannot be leased or licensed for more than 21 years.
Condition	The state of health of the native vegetation community: degree to which it has been degraded, simplified or otherwise altered.
Conservation	The processes and actions of looking after a place so as to retain its natural significance and always includes protection, maintenance and monitoring. In the VMP monitoring is used to measure the progress of work and evaluate the rehabilitation program.
Contaminant	An undesirable or harmful impurity.
Contaminated site	Land which has harmful contaminants caused by previous land use.
Corridor (wildlife)	Areas of native vegetation that link larger areas of remaining native vegetation.
Critical habitat	Habitat declared to be critical under Part 3 of the *TSC Act 1995*. For the purposes of the *TSC Act 1995* and other Acts as amended by the *TSC Act 1995*, critical habitat is the whole or any part or parts of an area or areas of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is essential for the survival of the species, population or ecological community.
Cut-stump	Method of weed eradication used for woody weeds whereby the stem is cut close to ground level and undiluted glyphosate applied within 30 seconds.
Desire lines	Routes people instinctively take through an open space.
Diversity	Consists of 2 components: species richness and relative abundance

Ecologically sustainable development	Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased. Also referred to as 'Environmentally Sustainable Development'.
Ecosystem	Communities of organisms and their physical environment interacting as a unit.
Ecosystem processes	The numerous interactions between different components (both living and non-living) of an ecosystem that support the biological elements of the system. These processes include the storage and recycling of nutrients and minerals, disturbance, competition, weathering and succession, and are generally necessary for maintaining the balance between interconnected elements of the ecosystem; for instance, green plants capture and process solar energy, which is then distributed throughout the ecosystem along food webs by animals.
Ecosystem resilience	The degree, manner and pace of restoration of the structure and function of the original ecosystem after disturbance, or more simply, the ability of an ecosystem to recover from disturbance.
Edge effects	Habitat conditions (such as degree of humidity and exposure to light or wind) created at or near the interface of bushland and open areas
Eight-part test	An eight-part test under Section 5A of the *EP&A Act 1979* is designed to determine 'whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats' listed on the Schedules of the *TSC Act 1995*, and consequently whether a Species Impact Statement is required.
Endangered species	Those likely to become extinct unless action is taken to remove the factors that threaten their survival.
Environmental weed	Species which have been introduced into the habitat, which naturalise from their point of introduction, displace native species and/or otherwise modify the natural environment.
Exotic species	An introduced species, especially one that is not of Australian origin.
Fabrication	A form of bushland regeneration used when the sites biophysical attributes have changed to the point where the original plant community cannot be reconstructed or recreated.
Feral animal	Wild exotic animal, usually a domesticated animal which has become wild.
Fire regime	The history of fire events in an area including the frequency, intensity and season of burning (season in this context refers to the time of the year in which the fire occurred).
Foliar spraying	Diluted glyphosate applied to the leaves by wand or spot spraying. Useful for the control of unwanted grasses and herbaceous weeds.
Fragmentation (habitat/ecosystem)	The division of natural areas by vegetation clearance, isolating the remnants and the species within them and limiting genetic flow.
Generalist species	Species that can survive and tolerate a broad range of environmental conditions.
Genetic Diversity	The variety of genetic information contained in the total genes of individual plants, animals and microorganisms of a place.
Geodiversity	The natural range (diversity) of geological, geomorphological and soil features, assemblages, systems and processes.
Gross pollutant trap	Device designed to trap debris and sediments in watercourses.
Habitat	The living space of a species or community, providing a particular set of environmental conditions.
Heath	A plant community dominated by small closely spaced shrubs, most of which have stiff and often small leaves.
Herbicide	Chemical substance used for killing plants.
Hydrology	The chemistry and physics of water and water movement.
Indigenous species	A species naturally distributed within a specific region, native to a particular locality. A species that occurs at a place within its historically known natural range and that forms

Key threatening process	part of the natural biodiversity of a place. Schedule 3 of the *TSC Act 1995* provides for the listing of key threatening processes. Key threatening processes are processes that adversely affect 2 or more threatened species or which could cause a species to become threatened.
Keystone weeds	Major or dominant weeds in a community which pose serious and immediate threats because of their ability to change the structure and floristic composition of a plant community over time. Also referred to as 'primary target weeds' or 'ecosystem modifiers'.
Life cycle	The series of forms that an organism takes as it lives and reproduces.
Life cycle requirements	The elements required by an organism to complete its life cycle. Eg sites for feeding, roosting and breeding and corridors for dispersal and foraging.
Maintenance weeding	Denotes low-key and infrequent weeding sessions. An area is said to be 'on maintenance' only after a diverse/healthy native plant community has been established.
Mesic	A plant with soft leaves and little fibrous tissue.
Monotypic	Having only one representative, eg a genus or family with a single species.
Mosaic burning	A pattern of burning that provides a mosaic of fire intervals that mitigates wildfire spread and provides a diversity of fire age classes
Native species	Normally used to refer to a species indigenous to NSW, but is also sometimes used to refer to a locally indigenous species.
Native vegetation	Vegetation that is indigenous to NSW, that is, of species that existed in NSW before European settlement.
Naturalised	An exotic plant that is established and reproducing as though native.
Natural Integrity	The degree to which a place or ecosystem retains its natural biodiversity and geodiversity and other natural processes and characteristics.
Natural Regeneration	Response of site to weed removal and other measures designed to stimulate soil in the soil seed bank (i.e. without planting)
Noxious weed	Weeds declared under the *Noxious Weeds Act 1993*. A plant that causes serious economic loss, or one that has a detrimental effect on man, animals or the environment.
Nurse crop	Planted species that grow fast and densely, with the aim of stabilising the soil, providing organic matter, nutrients and shelter for native seedlings. They are often sterile and/or annual species that die-out after a short period, creating space for natives to naturally seed and grow.
Obligate seeders	Species which have seeds that are dependent on fire for germination.
Operational land	Land that is classified as operational land under Division 1 of Part 2 of Chapter 6 of the *LG Act* 1993 (see *community land*). Areas classified as operational land have no restrictions on the sale or long-term lease of the land.
Opportunistic species	A species that can take advantage of adverse conditions and thrive in locations where more sensitive species will not survive.
Passive recreation	Recreation activities that require limited physical exertion on behalf of the participant. Examples of passive recreation activities include bird watching, walking or photography.
Pesticide	Any substance used to kill pest organisms.
pH	A measure of the degree of acidity or alkalinity; expressed on a logarithmic scale of 1 to 14: 1 is most acid, 7 neutral and 14 most alkaline.
Pile burns	Used for the disposal of weed waste by burning material in piles. The heat and smoke produced by the fire may also stimulate native regeneration.

Pioneer (early successional) species	Plant species that are the first to colonise a disturbed environment. They are characterised by their ability to disperse and germinate, rapid growth, high photosynthetic capacity and short life span.
Plant community	A unit of vegetation with a relatively uniform species composition and physical structure. Plant communities also tend to have characteristic environmental features such as bedrock geology, soil type, topographic position, climate, and energy, nutrient, and water cycles.
Primary weeding	Denotes weeding through an area for the first time only, may involve target weeding of selected species only or a thorough weeding of all invasive species.
Propagules	Any part of a plant that is able to produce a new plant when dispersed eg. Spore, seed, cutting, root or stem fragments.
Protection	The taking care of a place by managing impacts to ensure that natural significance (biodiversity/geodiversity) is retained.
Recovery plan	A plan prepared under Part 4 of the *TSC Act 1995* or Part 7A of the *Fisheries Management Act 1994* providing for the recovery of threatened species, populations or ecological communities.
Regeneration	The *natural* recovery of natural integrity from disturbance of a community of organisms or an ecosystem: from soil seed bank (*in situ*), vegetative reproduction or via recruitment from external sources.
Rehabilitation	To re-establish the original or repair damage.
Reinstatement	To introduce to a place one or more species or elements of habitat or geodiversity that are known to have existed there naturally at a previous time, but that can no longer be found in that place.
Relative Abundance	Amount of each species present at a site
Remnant	Usually a small patch of vegetation containing at least part of the original plant community floristics and structure.
Restoration	Returning existing habitats to a known or past state or to approximate the original natural condition by repairing degradation, removing exotic species, reinstatement or allowing recovery. For the purposes of the VMP – planting, using local native species to restore diversity and community structure.
Restoration ecology	The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.
Revegetation	The process of returning plant life to an area eg. planting tubestock, direct seeding, hydro-mulching, brush matting.
Rhizome	An underground stem, usually horizontal, producing leafy shoots and new stems eg Couch grass, Iris, Pampas grass (adj. Rhizomatous)
Run-off	The portion of precipitation (rain, hail, snow) which flows across the ground surface as water; major agent of water erosion.
Scalping	Mechanical removal of weeds and ground debris that exposes favourable mineral soil for planting.
Scarification	A method of seedbed preparation which consists of loosening the soil surface by a physical disturbance.
Sclerophyll	Plants with hard, stiff and tough leaves (typical in low rainfall areas).
Secondary weeding	Denotes weeding through an area the second time around, usually carried out 3-6 months after primary weeding.
Secondary weeds	Weeds not constituting a significant threat to the communities they invade: generally herbaceous and/or pioneer species.
Seed bank	The seed naturally available at a site; most of the seed bank is generally stored in the soil, but some may be stored in fruits, such as Banksia cones.

Selective herbicide	Herbicide is more toxic to some species than others, at specified concentrations.
Senescence	The growth phase in a plant or plant part (eg a leaf) from full maturity to death.
Scrub	A general definition of a plant community dominated by shrubs, including thickets: colonising open ground: 2-8 metres: often a single species.
Shrub	A multi branched woody plant less than 8 metres high and usually with many stems.
Soil coherence	The degree to which soil material is held together at different moisture levels.
Soil profile	The vertical sequence of layers (horizons) in the soil.
Species diversity	A measure of the number of individuals and their relative abundance in a site: comprising both species richness and relative abundance. The *variety* of species in a place.
Species richness	The number of species present at a site
Spot fires	Isolated fires started ahead of the main fire front by sparks, embers or other ignited material, sometimes to a distance of several kilometres.
Stakeholder	A person with an interest in an issue.
Stormwater	Water which runs off urban and agricultural catchments, which may carry rubbish, animal droppings, sewage overflows, grass clippings and heavy metals. This untreated water is carried in stormwater channels and discharged directly into creeks, rivers, harbours and oceans.
Target weeding	Weeding process that concentrates on eradication of certain species.
Threatened species	"A species listed in Part 1 or 4 of Schedule 1 or in Schedule 2 of the *TSC Act 1995*. More generally, threatened species is a plant or animal generally considered as vulnerable or endangered under various threatened species conservation laws. It is used to indicate that there is some level of threat as to the species viability in the wild. (Nature Conservation Council)
Tree injection	Method of weed eradication whereby holes are drilled into the stem (below the bark but NOT into the heartwood) and herbicide injected into each hole.
Tubestock	The growing of plant material in tubes or small pots.
Urban bushland	Bushland is defined in *SEPP-19* as meaning "land on which there is vegetation which is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation".
Urbanisation	The process of altering land uses to create and further develop urban centres.
Visual amenity	The views and visual aesthetics offered by a particular site.
Vulnerable species	A species specified in Schedule 2 of *TSC Act 1995*. More generally, vulnerable species that may soon become endangered if causal factors (habitat destruction, over-exploitation, other environmental disturbances) continue (EPA)
Woodland	A plant community dominated by trees with crowns relatively close to the ground (usually eucalyptus species) that are separated from each other and with grasses and other herbs forming a more or less continuous ground cover between them.

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