EDITH COWAN UNIVERSITY

ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION SCHEDULE

SOUTH WEST CAMPUS, BUNBURY

VERSION 1

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ATA Environmental
environmental scientists

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1. INTRODUCTION

1.1 Project Description

Edith Cowan University has commissioned this Environmental Management Plan (EMP) for the future development and ongoing management of the South West Campus located on Robertson Drive, Bunbury (Figure 1).

The philosophy of the University is to develop the campus to meet increased future growth of student numbers and course requirements, while maintaining a strong environmental conservation ethos which is sustainable over the long term. In order to assist in realising these opportunities, the EMP will address strategies to evaluate the present natural environment and determine potential environmental issues associated with future development.

1.2 Project Approach

The EMP comprises two parts that provide a framework of actions that Edith Cowan University can use to develop an environmentally sustainable work environment:

1. **Assessment Section** – provides a description of the existing environment of the South West Campus incorporating the findings of the flora and vegetation survey, desktop fauna assessment, tree condition assessment, hydrology, soils and geology and topography;

2. **Management Section** – identifies the optimum future use and long-term management of the natural environment of the campus, to achieve a balance between conservation and passive recreation.

   The Management Plans for this section include the following:

   - Drainage and Nutrient Management Plan (DNMP);
   - Vegetation and Fauna Management Plan (VFMP);
   - Waste Management Plan (WMP); and
   - Site Rehabilitation Plan.

   Each of the management plans incorporates information pertinent to the environmental issue being planned for and proposes management strategies to mitigate impact on the receiving environment. An implementation schedule provided at the end of each plan itemises the objective, management strategy, priority level and person/area responsible for undertaking the action.

This EMP is intended to be an evolving document that will be updated with relevant information as it becomes available.

2. CURRENT CAMPUS SERVICES

2.1 Sewer Capacity

The South West campus is currently serviced by a 150mm PVC gravity property sewer running along the northern boundary adjacent to Dettman Drive eastwards, and a further 150mm PVC property sewer running north partly along the boundary with TAFE, to the last access chamber (AC) located in the northeast corner of the campus land.

Cox Howlett and Bailey Woodland (2004) was commissioned by Edith Cowan University to carry out a Master Plan review of the South West campus and have determined that the campus site appears to be well serviced with a network of pipework and access points which have the capacity to be extended if the campus expands in the future. Actual peak sewer flows of the South West campus have been estimated at 1.3L/second, with TAFE peak flows of around 2L/second. The capacity of the pipework is currently 6L/second, therefore likely attention to the current sewer system will not be necessary until after 2021 (Cox Howlett and Bailey Woodland 2004).

2.2 Potable Water

The potable water for the South West campus is supplied by an Aqwest metered 50mm service line to a 22kL ballast tank. The University operates a Grundfos pressure system (CR4, CR8 and CR16 pumps) for potable water and limited fire water (see Section 2.3).

Cox Howlett and Bailey Woodland (2004) stated that site inspection of the potable water system revealed that only the CR4 and CR8 pumps were used for potable water, with the CR16 pump operating a limited fire service (without providing adequate flow for the hydrants). The CR16 also provides limited capacity to pressurise small diameter fixed hose reels on the campus site.

According to Cox Howlett and Bailey Woodland (2004), the potable water system was originally installed in approximately 1986, however based on actual current consumption, the system as is will be adequate until after 2021. However, the distribution network of potable water may be expanded based on the existing pipework, to suit future requirements.

2.3 Fire Water Supply

The fire ring main line for the South West campus has a direct connection (100mm copper) to the Aqwest 150mm main running along Dettman Drive.

The existing potable water ballast tank incorporates a 4.6kL fire water reserve which has been determined by Cox Howlett and Bailey Woodland (2004) to be inadequate for fire fighting. Fire Emergency Services Australia (FESA) has advised that for a campus with buildings over 1,000m^2 in surface area, a fire supply of 20L/s is required for four hours (288kL). This level of site storage would not be necessary provided that the level of flow on the site is guaranteed. During future expansion of the campus, Cox Howlett and Bailey Woodland (2004) state that the existing ring main can be added to provide a comprehensive network of hydrants.

2.4 Aqwest Water Treatment Facility

Aqwest operate a reservoir with its associated water treatment plant immediately to the south of the southern boundary of the South West campus. There is a dedicated reserve (No. 32152 533) that contains a mainline which leads from the Aqwest facility, north to the campus. No development may take place within this reserve.

Similarly, Aqwest have advised that the chlorine treatment plant should have a 200m buffer zone to further development and extension of the campus.

2.5 Garden and Grounds Water Supply

The campus gardens are currently reticulated from a bore licensed to Edith Cowan University. Current reticulation (to match evaporation rates) includes 1.85ha of gardens, lawns and turf. At this stage, there is capacity to reticulate a further 0.93ha.

2.6 Gas Supply

Alinta Gas advises that the South West campus is currently supplied via a medium pressure 50mm service main to the meter located in the northeast corner of the South West Campus. Downstream of the meter, the campus is reticulated via a 25mm supply line.

The service main from the feeder main is currently at 50% capacity. Cox Howlett and Bailey Woodland (2004) suggest that the network of gas distribution on site could easily be expanded in the future to suit further requirements.

2.7 Electricity Supply

Western Power supplies 3 phase power via overhead cables to a pole slightly south of Dettman Drive. From here, the cables go underground leading to a substation. The main board is located in the basement of the General Teaching Block. The substation is operated by Western Power.

Cox Howlett and Bailey Woodland (2004) have estimated that the existing electricity installation will be adequate until at least 2010. After this time, an additional incoming HV power cable may be required and an additional transformer with a capacity of at least 500kVA, to ensure that the installation will be adequate until after 2021.

2.8 Telephone

Telstra service the South West campus via a C3001 optic fibre that runs from a pit in Sweeney Street to a terminating pit adjacent to the General Teaching Block. Telstra has advised that the capacity of the fibre optic cable is unlikely to be reached and that any future expansion may emanate from the onsite telephone main distribution frame located in the current administration block.

3. EXISTING ENVIRONMENT

3.1 Background

3.1.1 Location

The South West campus of Edith Cowan University is situated approximately 5km south of Bunbury and is 46ha in size (Figures 1 and 2). The campus is bounded by the Bussell Highway and South West Health Campus to the west, is separated from Robinson Drive by Dettman Drive, and has residential areas and Aqwest Bunbury reservoir to the south. The South West Regional Campus of TAFE is located to the east.

3.1.2 Climate

The climate of the Bunbury region is classified as warm temperate Mediterranean, which has distinct seasons. Summers are dry and warm to hot and the winters are wet and cool. Daily mean temperatures range from 22 to 23^{o}C in January and 10 to 13^{o}C in July. The region is in a winter rainfall zone with most of the 840mm annual average falling between May and September.

3.1.3 Land Use

The campus site is currently zoned 'Educational' with a sub zoning of 'Tertiary Education'. The South West Campus is approximately 46ha in size with the existing campus facilities occupying approximately 12ha.

The majority of the South West Campus (southern portion) consists of native vegetation, which has high conservation value as it potentially forms a 'Green' link between Hay Park and Manea Park (Figures 1 and 2).

Edith Cowan University gained University status in 1991 and the vision for the South West campus in the future is to become a 'Super Campus' through consolidation with the adjacent South West Regional College of TAFE and the South West Health Campus.

3.2 Landform, Topography and Soils

The South West Campus is located within the Swan Coastal Plain which consists of a series of Aeolian sedimentary deposits and alluvial soils.

The topography of the site ranges from 5m AHD in the western portion (adjacent to Bussell Highway) to 43m AHD in the central portion of the site.

There are four main soil types (WA 1:50, 000 Geology Series 1981) present within the South West Campus including:

- **Quindalup Dunes (Qha)** – The Quindalup soils are located on the western boundary of the site within the low, flat wetland area. These soils are composed of calcareous sands and sheltered flats.

- **Spearwood Dunes (Qts)** – This soil type is located on the western portion of the site, characterised by the steep slope grading westwards towards the wetland area and consists of siliceous sands overlying Tamala Limestone.

- **Guildford Formation (Qpa)** – Known locally as 'Dardanup Loam', the unit forms the broad, slightly undulating plain west of Darling Scarp, and is located within the northern portion of the site. The formation consists mainly of alluvial soils, and is generally covered by up to 50mm thick of washed or wind-blown sand.

- **Bassendean Sand (Qpb)** – Forms the oldest of the main dune systems and is located through the central and southern portions of the site. The sand consists of fine, grey sand which is often nutrient deficient and hydrophobic.

3.3 Acid Sulphate Soils

Acid sulfate soils (ASS) are wetland soils and unconsolidated sediments that contain iron sulfides which, when exposed to atmospheric oxygen in the presence of water, form sulfuric acid. ASS form in protected low energy environments such as barrier estuaries and coastal lakes and commonly occur in low-lying coastal lands as Holocene marine muds and sands.

When disturbed, these soils are prone to produce sulfuric acid and mobilise iron, aluminium, manganese and other heavy metals. The release of these reaction products can be detrimental to aquatic biota, human health and built infrastructure.

The Western Australian Planning Commission (WAPC) has adopted Planning Guidelines to be used where there is evidence of a significant risk of disturbing acid sulfate soils (WAPC, 2003). The term 'evidence of significant risk' is taken to include:

- Land depicted in Figures 1-11 of the WAPC publication as having a "High risk of Actual Acid Sulfate Soil (AASS) and Potential Acid Sulfate Soil (PASS) <3m from surface".

- Land where site characteristics and local knowledge lead a decision-maker to form the view that there is significant risk of disturbing acid sulfate soils at that location.

Mapping in WAPC Planning Bulletin No. 64 shows the distribution of AASS and PASS in the Bunbury region (WAPC, 2003). On the basis of this mapping, the majority of the South West campus has Low to No risk of Actual Acid Sulphate Soils (ASSS) and Potential Acid Sulphate Soils (PASS) occurring at depths at greater than 3m (Figure 3). Therefore, future development or extensions to the campus within this area would not be limited by Acid Sulphate Soils.

The southeast and South West corners of the campus have been determined as having Moderate to Low risk of ASSS and PASS occurring at depths at greater than 3m (Figure 3). These areas are generally lower in the landscape relative to the rest of the campus. There is no plan in the future to develop or extend the campus within these areas.

3.4 Surface Hydrology and Groundwater

The Bunbury region conforms to hydrologic boundaries which includes the Harvey River Basin, the Collie River Basin and the Preston River Basin.

Depth to groundwater ranges from 0m to 1m AHD in the western portion of the site, to 30m AHD in the central and eastern portions of the site.

The region's groundwater resources are contained within the Perth and Collie Basins. The major aquifers of the Perth Basin are (in increasing depth) the Superficial, Leederville,

Yarragadee and Cockleshell Gully Formations. The Superficial Formation is used as a source of fresh water for homes and small farms and is recharged directly from rainfall. The Leederville Formation is used for public water supply at Bunbury. It is recharged by leakage downward from the Superficial Formation. The Yarragadee Formation is also used for public water supply and is recharged by the overlying superficial sediments and the surface streams that descend from the Blackwood Plateau.

3.5 Wetlands

There are no wetlands within the site protected under either the *Environmental Protection (Swan Coastal Plain Lakes)* (EPP) *Policy 1992* or included in the EPA's draft *Environmental Protection (Swan Coastal Plain Wetlands) Policy 2004*.

There are no wetlands within the site mapped in the DoE's *Geomorphic Wetlands Swan Coastal Plain* dataset.

The western portion of the site does, however contain a seasonally wet dampland area which is generally degraded.

3.6 Flora

The flora of the campus was surveyed by ATA Environmental (September 2004). The survey method included two representative grids (50 x 50m) located within each of the five main vegetation associations.

A total of 100 native plant species and 21 weed species were identified within the South West Campus site at the time of survey (Appendix 1). The dominant families were the Proteaceae (Banksia family), Papilionaceae (Pea family), Myrtaceae (Eucalyptus family) and Poaceae (Grass family).

At the time of survey six orchid species were identified. It is possible that further orchid species are present on the site as there are differences in the timing of flowering and length of flowering period for different orchid species. For example, in an April flora survey prepared for the City of Bunbury for Manea Park (directly east of the ECU study area), 16 orchid species were identified (Koch 1990).

There were up to 10 Eucalypt species within the campus grounds that were not native to Western Australia. These were not identified due to an inability to access seed pods and nuts at height.

3.6.1 Vegetation Associations and Condition

The vegetation of the South West Campus belongs to the Karrakatta Vegetation Complex (Central and South) as mapped by Heddle *et al.*, (1980). The Karrakatta Complex (Central and South) extends from Yanchep in the north to the south of Capel and is found within the Spearwood Dune System. Throughout its range, this vegetation complex is dominated by Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*), Marri (*Corymbia calophylla*) and Banksia species.

Tuart Woodlands mostly occupied the upland portion of the South West Campus from the northern to southern boundary, while the *Melaleuca preissiana* and *M. rhaphiophylla* Woodlands occupied the lower, wetland areas in the western portion of the South West

Campus. Jarrah and Marri were found scattered throughout the majority of the South West Campus, however were mostly located on the eastern and western slopes. Some Jarrah and Marri were also located within the wetland area of the campus site. *Banksia attenuata* was distributed evenly throughout the majority of the South West Campus, and the occasional *B. grandis* was found in the lower wetland area.

The following vegetation associations and conditions (Table 1) were recorded for the South West Campus (Figure 4):

TABLE 1
VEGETATION ASSOCIATIONS AND CONDITION WITHIN THE SOUTH WEST CAMPUS

Associations	Condition	Description
EgBaAf	Good - Very Good	Tuart and Banksia Woodland over Peppermint Low Woodland
EgEmBaAf	Good	Tuart Woodland over Jarrah/*Banksia attenuata*/ Peppermint Low Woodland
	Degraded - Good	
	Degraded	
EgEmCcBa	Good - Very Good	Tuart/Jarrah/Marri Woodland over *Banksia attenuata* Low Woodland
EmCcBa	Good - Very Good	Jarrah/Marri Woodland over *Banksia attenuata* Low Woodland
	Good	
	Degraded	
	Completely Degraded	
MpMrEmCcBa	Good	*Melaleuca preissiana/Melaleuca rhaphiophylla* Woodland over Jarrah/Marri/*Banksia attenuata* Woodland
	Degraded	

Note: Vegetation Condition has been described by Bush Forever (Bush Forever, Government of Western Australia 2000) with six main categories ranging from Completely Degraded to Pristine:

- Pristine – Pristine or nearly so, no obvious signs of disturbance;
- Excellent – Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species;
- Very Good – Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing;
- Good – Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing;
- Degraded – Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing; and
- Completely Degraded – The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with flora composing weed or crop species with isolated native trees or shrubs.

The condition of the vegetation throughout the South West campus was generally Good to Very Good (Figure 4). The areas of Degraded vegetation were mainly affected by weed infestations, Armillaria attack or hot fires. The Completely Degraded areas were devoid of natural vegetation and generally affected by weed infestations.

3.6.2 Significant Flora

A search was undertaken of the Department of Conservation and Land Management's (CALM) *Threatened (Declared Rare) Flora* database and the *Western Australian Herbarium Specimen* database for priority species known to be found within the local area of the South West campus. The result of this search is presented in Table 2:

TABLE 2
DECLARED RARE AND PRIORITY FLORA RECORDED IN THE VICINITY OF THE SOUTH WEST CAMPUS

Species	Conservation Status	Distribution
Acacia flagelliformis	P4	Picton, South Bunbury
Acacia semitrullata	P3	Elgan, Bunbury district
Aponogeton hexatepalus	P4	Bunbury
Caladenia speciosa	P4	Southeast Bunbury, Bussell Hwy, Bunbury
Jacksonia sparsa ms	P4	Bunbury
Lasiopetalum membranaceum	P3	Leschenault Inlet
Platysace ramosissima	P3	Bunbury
Pultenaea skinneri	P4	Southern Eaton, Picton Junction, Hastie Rd
Schoenus benthamii	P3	Manea Park, Bunbury Airstrip
Stylidium longitubum	P3	Near Bunbury
Verticordia attenuata	P3	South of Eaton, Picton

Note:
- R — Declared Rare Flora – Extant taxa
- X — Declared Rare Flora – Presumed extinct taxa
- P1 — Priority 1 – Poorly known taxa (taxa which are known from one or a few (generally <5) populations which are under threat).
- P2 — Priority 2 - Poorly known taxa (taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat).
- P3 — Priority 3 - Poorly known taxa (taxa which are known from several populations, and the taxa are not believed to be under immediate threat).
- P4 — Priority 4 – Rare taxa – taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors.

No DRF were recorded on the campus site in the September 2004 survey conducted by ATA Environmental. Two Priority 4 species were recorded in the survey. For example, in the September survey conducted by ATA Environmental, *Acacia flagelliformis* (P4) was located in the wetland area adjacent to the Bussell Highway (western boundary), and *Caladenia speciosa* (P4) was found in the central portion of the South West campus site. Priority 4 species are taxa that are not believed to be under immediate threat or not currently threatened by any identifiable factors. The list of flora species found on-site during the survey is contained in Appendix 1.

3.6.3 Tree Distribution, Condition and Significance

The majority of trees (>20cm diameter at breast height) measured within the South West campus were in the 20 to 40cm diameter class (68%) (Table 3). Seventeen percent of trees were in the 40 to 60cm diameter class, and 7% of trees were in the 60 to 80cm diameter class. The remainder of trees (8%) were greater than 80cm in diameter (Table 3).

TABLE 3
DIAMETER DISTRIBUTION OF TREE SPECIES >20CM DIAMETER AT BREAST HEIGHT (%)

Diameter Class	%
20 to 40 cm	68
40 to 60 cm	17
60 to 80 cm	7
80 to 100 cm	3
100 to 120 cm	2
120 to 140 cm	2
>140 cm	1

The largest diameter tree on-site was a Tuart with a diameter at breast height of 2.71m. In general, the largest trees were Tuarts. Figures 5, 6 and 7 indicate relative tree diameters throughout the South West Campus.

The tree species present on-site with a diameter greater than 20cm are represented in Table 4. *Banksia attenuata* was present throughout most of the South West campus, as was Marri (Figure 7). Tuart was generally restricted to the flat upland portion of the site, while Jarrah was mostly located on the eastern and western slopes (Figure 7). *Melaleuca preissiana* was isolated to the lower wetland area adjacent to the western boundary of the site.

TABLE 4
DISTRIBUTION OF TREE SPECIES >20CM DIAMETER AT BREAST HEIGHT (%)

Tree species	%
Banksia attenuata	39
Corymbia calophylla	31
Eucalyptus marginata	14
Eucalyptus gomphocephala	12
Xylomelum occidentale	6
Melaleuca preissiana	5
Agonis flexuosa	2
Nuytsia floribunda	1

The majority of trees listed in Table 4 and found throughout the site were generally in Good condition (Figure 5). The Tuart (*Eucalyptus gomphocephala*) associations are of most significance throughout the campus site and the trees were generally in Good condition. Vegetation clearing and grazing since European settlement has reduced the extent of Tuart dominated communities on the Swan Coastal Plain by up to 65% and since the mid-1990s, there has been a noticeable decline in the health of many tuart trees between Mandurah and Bunbury (Ecoscape, 2004).

While Tuart is not considered threatened, some of the vegetation communities containing tuart are under-represented in conservation reserves, or are not adequately protected on

private lands, and are particularly susceptible to threatening processes such as land clearing, climate variability, changes in vegetation structure resulting from altered fire regimes and past grazing, hydrological factors and weed invasion (Government of Western Australia, 2002). The Tuart resource on the South West Campus is therefore very important to manage and conserve.

3.6.4 *Armillaria luteobubalina* Distribution

Armillaria luteobubalina is a soil-borne fungus that causes root rot in a wide variety of plants. The fungus is native to Australia however it can affect any plant including natives, introduced species and fruit trees.

Infection of a plant occurs via the root system. This happens when infected roots come into contact with uninfected roots. The fungus is unlikely to spread through the soil by its own devices and is most commonly introduced to an area by infected plants, roots or mulches being brought into the area, or by disturbance and movement of infected roots into uninfected areas. *Armillaria* is thought to be able to survive in the soil for up to 50 years.

Symptoms of the disease include dieback of the limbs and branches, yellowing of foliage, splits in the trunk, poor vigour, the leaking of sap from the trunk, scars on the trunk and darkening of the larger roots. The removal of a small section of bark (as was conducted in this survey) may reveal the presence of mycelial fans (web or finger like fungal growths), that are usually white and with a characteristic mushroom odour. The timber of infected trees often has a pitted appearance.

Tree health and condition is an important factor in the chances of developing *Armillaria* infection. For example, stresses such as drought, flooding, disturbance or compaction of soil, can often weaken the defence systems of trees and increase the chances of *Armillaria* infection.

A survey of all trees on the campus was undertaken by ATA Environmental in September 2004. The distribution of *Armillaria* throughout the site is represented in Figure 5. Seven percent of all the trees within the South West Campus were estimated to be infected with *Armillaria* and approximately 80% of these trees were *Banksia attenuata*. The remainder of *Armillaria* infections occurred in Tuart, Jarrah and Marri (Figure 5).

3.7 Fauna

A regional desktop search using the Western Australian Museum on-line database was used to develop a list of potential bird, reptile, mammal and amphibians in the site. The regional search was bounded by 32° 50’ to 33° 50’S, and 115° to 116° 20’E. This is a wide search area; however there is little data available on the Museum database for the Bunbury region so a wider search area was necessary to cover sufficient species. Other publications were also used to provide supplementary information including Tyler *et al.,* (2000) for frogs, Storr *et al.,* (1983, 1990, 1999 and 2002) for reptiles, Johnstone and Storr, (1998) for birds and Strahan (1995) for mammals.

A search of CALM’s Threatened and Priority Species database was undertaken to identify potential scheduled and threatened species in the region (Appendix 2).

A search of the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* on-line database was also undertaken.

These sources of information were used to create lists of species expected to occur at the site. As far as possible, expected species are those that are likely to utilise the site, and such lists often include species that have been recorded in the general region as vagrants or for which suitable habitat is absent. Particularly among the birds, for example, vagrants can be recorded almost anywhere.

Taxonomy and nomenclature for fauna species used in this report generally follow FaunaBase which is based on Aplin and Smith (2001) for amphibians and reptiles, How *et al.*, (2001) for mammals and Johnstone (2001) for birds.

3.7.1 Reptiles, Amphibians and Mammals

Reptile, amphibian and mammal species expected to occur at Edith Cowan University, Bunbury are listed in Appendices 2, 3 and 4.

The regional desktop search of the Western Australian Museum database identified 13 species of amphibian, 46 species of reptile and 32 species of mammal (5 introduced or feral) that may be present in the region. However, not all of these species may necessarily be present on site because of the absence of specific microhabitat requirements or the transient nature of some species.

3.7.2 Avifauna

Based on the results of the database searches, up to 141 species of birds may potentially occur at the site. However it is unlikely all 141 species would occur at the site due to an absence of specific microhabitat requirements or the seasonal nature of the species. The disadvantage of lists of predicted species is that in the process of covering all eventualities, an area can appear to have a more diverse fauna than is actually the case.

3.7.3 Significant Vertebrate Species

The fauna species listed in Table 5 have either been previously recorded or have the potential to occur in the vicinity of the South West Campus.

3.7.4 Potential Species Identified under the *EPBC Act 1999*

Ten threatened species of fauna and four migratory species of birds potentially occurring in the Edith Cowan University, Bunbury area were highlighted as having national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999*. These species are listed in Table 5.

TABLE 5
SIGNIFICANT VERTEBRATE SPECIES PREDICTED TO OCCUR NEAR THE SOUTH WEST CAMPUS, BUNBURY

Species	Status under Wildlife Conservation Act Schedule (S) / Priority (P)	Status under Commonwealth Environment Protection and Biodiversity Act	Recorded (R) or Predicted (P)	Comment
Chuditch (*Dasyurus geoffroii*)	Schedule 1	Vulnerable	R	Species unlikely to occur within area.
Bilby (*Macrotis lagotis*)	Schedule 1		R	Species unlikely to occur within area.
Western Ringtail Possum (*Pseudocheirus occidentalis*)	Schedule 1	Vulnerable	R	Species possible within the area.
Quokka (*Setonix brachyurus*)		Vulnerable	R	Species highly unlikely to occur within area.
Australasian Bittern (*Botaurus poiciloptilus*)	Schedule 1		R	Species possible within area.
Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)	Schedule 1	Vulnerable	R	Species likely to occur within area.
Carnaby's Black-Cockatoo, (*Calyptorhynchus latirostris*)	Schedule 1	Endangered	R	Species likely to occur within area.
Forest Red-tailed Black Cockatoo (*Calptorhynchus banksii naso*)	Schedule 1		R	Species likely to occur within area.
Peregrine Falcon (*Falco peregrinus*)	Schedule 4		R	Species possible in the area.
Austromerope poultoni	Priority 1		R	Species or species habitat possible in the area.
Black Bittern (*Ixobrychus flavicollis australis*)	Priority 2		R	Species possible within area.
Southern Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)	Priority 3		R	Species possibly in the area.
Black striped Minnow (*Galaxiella nigrostriata*)	Priority 3		R	Unlikely as there are no shallow isolated pools in peat flats surrounding forested areas.
Pachysaga munggai	Priority 3		R	Species or species habitat possibly in the area.
Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)	Priority 4		R	Species likely to occur within area.
Western Brush Wallaby (*Macropus irma*)	Priority 4		R	Species possibly in the area.
Western False Pipistrelle (*Falsistrellus mackenziei*)	Priority 4		R	Species possibly in the area.
Water Rat (*Hydromys chrysogaster*)	Priority 4		R	Species possibly in the area.
Little Bittern (*Ixobrychus minutus*)	Priority 4		R	Species possibly in the area.
Bush Stonecurlew (*Burhinus*	Priority 4		R	Species likely to occur

Species	Status under Wildlife Conservation Act Schedule (S) / Priority (P)	Status under Commonwealth Environment Protection and Biodiversity Act	Recorded (R) or Predicted (P)	Comment
grallarius)				within the area.
Hooded Plover (*Charadrius rubicollis*)	Priority 4		R	Unlikely to occur in the area as it inhabits margins of shallow salt lakes.
Eastern Curlew (*Numenius madagascariensis*)	Priority 4		R	Species unlikely to occur within the area.
Crested Shrike-tit (*Falcunculus frontatus leucogaster*)	Priority 4		R	Species unlikely to occur within the area.
Western Whipbird –western heath (*Psophodes nigrogularis nigrogularis*)	Priority 4	Endangered	R	Species unlikely to occur within the area.
Western Whipbird – western mallee (*Psophodes nigrogularis oberon*)	Priority 4	Vulnerable	R	Species unlikely to occur within the area.
Southern Giant-Petrel (*Macronectes giganteus*)		Endangered Migratory	P	Species unlikely in the area because it is a marine species.
Northern Giant-Petrel (*Macronectes halli*)		Vulnerable Migratory	P	Species unlikely in the area because it is a marine species.
Shy Albatross (*Thalassarche cauta*)		Vulnerable Migratory	P	Species unlikely in the area because it is a marine species.
White-bellied Sea Eagle (*Haliaeetus leucogaster*)		Migratory	P	Species unlikely in the area because it is a marine species.

3.7.5 Significant Fauna

In Western Australia, all native fauna species are protected under the *WA Wildlife Conservation Act 1950-1979.* Fauna species that are considered rare, threatened with extinction or have a high conservation value are specially protected under the Act. In addition, some species of fauna are covered under the 1991 ANZECC convention, while certain birds are listed under the Japan and Australian Migratory Bird Agreement (JAMBA) and the China and Australian Migratory Bird Agreement (CAMBA).

Comments have been provided below on Scheduled or Priority listed fauna that are listed as potential or likely to occur on site: Classification of rare and endangered fauna under the Wildlife Conservation (Specially Protected Fauna) Notice 1998 recognises four schedules of taxa. These are:

Schedule 1 – fauna that are rare or likely to become extinct and are declared to be fauna in need of special protection.

Schedule 1 species listed as likely or potential to inhabit the South West campus site include:

- **Chuditch (*Dasyurus geoffroii*)** – This species is the largest carnivorous marsupial in Western Australia. Formally found over 70% of Australia, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of

South West WA. They den in hollow logs and burrows and have also been recorded in tree hollows and cavities.

Habitat alteration and removal of suitable den logs and den sites following land clearing, grazing and frequent wildfire have contributed to a decline in Chuditch numbers. Competition for food and predation by foxes and cats, hunting and poisoning have also contributed to its decline. Seventeen records of the Chuditch have been made in the area since 1986.

- **Western Ringtail Possum (*Pseudocheirus occidentalis*)** – It is closely associated with the Peppermint *Agonis flexuosa* that occur as the dominant overstorey species in woodland and also as a co-dominant in mixed woodland of Tuart (*Eucalyptus gomphocephala*), Jarrah (*E. marginate*), Marri (*Corymbia calophylla*) and *Banksia* spp. between Australind/Eaton to Waychinicup National Park.

  The major factors thought to be contributing to the decline of the Western Ringtail Possum include habitat loss and/or modification, predation by introduced predators, and changing fire regimes. In coastal populations the fox is the major predator. The Western Ringtail Possum is possible in the wooded areas of the South West Campus.

- **Quokka (*Setonix brachyurus*)** - Once very common in areas such as the Swan Coastal Plain near Perth and Gingin, quokkas are now uncommon on the mainland and confined to isolated pockets within the South West corner of Western Australia. They are, however, found at Dwellingup, Jarrahdale, Harvey and Collie, in the Stirling Range National Park and along the South Coast to Two Peoples Bay. On the mainland, populations are currently restricted to densely vegetated coastal heaths, swamps and riverine habitats where they are less vulnerable to predation.

  The last sightings of Quokkas in the region were in 1931 (Busselton) and 1976 (Gelorup), therefore the species is unlikely to occur in the area.

- **Australasian Bittern (*Botaurus poiciloptilus*)** - The Australasian Bittern is the largest of Australia's bittern species. The Australasian Bittern inhabits bulrushes and reedbeds of wetland areas, but will venture out onto mudflats to feed on amphibians, small lizards or snakes, crustaceans and insects. Two Australasian Bittern's were found at Benger Swamp Nature Reserve in 1992. The Australasian Bittern is potentially found near the South West Campus.

- **Baudin's Cockatoo (*Calyptorhynchus baudinii*)** – This species is most common in the far South West of WA where it breeds. Breeding records come from the southern forests north to Collie and east to near Kojonup. Baudin's Cockatoo is typically found in vagrant flocks and utilises the taller, more open Jarrah and Marri woodlands, where it feeds mainly on Marri seeds and various Proteaceous species. It breeds in Spring/Summer in the southern forests, nesting in tree hollows (primarily Marri). Baudin's Cockatoos are likely to be found at the South West Campus.

- **Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)** - This species inhabits the South West of WA. Its preferred habitat is the woodland where it preferentially feeds on plants of the Proteaceae family. In winter, flocks can be found in heaths. It may utilise the Jarrah and Banksia woodlands of the site for feeding but is not known to breed in the area. Carnaby's Cockatoos are likely to be present at the South West Campus.

- **Forest Red-tailed Black Cockatoo (*Calptorhynchus banksii naso*)** – This species is a large cockatoo restricted to the South West of WA. It is most commonly seen in Eucalypts where it is attracted to seeding Marri, Jarrah, Blackbutt, Karri and Snottygobble. Forest Red-tailed Black Cockatoo's were formally common but now rare to uncommon and patchily distributed. They usually travel in pairs or small flocks, seldom in large flocks (up to 200). The main cause of population decline has been due to habitat destruction and alteration. It is likely to be present at the South West Campus.

Schedule 2 – fauna that are presumed to be extinct and are declared to be fauna in need of special protection. There are no Schedule 2 fauna likely to inhabit the South West Campus.

Schedule 3 – birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds, and birds in danger of extinction which are declared to be fauna in need of special protection. There are no Schedule 3 fauna likely to inhabit the South West Campus.

Schedule 4 – fauna that is in need of special protection, otherwise than for the reasons mentioned in Schedule 1, 2 or 3. Schedule 4 species listed as likely or potential to inhabit the South West Campus site include:

- **Peregrine Falcon (*Falco peregrinus*)** – This species is found across most of Australia, but only occurs in low densities and has a wide and patchy distribution. It favours hilly or mountainous country and open woodlands and may be an occasional visitor to the South West Campus.

In addition to the above 'schedule' classifications, CALM also classifies fauna under five different Priority codes:

Priority 1 – Taxa with few, poorly known populations on threatened lands. Taxa that are known from few specimens or sight records from one of a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened species. Priority 1 species listed as likely or potential to inhabit the South West Campus include:

- ***Austromerope poultoni*** – This species of scorpion fly is associated with forest litter and appears to be active after rainy periods. Little else is known of its biology and habitat requirements. It is possible it is present in the bushland at the South West Campus.

Priority 2 – Taxa with few, poorly known populations on conservation lands or taxa with several, poorly known populations not on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands no under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. Priority 2 species listed as likely or potential to inhabit the South West Campus include:

- **Black Bittern (*Ixobrychus flavicollis australis*)** –Black Bitterns are found in the Kimberley, Pilbara and South West (north to Yanchep and Northam and east to Albany). They inhabit freshwater pools, swamps and lagoons, which are well screened with trees. Occasionally feeding by day but mainly sheltering in dense waterside vegetation. Locally moderately common, but generally uncommon and declining on the Swan Coastal Plain. It is unlikely to occur at the South West Campus due to the absence of habitat.

Priority 3 – Taxa with several, poorly known populations, some on conservation lands. Taxa which are only known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. Priority 3 species listed as likely or potential to inhabit the South West Campus include:

- **Southern Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)** – Formerly widespread in eastern and South Western Australia, it is now found from Perth to Albany, west of Albany highway. It occurs at low densities in the northern Jarrah forest, and higher densities in the Perup/Kingston area, Collie River valley, and near Margaret River and Busselton.

  Habitat clearing and fragmentation, and habitat alteration by logging and mining are the main causes threatening populations. The greatest threat appears to be the reduced availability of trees with hollows, and predation by cats and foxes. Residual habitat is often fragmented, thereby isolating populations and impeding genetic exchange. Multiple sightings in nearby areas indicate that they may be present on the South West Campus.

- ***Pachysaga munggai*** – A species of cricket found in slightly open vegetation where it lives in leaf litter by day and emerges at night to feed and sing from low vegetation. It is possible that it occurs at the South West Campus.

Priority four and five – Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could if present circumstances change. These taxa are usually represented on conservation lands. Taxa that are declining significantly but are not yet threatened. Priority 4 species listed as likely or potential to inhabit the South West Campus include:

- **Quenda or Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)** –Quenda prefer dense scrub (up to one metre high), with swampy vegetation. They will often feed in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover.

  Major threats to Quenda include habitat fragmentation and loss of habitat on the coastal plain and wheat belt, fire in fragmented habitat, predation by foxes, predation of young by cats and predation around residential areas by dogs. Southern Brown Bandicoots have been observed in the surrounding areas and it is possible they are present at the South West Campus.

- **Western Brush Wallaby (*Macropus irma*)** – This species was very common in the early days of settlement however, its range has been seriously reduced and fragmented due to clearing for agriculture and there is a significant decline in abundance within most remaining habitat. It is now distributed across the South West of WA from north of Kalbarri to Cape Arid. The optimum habitat is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets.

  An increase in the number of foxes in the early 1970's in South Western Australia appears to have led to a decline in the numbers of Western Brush Wallabies. It is thought that juveniles not long out of the pouch may fall prey to this predator. It is now uncommon throughout its range but its numbers increase in response to fox baiting. Western Brush Wallaby's have been sighted around Bunbury and are possible at the South West Campus.

- **Western False Pipistrelle (*Falsistrellus mackenziei*)** – This bat species lives in hollows in old trees, branches and stumps. It is normally found in colonies of 5 to 30 bats. Western False Pipistrelle's eat flying-insects caught between spaces between canopy and understorey of tall forest trees. It is vulnerable to loss of roost sites in tree hollows and loss of feeding grounds by forestry activities, clearing for agriculture and housing.

  Western false pipistrelles live mainly in wet sclerophyll forests of Karri, Jarrah and Tuart eucalypts. They are fast, direct, high fliers that have been caught in the forest 8 metres above the ground. It is possible they are present at the South West Campus.

- **Water Rat (*Hydromys chrysogaster*)** – It is found mainly near permanent bodies of freshwater, occasionally at temporary waterholes. They can also survive in areas where rivers and streams have become polluted or are brackish. About the size of a rabbit, the Water Rat is well adapted for water with webbed toes on the front and hind feet, which are broad and act as paddles. It feeds mainly on crustaceans, molluscs, and fish, although they have been observed feeding on ducks, poultry, frogs, turtles, bats, house mice, and aquatic insects. The Water Rat is potentially found on campus due to a nearby wetland.

- **Little Bittern (*Ixobrchus minnutus*)** –It is found in the far northeast (lower Ord River) and the South West (north to Moora and east to Two Peoples Bay). It is most often seen in dense beds of *Baumea*, *Typha* and other tall rushes growing in freshwater swamps, around lakes and long rivers. Locally common on coastal wetlands east and west of Albany, however generally uncommon or seldom reported. It is potentially found at the South West Campus due to nearby wetlands.

- **Bush Stone-curlew (*Burhinus grallarius*)** – It is regarded as uncommon or rare throughout the region having declined as a result of feral cats and foxes. It can be found in open wooded country or scrubs, among many other habitats. When sighted it will normally crouch down or stand perfectly still and rely on camouflage to disguise it. When approached, it will normally walk away rather than fly (especially during the day).

  They have a wide-ranging diet, but prefer to feed on insects, molluscs, small lizards, seeds and occasionally small mammals. Feeding takes place at night and all food is taken from the ground. It is regionally present, and therefore possible on the South West Campus.

3.7.6 Other Species

Although it did not register on the CALM threatened and Priority search, the Carpet Python may occur in the area. The Carpet Python (*Morelia spilota imbricata*) is a large python found across the South West of Western Australia, north to Geraldton and Yalgoo, and east to Kalgoorlie, Fraser Range and Eyre. They inhabit forest, heath, or wetland areas and shelter in hollow logs or in branches of large trees. They feed on a variety of vertebrates including small mammals and reptiles. Carpet Pythons are often found in colonies, particularly around breeding in spring. This species is widespread within the South West, but is not in high density across its distribution. It is therefore possible that it occurs at the South West Campus.

PART 2: ENVIRONMENTAL MANAGEMENT PLANS

PART 2: ENVIRONMENTAL MANAGEMENT PLANS

4. DRAINAGE AND NUTRIENT MANAGEMENT PLAN

4.1 Management Objectives

An important objective of drainage and nutrient management is to develop an appropriate strategy that will result in minimising the amount of nutrients potentially entering the groundwater and the wetland system from the overall site.

Management plans should assist in the reduction in the amount of leachable nutrients resulting from surface run-off or infiltration below the root zone. In association with the drainage design, drainage and nutrient management will enable adverse impacts on groundwater quality in the superficial aquifer to be minimised.

The management measures outlined in this plan are intended to:

- maintain groundwater quality;
- protect groundwater resources;
- limit impacts on groundwater levels; and
- minimise impacts on any sensitive receiving environments (eg wetlands).

Details of management measures applicable to drainage and nutrient management and water management are outlined separately below.

The overall outcome in relation to these issues and the management proposed should be to have minimal impact on the water quality within the superficial aquifer and no adverse impact or loss of associated water resource, and changes to groundwater levels within acceptable limits.

4.2 Background

The clearing of native vegetation and its replacement with impervious surfaces, such as buildings and paved roads, will result in a significant increase in surface runoff within the campus grounds.

Changes to groundwater quality, quantity or levels in wetlands can rapidly show the health status of the wetland and surrounding environment. For example:

- falling water levels in wetlands can indicate high use of shallow groundwater and/or reduced replenishment of the groundwater resource;

- elevated water levels can indicate a change in the water balance due to a changed land use (eg. vegetation clearing, increased recharge);

- nutrient enrichment of wetlands will be reflected in increased nutrient loadings of surface runoff and groundwater potentially resulting in algal blooms; and

- changes in wetland vegetation can indicate physical disturbance, nutrient enrichment and changes to water levels.

These factors can be controlled through the application of appropriate drainage and nutrient management measures as described in the following sections.

The Department of Environment's (Department of Environment 2004) principal objectives for managing urban stormwater in Western Australia are stated as:

- **Water Quality** - To maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.
- **Water Quantity** - To maintain the total water cycle balance within development areas relative to pre-development conditions.
- **Water Conservation** - To maximise the reuse of stormwater.
- **Ecosystem Health** - To implement stormwater systems that are economically viable in the long term.
- **Public Health** - To minimise the public risk, including risk of injury or loss of life to the community.
- **Protection of Property** - To protect the built environment from flooding and waterlogging.
- **Social Values** - To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater.
- **Development** - To ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

With respect to stormwater management guidelines, no specific standards or criteria for water quality management are established in the DoE's Stormwater Management Manual for Western Australia (Department of Environment 2004). In the interim the DoE has encouraged the use of "source controls" and "in transit" controls as the primary approach for stormwater quality management.

Previous studies (ATA Environmental, 1999) have shown that minimal nutrient (eg. 2kgN/ha/yr and 0.2kgP/ha/yr) is transported in stormwater (eg. runoff from roads, roofs, and pathways), and therefore is unlikely to impact on groundwater quality or wetland status compared with either fertilisation or livestock agistment.

Nevertheless, there will be a requirement for stormwater management on the campus especially for any future development in closer proximity to the wetland area located on the western boundary.

4.3 Nutrient Management

The DNMP has been prepared to minimise the export of nutrients from the campus. In developing a water quality management strategy for South West Campus, the primary focus is on nutrient input and export as the most significant water quality issue. Leaching of the nutrients nitrogen and phosphorous may lead to pollution of the superficial aquifer and excess nutrient loading to the wetland along the western boundary of the campus. The superficial aquifer is largely used for domestic garden irrigation and as such there is little concern for the affects of high nutrient concentrations on human health (Water Authority of Western Australia, 1994). However, the predominant north-western flow direction of the superficial aquifer (Water Authority of Western Australia, 1994) towards the coast may result in excessive leaching to nutrient sensitive marine environments.

4.3.1 Nutrient Sources

The major nutrient source from 'built up' areas (eg. university infrastructure) is likely to originate from application of fertilisers to lawns, gardens and landscaped areas of open space.

Of the fertiliser applied to the South West Campus lawns, gardens and areas of open space, vegetation surrounding the campus infrastructure may take up some of the leached nutrients. However, depending on the timing of fertiliser application, a portion of applied nutrient could potentially end up in the groundwater and move through the profile towards the wetland area adjacent to the Bussell Highway (western boundary). Although phosphorous may be bound within the soil profile, no such process occurs for nitrogen. The negative consequences of over-application of fertilisers, such as eutrophication of wetlands should therefore be considered in the overall management of fertiliser application.

The implementation of the DNMP will assist in a significant reduction in the total amount of leachable nutrients that are available through mobilisation by surface runoff or infiltration below the root zone.

Management Strategies:

D1 Establish baseline data collection of current nutrient status of soil profiles within developed garden beds and lawn areas.

D2 Minimise the export of nutrients from the campus to prevent pollution of the superficial aquifer, and prevent degradation of the wetland.

4.3.2 Maximum Nutrient Application Criteria

The Department of Environment and Water Catchment Protection (DEWCP) has developed recommended maximum nutrient loadings for the protection of public water resources, based on soil type of a site and drainage features. Edith Cowan University can be defined as generally containing Category 'A' soils (coarse/sandy soils draining to wetlands with moderate/high eutrophication risk).

To protect groundwater resources and quality, the DEWCP maximum permitted nitrogen and phosphorus applications to lawns, gardens, areas of open space on Category A soils are 140kgN/ha/year and 10kgP/ha/year (Waters and Rivers Commission, 1998) (Table 6).

TABLE 6
VULNERABILITY CATEGORIES AND RECOMMENDED MAXIMUM NUTRIENT APPLICATION CRITERIA FOR IRRIGATION WATER

VULNERABILITY	CHARACTERISTICS	MAXIMUM APPLICATION RATE kg/hectare/yr	
		Nitrogen (N)	Phosphorus (P)
Category 'A'	Coarse sandy soil/gravel draining to surface water with moderate/ high risk of Eutrophication	140	10
Category 'B'	Coarse sandy soil/gravel draining to water with a low risk of Eutrophication	180	20

VULNERABILITY	CHARACTERISTICS	MAXIMUM APPLICATION RATE kg/hectare/yr	
		Nitrogen (N)	Phosphorus (P)
Category 'C'	Loam/clay soil (PRI >10) draining to water with moderate/high Eutrophication risk	300	50
Category 'D'	Loam/clay soil (PRI >10) draining to water with a low risk of Eutrophication	480	120

Source: Water and Rivers Commission 1998

The main sources of nitrate and phosphate within the South West Campus are likely to include lawn and garden fertilisation (eg. inorganic fertilisers).

Standard fertilisation rates for Public Open Space in residential developments supply an average of 17kgN/ha/year and 4kgP/ha/year (Gerritse *et al*., 1990). Given the nature of the sandy soils throughout the campus, a proportion of applied nutrients may leach into the groundwater. Therefore, the standard fertilisation rates noted by Gerritse *et al*. (1990) should be adequate for the campus grounds and are also well under the maximum nutrient application criteria as noted in Table 1.

Management Strategy:

D3 Maintain the recommended guidelines for fertiliser application rates for the sandy soils of the Swan Coastal Plain using organic fertilisers where practicable (refer to Table 6).

4.3.3 Fertiliser Regime

Fertiliser use will be managed to minimise its application and its inclusion in runoff. The following practices should apply in open space areas within the campus grounds:

- Minimal application of fertilisers;
- Soil nutrient tests;
- Appropriate timing of fertiliser application;
- Use of phosphorus-free fertilisers and slow release fertilisers (where fertiliser application is necessary);
- Suitable irrigation regime to avoid leaching nutrient and fertiliser through the soil profile;
- Appropriate selection of grass species;
- Use of high quality topsoil;
- Planting of native vegetation;
- Appropriate design of lawn areas and gardens to minimise runoff; and
- Selection of fertiliser application methods.

Within open space areas, the application of fertiliser will be kept to the minimum required to ensure healthy growth. Fertiliser will be applied at a rate lower than typically recommended application rates and monitored to ensure satisfactory growth and appearance, as is currently the case. Slow release fertilisers will be used to minimise leaching of nutrients into the superficial aquifer.

The soil nutrient analyses will be undertaken to ensure excessive fertiliser applications do not occur. Soil tests will be conducted at least annually prior to the active growing season to determine the level of nutrients required. Soil samples will be taken from both established garden beds and lawn areas and tested for TP and TN concentrations (other trace minerals may

also be tested for at the same time depending upon cost of analyses). The addition of phosphorus to grassed areas will only be undertaken if soil analyses confirm phosphorus levels in the soil are unacceptably low and require adjustment.

It is envisaged that quantities of fertiliser will be applied throughout the year, predominantly in the warmer months during the active growing periods. Applications in winter when rainfall is greatest will be minimal, and avoided altogether if possible, to reduce the risk of nutrients leaching through the soil profile and entering the lake via surface runoff.

The rate of application of fertiliser will depend on the appearance and the amount of use the grassed area experiences and be guided by results of soil sample analyses. Inspection of grassed areas will be carried out regularly as part of routine maintenance of the POS areas to identify turf condition and the need for fertiliser. Higher dosage or more frequent application may be necessary during the initial 12 months following planting of new lawn areas to ensure strong vigorous growth and root establishment. The application rate will be adjusted to ensure the minimum fertiliser is provided to achieve the required results.

Fertiliser application within the open spaces areas will be further managed by ensuring:

- Fertiliser application is not undertaken if rainfall is likely within the following two weeks;
- Fertilisers are not applied within 5m of any sensitive receiving environments (eg wetlands/compensating basins);
- The irrigation regime, particularly shortly after fertiliser application, is kept to a minimum; and
- Preference for the use of drop spreader rather than rotary type spreaders when applying fertiliser to lawn areas.

Slow release fertilisers should be used in winter to eliminate leaching of nutrients into the superficial aquifer. Research has shown that slow release fertilisers may have a leaching rate as low as 2% if applied correctly. The selection of slow release fertilisers is usually determined following soil and tissue tests.

Fertiliser application rates should be documented annually and soil testing carried out at least once per year to monitor salinity and phosphorus loadings.

Management Strategies:

D4 Use slow release fertilisers on gardens, lawns and fields as recommended.

D5 Ensure appropriate timing and application methodology of fertiliser programs for gardens, lawns and playing fields.

D6 Give preference to planting native species of local provenance and low water use species to reduce water and nutrient requirements.

D7 Undertake a cost/benefit analysis of composting on-site versus buying in campus requirements from off-site.

4.4 Pesticide Management

The use of chemicals for the management of lawn disease and pests should be limited to preventative use only and not involve routine applications.

In the event that application of pesticides, insecticides or herbicides is required, selection should be selected be determined according to:

- Good performance;
- Low mobility;
- Low persistence; and
- Low toxicity.

Table 7 lists chemicals, their trade names and their 'target' that are commonly used in the control and prevention of weeds, pests and related diseases. The use of particular chemicals should be updated when new chemicals become available according to the above criteria.

Management Strategy:

D8 Application of chemical pesticides is to be limited to eradication use in the event that either biological, cultural or physical eradication methods are not considered to be appropriate in keeping with ECU Procedure: Pesticides, Handling, Storage and Use of (refer to Appendix 3).

TABLE 7
CHEMICALS/TRADE NAMES

CHEMICAL		TRADE NAME	WEEDS					PESTS				DISEASES					
			Broadleaf	Crabgrass	Wintergrass	Clovers	Couch	Cutworm	Black Beetle	Stem Weevil	Billbug	Pythium	Dollar Spot	Spring Dead Spot	Take-All-Patch	Fusarium Patch	Brown Patch
HERBICIDES	Bromoxynil/MCPA	Chipco Buctril G	✓														
	Glyphosate	Roundup	General control														
	Dithiopyr	Dimension		✓													
	Propyzamide	Kerb			✓												
	Oxidiazon	Ronstar G	General control														
	Disodium Methyl Arsonate	DSMA		✓													
	MCPA/Bromoxynil	Chipco Fairway	✓			✓											
	Bensulide	Exporsan			✓												
	Siduron	Tupersan/Fusilade					✓										
INSECTICIDES	Cyfluthrin	Baythroid Turf						✓	✓								
	Chlorpyrfos	Chipco Chlorfos							✓	✓							
	Fipronil	Chipco Choice								✓							
	Imidacloprid	Provado Turf							✓		✓						
	Diazinon	Pennside							✓	✓							
FUNGICIDES	Fosetyl	Chipco Aliette										✓					
	Bitertanol	Baycor Turf											✓	✓			
	Triadimental	Bayfidan Turf											✓		✓		
	Mancozeb	Chipco Fore Flo															✓
	Iprodione	Rovral Green														✓	✓
		Banner													✓		

4.5 Chemical Storage

All chemicals associated with the management of the campus gardens should be stored in a locked storage and maintenance shed. The storage and handling of chemicals at the site will be in accordance with Department of Health guidelines and will include provision for appropriate ventilation, drainage and training of personnel.

Management Strategy:

D9 All chemicals related to the management of campus grounds will be appropriately stored.

D10 The storage and handling of chemicals will be in accordance with Department of Health guidelines.

D11 Disposal of chemical containers is to be undertaken according to the manufacturer's instructions and in keeping with ECU Procedure: Pesticides, Handling, Storage and Use of (refer to Appendix 3).

4.6 Surface Water Monitoring Program

The wetland and compensating basin are currently being monitored for a limited suite of analytes on an annual basis by *Ribbons of Blue* in association with the University's Society and Environment students.

There is therefore potential for biannual monitoring and reporting on the quality and quantity of groundwater flow within the campus grounds to continue to be incorporated as field work by students in the Society and Environment course, with annual reporting of findings being directed to the ECU Bunbury Campus Environment Committee.

It is recommended that the following standard chemical analyses of water samples collected from both sites include the following parameters:

- Nitrite ((NO_2-N)
- Nitrate (NO_3-N)
- Ammonia Nitrogen (NH_3-N)
- Total Nitrogen
- Total Phosphorus
- Orthophosphates (PO_4-P)
- Salinity (TDS)
- pH
- Groundwater levels

The sampling and analysis of the surface water should be undertaken according to the current water quality guidelines contained in 'Assessment Levels for Soil, Sediment and Water' (Government of Western Australia, 2003) and analysis should be conducted by an accredited laboratory if practicable.

Management Strategies:

D12 Implement a biannual monitoring program of surface waters in the compensating basin and wetland located within the South West Campus that will:

i. Measure quantity (through standing water level);
ii. Measure quality (refer to suite of analytes in Section 4.6);

iii. Report annually to the Campus Environmental Committee.

4.7 Prioritisation of Management Strategies

Table 8 prioritises the management strategies for the South West campus and identifies the frequency with which the strategy should be implemented and the person(s)/parties responsible for undertaking the action.

TABLE 8
PRIORITISATION AND IMPLEMENTATION SCHEDULE OF MANAGEMENT STRATEGIES FOR DRAINAGE AND NUTRIENT MANAGEMENT

OBJECTIVE	MANAGEMENT STRATEGY	PRIORITY	FREQUENCY	RESPONSIBILITY
Nutrient Management	***D1*** Establish baseline data collection of current nutrient status of soil profiles within developed garden beds and turf areas.	High	Once off	Facilities Management Office
	D2 Minimise the export of nutrients from the campus to prevent pollution of the superficial aquifer, and prevent degradation of the wetland.	High	Ongoing	Campus Services
Nutrient Sources	***D3*** Maintain the recommended guidelines for fertiliser application rates for the sandy soils of the Swan Coastal Plain using organic fertilisers where practicable (refer to Table 6).	High	Ongoing	Campus Services to review contractors schedule
	D4 Use slow release fertilisers on gardens and lawn areas only as required.	High	Ongoing	Campus Services
	D5 Ensure appropriate timing and application methodology of fertiliser programs for gardens and lawn areas.	High	Ongoing	Provide information to Carl Overbye
	D6 Giver preference to planting native species of local provenance and low water use plants to reduce water and nutrient requirements.	High	Ongoing	Campus Services
	D7 Undertake a cost/benefit analysis of composting on-site versus buying in campus requirements from off-site.	Medium	Once off	Ron Hewitt/ Carl Overbye
Pesticide Management	***D8*** Application of chemical pesticides is to be limited to eradication use in the event that either biological, cultural or physical eradication methods are not considered to be appropriate in keeping with ECU Procedure: Pesticides, Handling, Storage and Use of (refer to Appendix 3).	High	Currently twice yearly for ants and bees	All grounds staff
	D9 All chemicals related to the management of campus gardens will be appropriately stored in keeping with ECU Procedure: Pesticides, Handling, Storage and Use of (refer to Appendix 3).	High	Ongoing	Campus Services

OBJECTIVE	MANAGEMENT STRATEGY	PRIORITY	FREQUENCY	RESPONSIBILITY
Chemical Storage	***D10*** The storage and handling of chemicals will be in accordance with Department of Health guidelines.	High	Ongoing	Campus Services
	D11 Disposal of chemical containers is to be undertaken according to the manufacturer's instructions and in keeping with ECU Procedure: Pesticides, Handling, Storage and Use of (refer to Appendix 3).	High	Ongoing	Campus Services
Surface water Monitoring Program	***D12*** Implement a biannual monitoring program of surface waters in the compensating basin and wetland located within the South West Campus that will: i) measure quantity (through standing water level); ii) measure quality (refer to suite of analytes in Section 4.6); and iii) report annually to Campus Environmental Committee	High	Twice yearly data collection/ Reporting annually	Sandra Wooltorton

5. VEGETATION AND FAUNA MANAGEMENT PLAN

5.1 Background

This Vegetation and Fauna Management Plan (VFMP) will identify the level of potential future impacts on vegetation, significant flora and significant fauna and habitat arising from current and future development within the campus site. The VFMP will detail management options for significant flora and fauna species, in the context of sustainable development.

5.2 Vegetation

5.2.1 Tuart Woodland Management

While Tuart is not considered threatened, some of the vegetation communities containing tuart are under-represented in conservation reserves, or are not adequately protected on private lands, and are particularly susceptible to threatening processes such as land clearing, climate variability, changes in vegetation structure resulting from altered fire regimes and past grazing, hydrological factors and weed invasion (Government of Western Australia, 2002). Within the Bunbury Local Government Area there is an estimated total of 267.3ha of remnant Tuart Woodlands with the majority (170.6ha) located on private lands where there are substantial threats from development and alternative land uses (Government of Western Australia, 2004). The tuart resource on the South West campus site is therefore very important to manage and conserve. The occurrence of three Tuart Woodland associations in good to very good condition across the South West campus provides a unique conservation opportunity for the university. The Tuart Woodland associations identified within the campus are outlined in Table 1 and their locations across the campus are shown in Figure 4.

It is recommended that Tuart Woodland conservation be incorporated into structure planning for the South West campus in order to ensure continued conservation and management of the woodlands within the framework of future sustainable development of the campus. Where possible, future development of the South West Campus should be restricted to the more degraded sections of the Tuart Woodland associations. In particular, clearing for future campus buildings should be limited to the necessary building envelope and service tracks, with fuel reduction for fire prevention.

The Tuart Woodland association immediately south of the current limit of campus buildings contains sections of degraded trees (see Figures 5 and 6) that will enable extension of the campus infrastructure while maintaining the integrity of the good to very good condition Tuart Woodland within the central corridor. Where clearing of the woodland is unavoidable the “no-net-loss” principle may be applied, whereby other areas are rehabilitated to ensure no-net-loss of woodland quality or quantity and habitat function.

The most prominent feature of the Tuart Woodland associations at the South West Campus is the corridor of good to very good condition woodland that runs from the northern to the southern boundary of the campus (see Figures 5 and 6). Conservation of this corridor of woodland will provide a high degree of connectivity across the site. In order to maintain the quality of this corridor of woodland it is recommended that access to the woodland be limited where possible and thorough weed management conducted (refer to Site Rehabilitation Plan). Areas that are set aside for conservation purposes need to be separated from active recreational areas to prevent disturbance and weed invasion. This may achieved through informal fencing, such as pine bollards, or through revegetation with existing species at high densities. High density plantings will act as a barrier to movement into more sensitive areas. More information regarding revegetation and weed management of the site may be found in the Site Rehabilitation Plan.

Ecoscape (2004) states that Tuart Woodland associations with "low visible disturbance understorey" are rare within the Bassendean soil system, as they are considered to be at the extremes of their natural range or have been extensively cleared. They rate highly for conservation management consideration due to their poor representation and their likelihood of containing unique understorey vegetation associations (Ecoscape, 2004). The South West Campus contains Tuart Woodland associations over the Bassendean sands which occur within the central and southern portions of the site. Further detailed flora surveys may be required to determine if the Tuart Woodland association occurring on the Bassendean sands is of high conservation value. The report "Tools for identifying 'indicative high conservation' tuart woodlands" (Ecoscape, 2004), prepared for the Department of Conservation and Land Managements Tuart Response Group, outlines a method for determining the conservation value of Tuart Woodland associations.

The location of the Aqwest Water Treatment Facility immediately south of the southern campus boundary, and requirement of a 200m buffer from the chlorine treatment plant, limits the extent of future development within the southern potion of the campus. This limitation may enable a dedicated reserve to be declared within the campus grounds.

To encourage community participation, awareness and education management of the Tuart Woodland associations within the South West Campus may be conducted in partnership with the community through the formation of a 'friends' group or through community tuart conservation groups.

Management Strategies:

V1 With regard to recognising the importance of the Tuart Woodland that occurs within the campus grounds:

i. Incorporate Tuart Woodland conservation into structure planning for the campus, where practicable, to ensure continued conservation of the woodland within the framework of future sustainable development of the campus.
ii. Investigate the option for a Tuart Woodland reserve within the 200m buffer of the Aqwest Water Treatment Facility.
iii. Encourage community participation and key stakeholders awareness and education through the formation of a 'friends' group or partnership with community Tuart conservation groups.

V2 Undertake a spring flora survey to determine the conservation status of the Tuart Woodland located on Bassendean sands using the Ecoscape (2004) methodology.

V3 Future campus development should preferably be undertaken within degraded sections of woodland with clearing for future campus infrastructure being restricted to the defined building envelope and applicable service tracks.

V4 Apply the "no-net-loss" principle where clearing for future development is unavoidable.

V5 Protect the remnant north-south corridor of good to very good condition Tuart Woodland through access restriction, weed management and revegetation.

V6 Separate conservation and active recreational areas through informal fencing or high density plantings.

5.2.2 Armillaria Management

Approximately 7% of the trees surveyed on the South West Campus site were assessed as being infected with *Armillaria*. Figure 5 shows that areas of *Armillaria* infection are close to pathways, firebreaks and tracks. Usual prescriptions for firebreaks on-site mostly include cultivation of the breaks with a scarifier pulled by a tractor. This technique may be aiding in the spread of infected material and therefore should be replaced with a non-invasive firebreak program such as the use of knockdown herbicides (eg. Glyphosate).

At present, there are no simple methods for controlling *Armillaria*. Prevention is the best treatment and hygiene is essential for ensuring the disease is not spread from infected sites to uninfected sites. Removal of infected material such as roots after excavation will reduce the potential impact of the disease spreading. Isolation of infected areas by trenching (at least to 1.1m depth) and the installation of root barriers can be very effective in situations where the infection area is well defined (Figure 5). However, on an area the size of the South West Campus, this technique may be cost inhibitive. Another technique is the clearing, aerating and drying of the root collar of an infected tree. This can be very useful on high value trees (eg. Tuart and Jarrah) that are infected. There are no chemicals that effectively control the *Armillaria* disease in trees and plants.

Management Strategies:

V7 Continue alternative firebreak cultivation with non-invasive method (selective use of knockdown herbicides to prevent spread of soil-borne diseases) in consultation with the City of Bunbury/ranger services.

5.2.3 Tree Removal and Branch Lopping Recommendations

Figure 6 indicates the trees surrounding the campus grounds, which have been assessed as requiring removal of branches or complete removal. Some of these trees have died or are in poor condition as a result of *Armillaria* infection, however the majority of trees requiring pruning or removal have been assessed as dangerous to the general public because of branches and limbs that may fall at any time (Figure 6).

Management Strategies:

V8 Establish a programme (costing and resources) to undertake tree removal and branch lopping to be conducted as indicated using a qualified tree surgeon for those trees identified in Figure 6.

5.3 Fauna

Thirteen species of amphibian, 46 species of reptile, 32 species of mammal (five introduced or feral), and 141 species of birds may be present at the South West Campus. However, not all of these species will be necessarily present on site because of the absence of specific microhabitat requirements.

A number of Schedule or Priority Species listed under the *Western Australian Wildlife Act 1950* or Vulnerable, Endangered or Migratory species listed under the *Environment Protection and Biodiversity Conservation Act 1999* were predicted in the region. Because no trapping or detailed site investigations were carried out as part of this assessment, it is not possible to conclude whether future development of the site will substantially modify, destroy or isolate an area of important habitat of these species, or seriously disrupt the lifecycle

(breeding, feeding, migration or resting behaviour) of an ecologically significantly proportion of the population of any of the listed species.

The measures outlined with regard to the management of locally significant vegetation and other native vegetation will act to preserve habitat for native fauna within the South West Campus. Specific management measures to protect native fauna are outlined in the following section.

5.3.1 Fauna Habitat Management

The retention of intact portions of bushland and the restriction of clearing to within building envelopes in the South West Campus are positive management measures to protect native fauna in the South West Campus.

Additional measures to protect native fauna in the South West Campus include:

- conducting a detailed fauna survey and site investigation to identify important habitat in order to develop site specific fauna management and to guide conservation and future sustainable development within the South West Campus site;
- dead trees and logs not to be removed from the woodland areas that do not present a potential fire hazard to surrounding infrastructure;
- adopting appropriate measures to advise surrounding landowners of the responsibilities of cat ownership and how cats may impact native fauna within the campus area (eg. cat curfews as a management measure);
- informing all surrounding landowners, students, staff and members of the public of the conservation value of the surrounding areas to significant flora and fauna populations and encourage them to plant local native flora, manage weeds and control the activities of dogs and other pets in their own land holding;
- any brochures available from the Council and appropriate Government Departments will be made available to surrounding landowners, students, staff and members of the public about the high environmental values of the areas, and how they may contribute to the management of this area; and
- prevent degradation and improve native fauna habitat by implementing weed control programs; adopt fire management measures; replant suitable native understorey species, where required; and fencing to allow for the movement of the native animals.

Management Strategies:

V9 Conduct a detailed fauna survey of the campus grounds to identify important habitat and develop a site-specific fauna management plan.

V10 Retain dead trees and logs in woodland areas that do not present a potential fire hazard to surrounding infrastructure.

5.4 Access Management and Community Education

Due to the good to very good condition of the majority of woodland vegetation within the South West Campus grounds and the potential habitat it provides for native fauna, it is recommended that access to the woodland areas be limited to designated pathways and required service tracks.

The enhancement of existing pathways and possible establishment of a limited number of new pathways throughout the South West Campus site will enable public access to the site for passive recreation and appreciation of the natural environment.

Prevention of unwanted vehicles (ie. non-service vehicles, motorbikes) and horse access from the woodland areas is important in order to prevent the spread of weeds and degradation.

Signs can be used as a passive method of access control while advising users of the conservation value of the vegetation and should be erected at strategic access points and along the pathway network to provide information and discourage random movement. Signs should make use of simple messages to convey information in an easy to read manner.

Management Strategies:

V11 Liaise with the 'Friends of Manea Park'/City of Bunbury to raise community awareness of the conservation significance of the woodlands through the installation of educational signage.

V12 Discourage inappropriate vehicle and horse access through signage installed near service track entry points and pathways.

5.5 Monitoring and Auditing

The following criteria will be used to assess the performance of the Vegetation and Fauna Management Plan:

- no additional disturbance to the vegetation structure as a result of increased recreational activities/population;
- a natural vegetation structure and coverage within the degraded and completely degraded areas of the South West Campus within 5-10 years; and
- reduction in the extent of weed invasion particularly adjacent to the tracks and firebreaks (ie. reduction of aggressive weeds) through slashing or mowing of infested track and firebreaks before weeds go to seed.

A monitoring program could be established by environmental students which will encompass both the monitoring of vegetation and revegetation within the South West Campus. Environmental students may also be utilised to conduct a detailed fauna survey and site investigation to determine fauna habitat at the South West campus. There are currently no environmental studies on offer at the South West campus however Environmental Management and Biological Sciences courses are on offer to students from the Joondalup Campus. There is therefore potential for monitoring and reporting on the performance of the VFMP within the campus grounds to be incorporated as either field work or work experience by interested students from the above courses, with students reporting to the South West Campus Environment Committee.

The conservation value of the Tuart Woodland associations within the site may also be determined by Environmental Management or Biological Science students using the method outlined by Ecoscape (2004).

The vegetation monitoring program could include the installation of permanently marked plots (2 x 2m, randomly placed) which could be monitored on a three monthly basis to determine impacts from potential weed invasion, trampling/loss and overall reduction to vegetation condition, on a seasonal basis.
Similarly, transects could be established and monitored by students on a six-monthly basis to determine rehabilitation success and measure the potential impacts from weed invasion, *Armillaria* infection or human traffic pressures. In addition, permanent pegs could be installed throughout various vegetation types and conditions for photographic monitoring on a

six-monthly basis. Assessment of germination, weed infestation and overall success of rehabilitation proposed, should be conducted at least on a six-monthly basis from time of planting/seeding for at least a two year period. This will allow identification of areas requiring augmentation or remedial works, to be identified early and appropriately planned.

Management Strategies:

V13 Implement monitoring and reporting of the performance of the Vegetation and Fauna Management Plan within the South West Campus.

5.6 Prioritisation of Management Proposals

Table 9 prioritises the management strategies for the South West campus and identifies the frequency with which the strategy should be implemented and the person(s)/parties responsible for undertaking the action.

TABLE 9
PRIORITISATION AND IMPLEMENTATION SCHEDULE OF MANAGEMENT STRATEGIES FOR VEGETATION AND FAUNA

OBJECTIVE	MANAGEMENT STRATEGY	PRIORITY	FREQUENCY	RESPONSIBILITY
Tuart Woodland Management	***V1*** With regard to recognising the important of the Tuart Woodland that occurs within the campus grounds: i. Incorporate Tuart Woodland conservation into structure planning for the campus to ensure continued conservation of the woodland within the framework of future sustainable development of the campus. ii. Investigate the option for a Tuart Woodland reserve within the 200m buffer of the Aqwest Water Treatment Facility. iii. Encourage community participation, awareness and education through formation of a 'friends' group or partnership with community tuart conservation groups.	High		Facilities & Services
	V2 Undertake a spring flora survey to determine the conservation status of the Tuart Woodland located on Bassendean sands within the campus grounds using the Ecoscape (2004) methodology.	High		Apply for funding to the 2007 minor works funding.
	V3 Future campus development should preferably be undertaken within degraded sections of woodland with clearing for future campus infrastructure being restricted to the defined building envelope and applicable service tracks.	High		Facilities & Services / Capital Projects
	V4 Apply the "no-net-loss" principle where clearing for future development is unavoidable.	High		Facilities & Services / Capital Projects
	V5 Protect the remnant north-south corridor of good to very goodcondition Tuart Woodland through access restriction, weed management and revegetation.	High		Facilities & Services / Capital Projects

OBJECTIVE	MANAGEMENT STRATEGY	PRIORITY	FREQUENCY	RESPONSIBILITY
	V6 Separate conservation and active recreational areas through informal fencing or high density plantings.			Campus Services
***Armillaria* Management**	***V7*** Investigate alternative firebreak cultivation with non-invasive method such as the selective use of knockdown herbicides to prevent the spread of soil borne diseases.	High	Once off	Fire Management Consultant
Tree Removal and Branch Lopping	***V8*** Establish a programme (costing and resources) to undertake tree removal and branch lopping to be conducted as indicated using a qualified tree surgeon for those trees identified in Figure 6.	Medium		Grounds Management/ Carl Overbye to establish Plan.
Fauna Habitat Management	***V9*** Conduct a detailed fauna survey of the campus grounds to identify important habitat and develop a site-specific fauna management plan.	High	Once off	Facilities & Services – subject to 2007 minor works funding.
	V10 Retain dead trees and logs in woodland areas that do not present a potential fire hazard to surrounding infrastructure.	Medium		Campus Services
Access Management and Education	***V11*** Liaise with the 'Friends of Manea Park'/City of Bunbury to raise community awareness of the conservation significance of the woodlands through the installation of educational signage.			Facilities & Services – subject to 2007 minor works funding.
	V12 Discourage inappropriate vehicle and horse access through signage installed near service track entry points and pathways.	High		Campus Services
Monitoring and Auditing	***V13*** Implement monitoring and reporting of the performance of the Vegetation and Fauna Management Plan within the South West campus.	High	Annual Review	Environmental Committee

6. SITE REHABILITATION PLAN

6.1 Objectives

The objective of the Site Rehabilitation Plan (SRP) is to revegetate degraded portions of the site with plant species endemic to the local area, to a condition which improves the environmental values of the South West Campus.

Specifically, the rehabilitation program will aim to create:

- a continuous vegetated understorey in both the upland and lowland areas of the campus, which is contiguous and compliments the existing overstorey trees; and
- an environment in which weed growth is controlled and reduced to a level which will not impact significantly on the natural distribution of native plants.

6.2 Site Preparation

It is intended that the rehabilitation program for the South West campus will reflect the existing topography and hydrology. Therefore, no major earthworks are proposed for this program. Minor works associated with site preparation are proposed to increase the early establishment and later growth of seedlings.

Figure 6 indicates the overstorey trees within the South West campus that are either Dead or in Poor condition. These areas should be initially targeted for rehabilitation as they generally support more weed species (ie. more open canopy). These weed species will require removal or control prior to re-planting with native species.

In the event that a chemical means of weeding is the preferred/or practical option, then Glyphosate based herbicides (broad spectrum, non-selective systemic herbicide with low toxicity and bioaccumulation in aquatic animals and insects) applied through 'touch wands' can be utilised during the active growing season of the weed species. This chemical should not be sprayed to reduce the chance of spray drift.

Manual methods of weed reduction should be utilised where practicable although over a large area it is difficult to implement this unless the weeding program can be organised as part of a group activity.

Ripping of topsoil is normally conducted prior to rehabilitation of sites (ie. to improve soil aeration and provide a soft rooting medium for seedlings), however ripping is not advocated in the rehabilitation program for the South West campus as the spread of *Armillaria* may be increased. Care should be taken to reduce the extent of soil disturbance throughout the South West Campus.

Management Strategy:

S1 Target areas that are designated as being in Dead or Poor condition on Figure 6 for initial rehabilitation while ensuring that areas in Good condition are buffered.

6.3 Weed Control

The introduction and spread of weeds in bushland areas presents a major threat to biodiversity including the loss of native floristic diversity, vegetation structure and native fauna habitat. In addition, the prevalence of weeds in bushland areas can increase the threat of fire. The most

effective method of keeping weeds out of the campus grounds will be to maintain the vegetation in good condition so that it is resistant to weed invasion and control and preventing the source of invasion.

The first stage of a successful bushland rehabilitation program should be weed control and in this management plan is considered as part of an integrated process that also comprises revegetation and fire management.

Weed species compete very successfully with native vegetation for soil nutrients and water and have the potential to quickly dominate the rehabilitation area, particularly if the ground or soil is disturbed in any way. It is anticipated that localised management of weeds conducted prior to any revegetation works will improve the success of the revegetation program. On-going weed control will be required to be undertaken.

Resources should be focused towards eradicating introduced plants that are at present scattered in the campus grounds but have the potential to invade into other areas. The spring flora survey identified an extensive variety of weeds (refer to Appendix 1).

Environmental Weeds

A weed is defined in the National Weeds Strategy as "*a plant that has, or has the potential to have, a detrimental effect on economic, social or conservation values"* (ARMCANZ *et al.* 1999). Weeds are a significant threat to the primary production, biodiversity and conservation values of Western Australia. In bushland areas weeds can displace native plants, prevent recruitment of native plants, change the availability of food or water for fauna, affect the cycling of nutrients and change the characteristics of fire, eventually resulting in a simplification of the bushland ecosystem (Hussey *et al*. 1997).

A study undertaken by the Kings Park and Botanic Garden in association with CALM on methods to control specific weeds in the Perth metropolitan region prioritised weeds according to the threat that they pose (Dixon and Keighery 1995). The inherent implication in this prioritising indicates the order in which infestation of the species should be attended to.

Three classifications were used:

- Priority 1 **(P1)** = major weeds
- Priority 2 **(P2)** = nuisance weeds
- Priority 3 **(P3)** = minor weeds

The most common and potentially serious weeds recorded within the campus grounds and their priority level according to Dixon and Keighery (1995) include:

- *Erodium* sp. **(P3)**
- *Pelargonium littorale*
- *Romulea rosea* (Guildford Grass) **(P1)**
- *Trifolium fragiferum* (Strawberry Clover)
- *Trifolium glomeratum* (Cluster Clover) **(P3)**
- *Aira caryophyllea* (Silvery Hair Grass)
- *Anthoxanthum odoratum* (Sweet Vernal Grass)
- *Arctotheca calendula* (Cape Weed) **(P3)**
- *Avena fatua* (Will Oat) **(P1)**
- *Briza minor* (Shivery Grass) **(P2)**
- *Bromus diandrus* (Great Brome) **(P3)**
- *Cynodon calycina* (Couch) **(P1)**
- *Ehrharta calycina* (Veldt Grass) **(P1)**

- *Lolium perenne* (Perennial Ryegrass) **(P3)**
- *Rumex* sp. (Dock) **(P3)**
- *Solanum nigrum* (Black Berry Nightshade) **(P2)**
- *Typha orientalis (*Bulrush) **(P1)**

Other weed species that are present within the campus grounds but not observed during the survey period include:

- *Zantedeschia aethiopica* (Arum Lily) **(P1)**
- *Ricinus communis* (Castor Oil Plant) **(P3)**

The appropriate methods to eradicate and control each of these weeds are identified in Appendix 4.

Declared Plants

Under the *Agriculture and Related Resources Protection Act* 1976 Declared Plants are defined as "Pest plants targeted for legislative control…which have, or could have, serious economic, environmental or social impact" (Department of Agriculture Western Australia, 2005). It follows that only certain species of plants are classed as Declared Plants and are only Declared Plants in certain areas. For example, Blackberry exists as a Declared Plant in some South West regions of Western Australia but not elsewhere in the State (refer to Table 10).

Of the weeds identified on the campus grounds, only the Arum Lily is a declared plant **(Category P1/P4).** Under the Act the owner or occupier of the land containing declared plants of Category P2, P3, P4 and P5 is required to control the plant. It is recommended that the eradication of this species from the campus grounds is given the highest priority. Department of Agriculture information relating specifically to the Arum Lily is included as Appendix 4.

Prior to planting in any areas designated as requiring rehabilitation, an application of herbicide to kill any germinants resulting from early winter rainfall may need to be undertaken. In those areas in close proximity to the wetland proper, the recommended herbicide is Glyphosate Bi-Active. Herbicide use should be in accordance with the DoE's recommendations contained in 'Herbicide Use in Wetlands' – Water Note WN22 (Water and Rivers Commission 2001).

Weed control methods of the proposed rehabilitation areas should be implemented during tube stock planting and throughout the following months to minimise competition for water and nutrients with native species.

Weed growth should be monitored on a monthly basis after rehabilitation has commenced and appropriate control methods implemented as necessary. The requirement and frequency for weed growth monitoring will be assessed after the initial 12 months following planting and a program established for the following 12 months based on the experience over the previous year.

TABLE 10
CATEGORIES OF DECLARED PLANT SPECIES IN WESTERN AUSTRALIA
(Agriculture and Related Resources Protection Act 1976)

Standard Control Code	Category
P1 **Prohibits movement**	The movement of plants or their seeds is prohibited within the State. This Prohibits the movement of contaminated machinery and produce including livestock and fodder.
P2 **Aim is to eradicate infestation**	Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3 **Aims to control infestation by reducing area and/or density of infestation**	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. **Treat to destroy and prevent seed set all plants:-** • Within 100m inside of the boundaries of the infestation. • Within 50m of roads and high-water mark on waterways. • Within 50m of sheds, stockyards and houses. Treatment must be done prior to seed set each year. **Of the remaining infested area:-** • Where plant density is 1-10 per hectare treat 100% of infestation. • Where plant density is 11-100 per hectare treat 50% of infestation. • Where plant density is 101-1000 per hectare treat 10% of infestation. Properties with less than 2 ha of infestation must treat the entire infestation. Additional areas must be ordered to be treated.
P4 **Aims to prevent infestation spreading beyond existing boundaries of infestation**	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and or machinery. Treat to destroy and prevent seed set all plants:- • Within 100m inside of the boundaries of the infested property. • Within 50m of roads and highwater mark on waterways. • Within 50m of sheds, stockyards and houses. Treatment must be done prior to seed set each year. Properties with less than 2ha of infestation must treat the entire infestation. Additional areas may be ordered to be treated
Special requirements	In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.
P5	Additional areas must be ordered to be treated.

Management Strategies:

S2 Develop and implement a weed control program that prioritises control of weeds based on status as a Declared Plant, invasiveness (refer to Priority status), distribution and impacts, focuses on areas adjacent to those that are largely weed free, and is integrated with rehabilitation works.

The weed control program with incorporate the following aspects:

i. Preference will be given to the manual removal of weeds or spot applications.
ii. Herbicide use will be undertaken in accordance with the adopted ECU procedures for Pesticides, Handling, Storage and Use (Appendix 3).
iii. Herbicides will not be blanket sprayed either within the wetland located on the

western boundary of the campus or its surrounding 50m buffer or where the chemical may come into contact with any water bodies.

iv. Initial weed control methods will focus on:
- concentrating on small infestations of aggressive weeds to prevent
- significant infestations;
- controlling the source of invasion;
- removing weeds before seed set;
- planting native overstorey species to shade out weeds; and
- prioritising for hand weeding.

v. Appropriate methods identified in Appendix 4 will be employed to eradicate and control designated weeds.

vi. Weed growth will be monitored on a monthly basis after rehabilitation has commenced and appropriate control methods will be implemented as necessary.

6.4 Rehabilitation Methods

The rehabilitation methods will require a combination of planting seedlings and direct seeding to establish plants in the rehabilitation area listed in the following sections.

6.4.1 Seedling Planting

- Local native species will be used in the areas requiring revegetation wherever possible;
- If local seedlings are not available, a local nursery will be engaged to supply seedlings according to the native species listed below;
- Seedlings will be planted in late autumn to early winter to take advantage of the following winter/spring rainfall;
- Seedlings will only be planted after initial rainfall has thoroughly moistened the soil.
- No fertilisers will be used at the time of planting;
- It will not be necessary to water the plants on planting provided they are well watered before planting and the planting precedes good rainfall;
- Seedlings will only be planted into relatively weed free areas;
- Care will be taken to ensure plants are planting in nodal clumps to achieve a natural effect; and
- Spacing of seedlings will be according to Table 12.

6.4.2 Direct Seeding

- Local plant seed will be obtained from the area wherever possible and appropriately treated;
- If local seed is available, engage a local nursery to supply a seed mix according to the native species listed in Appendix 1;
- Areas to be planted will be weed free and the ground lightly tilled to create random furrows approximately 50mm deep in which the seed can lodge;
- The seed will be mixed and bulked with an inert material, for example, horticultural vermiculite, before broadcasting by hand; and
- Application rates for direct seeding will be approximately 5kg of seed per hectare. It is recommended that a light cover of mulch be placed over direct seeded areas to prevent weed invasion.

Management Strategies:

S3 Use methods identified for seedling planting and direct seeding.

S4 In bushland areas being rehabilitated use only native species of local provenance that

are compatible with the hydrology of the area. The species that occur in Appendix 1 will be the basis for selecting species for rehabilitation, subject to commercial availability.

6.5 Planting Methods and Density

The planting of tube stock (ie. direct planting of seedlings or saplings into the ground) is recommended throughout the areas to be rehabilitated, and will to some extent, be determined by tube stock availability from suppliers. As a general rule, however, the main tree species to be utilised in the rehabilitation program (eg. Tuart and *Banksia* spp.) are best established as tube stock.

No artificial irrigation is proposed for the rehabilitation. Therefore, planting shrubs and trees and sowing seeds will be undertaken during May/June to maximise the use of rainfall to irrigate the young plants. Planting within the seasonally wet areas of the site (eg. the wetland region on the western boundary) will also occur in May/June to allow maximum root growth before summer.

Individual species will be planted irregularly to reflect the distribution found in natural areas. The recommended approximate density of planting appropriate for sample species is provided in Table 11.

Management Strategies:

S5 Rehabilitate areas identified through planting of native species in planting densities as recommended in Table 11.

S6 Rehabilitate by implementing weed control and revegetate using techniques of direct seeding and seedling plantings using local native plants and seed wherever possible.

S7 Prioritise planting according to the following elements:

i. informal access paths requiring closure;
ii. areas where weeds have been controlled; and
iii. other degraded areas requiring rehabilitation.

TABLE 11
PLANTING DENSITY OF RECOMMENDED REHABILITATION SPECIES

Species	Height (m)	Planting Density
Sedges/Rushes		
Baumea preissii	1	4/ m^2
Juncus pallidus	1 – 2	2/ m^2
Shrubs		
Allocasuarina humilis	1.5	1/ 2m^2
Calothamnus quadrifidus	2	1/ 2m^2
Astartea fascicularis	2	1/ 2m^2
Persoonia longifolia	2 – 4	1/ 10m^2
Acacia pulchella	2	1/ 10m^2
Stirlingia latifolia	2	1/10m^2
Trees		

Species	Height (m)	Planting Density
Banksia attenuate	10	1/10m^2
Banksia ilicifolia	10m	1/10m^2
Xylomelum occidentale	10	1/10m^2
Melaleuca preissiana	10	1/ 10m^2
Corymbia calophylla	20	1/15m^2
Eucalyptus marginate	20	1/ 15m^2
Eucalyptus gomphocephala	20-30	1/ 20m^2

6.6 Protection of Greenstock

Grazing by rabbits (and kangaroos) may be a difficult issue to address and could severely hamper revegetation efforts. Therefore, a rabbit control program may be necessary and should be developed in consultation with the City of Bunbury.

Where possible, tube stock of tree species should be protected from rabbit damage through the use of tree guards. Tree guards also aid in minimising disturbance of the seedlings from kangaroos or wind and also in the spread of competitive weeds.

Management Strategies:

S8 Install tree guards as required.

S9 Develop a feral pest control program in keeping with the ECU Procedures: Pest Management and Control (Appendix 5) in consultation with the City of Bunbury.

6.7 Public Feedback and Education

Environmental education is one of the best means to achieve sustainability and protection of the rehabilitated environment. Edith Cowan University will promote environmental education to staff, students and adjoining residents/landholders regarding the environmental and aesthetic benefits of maintaining the rehabilitated bushland areas within the South West campus.

The maintenance of the rehabilitation areas (eg. restricting weeds, litter, vehicular access and domesticated animal access) is an important component of their environmental obligation.

Highlight the importance of rehabilitation/revegetation works through notices on campus bulletin/notice boards. Install appropriate signage indicating areas being rehabilitated and requesting that members of the public refrain from entering these areas.

Management Strategy:

S10 Promote sustainability and environmental education throughout the campus and broader community through the installation of appropriate signage at rehabilitation sites.

6.8 Monitoring and Review

The implementation of management measures detailed in this management plan should be flexible in responding to changes in the natural environment and community values.

The programme of monitoring the success of the management measures proposed is essential for the purposes of reviewing and updating the plan. This will ensure that the objectives of the plan are achieved and that any changes or new developments in management techniques can be incorporated.

Implementing monitoring procedures enables an assessment of the success of management measures addressing rehabilitation works and weed control activities. This will allow identification of areas requiring augmentation or remedial works to be identified early and appropriately planned. In addition, the monitoring will ensure that an adequate representation of species and plant density is achieved.

Rehabilitation 'success' is a difficult attribute to define and measure, however various methods to assess revegetation performance can be implemented as part of the monitoring requirements of the SRP. Table 12 lists the parameters to be used to assess performance of the South West campus rehabilitation program. These are:

- survival of seedlings (75% survival of tube stock);
- foliage cover (40-50% cover, excluding weeds, 3 years after implementation of rehabilitation);
- species representation (one third of the species planted is evident in any area of $100m^2$);
- presence of weeds (no declared weeds within the rehabilitated area 3 years after implementation); and
- overall success of plant establishment (a subjective measure based on visual assessment of species composition, plant density and plant health. For example, an area might not meet the above criteria but has the ability to attain it. For instance an area might not contain 40-50% foliage cover but is growing well and will attain that in a few years without the need for remedial action).

If these performance criteria are not met then remedial action will be undertaken as required so that the criteria can be satisfied.

An additional factor that may be measured to determine the success of a rehabilitation program includes the colonisation of the rehabilitation area by various types of fauna (birds, amphibians and insects) can be a useful measure of success. However, it is not proposed to monitor this additional factor.

Management Strategy:

S11 Implement monitoring procedures to enable an assessment of the success of management measures being undertaken.

6.9 Prioritisation of Management Strategies

Table 13 prioritises the management strategies for the South West Campus and identifies the frequency with which the strategy should be implemented and the person(s)/parties responsible for undertaking the action.

TABLE 12
METHOD OF ASSESSMENT TO MEASURE REHABILITATION PERFORMANCE

Assessment Parameter	Assessment Method (based on 5 replicates, 10m x 10m)	Performance Criteria
Seedling survival	Require seedling health to be measured.	Survival rate of planted tube stock to be 75% 3 months after planting.
Foliage cover	As per the Australian Soil and Land Survey Handbook (McDonald *et al*. 1998).	40-50% cover (excluding weeds) 3 years after implementation of rehabilitation.
Species representation	Number of species present calculated from the % of number of species originally planted.	One third of species sown and planted being evident in any area of $100m^2$ at any time after rehabilitation.
Presence of weeds	Identification of any declared plants and significant environmental weed species within the rehabilitated areas.	No declared weeds within the rehabilitated area 3 years after implementation. Environmental weeds controlled to an extent where their impacts on new plant growth are of decreasing significance.
Overall success of plant establishment	Subjective measure based on a visual assessment of species composition, plant density and plant condition within the rehabilitated areas. Five categories used (Excellent, Good, Satisfactory, Poor and Unacceptable. Photographic record of plant growth in each rehabilitated area. Overall assessment of the ability of the revegetated area to attain a final required vegetation structure and composition.	Species composition and projected plant growth (size, form) likely to achieve foliage cover target (40% cover, excluding weeds, 3 years after implementation).

TABLE 13
PRIORITISATION AND IMPLEMENTATION SCHEDULE OF MANAGEMENT STRATEGIES FOR SITE REHABILITATION

OBJECTIVE	MANAGEMENT STRATEGY	PRIORITY	FREQUENCY	RESPONSIBILITY
Site Preparation	***S1*** Target areas that are designated as being in Dead or Poor condition for initial rehabilitation while ensuring that areas in Good condition are buffered.	High	Ongoing	F & S Grounds
Weed Control	***S2*** Develop and implement a weed control program that prioritises control of weeds based on status as a Declared Plant, invasiveness (refer to Priority status), distribution and impacts, focuses on areas adjacent to those that are largely weed free, and is integrated with rehabilitation works. The weed control program with incorporate the following aspects: i. Preference will be given to the manual removal of weeds or spot applications. ii. Herbicide use will be undertaken in accordance with the adopted ECU procedures for Pesticides, Handling, Storage and Use (Appendix 3). iii. Herbicides will not be blanket sprayed either within the wetland located on the western boundary of the campus or its surrounding 50m buffer or where the chemical may come into contact with any water bodies. iv. Initial weed control methods will focus on: i. concentrating on small infestations of aggressive weeds to prevent ii. significant infestations; iii. controlling the source of invasion; iv. removing weeds before seed set; v. planting native overstorey species to shade out weeds; and vi. prioritising for hand weeding. v. Appropriate methods identified in Appendix 4 will be employed to eradicate and control designated weeds. vi. Weed growth will be monitored on a monthly basis after rehabilitation has commenced and appropriate control	High	Ongoing	Facilities & Services Carl Overbye /resourcing through 2007 minors works funding

OBJECTIVE	MANAGEMENT STRATEGY	PRIORITY	FREQUENCY	RESPONSIBILITY
	methods will be implemented as necessary.			
Rehabilitation Methods	***S3*** Use methods identified for seedling planting and direct seeding.		Ongoing	Campus Services
	S4 In bushland areas being rehabilitated use only native species of local provenance that are compatible with the hydrology of the area. The non-weed species that occur in Appendix 1 will be the basis for selecting species for rehabilitation, subject to commercial availability.		Ongoing	Facilities & Services
Planting Methods and Density	***S5*** Rehabilitate areas identified through planting of native species in planting densities as recommended in Table 12.	High	Ongoing	Campus Services
	S6 Rehabilitate by implementing weed control and revegetate using techniques of direct seeding and seedling plantings using local native plants and seed wherever possible.	High	Ongoing	Campus Services/ Contractor
	S7 Prioritise planting according to the following elements: i. informal access paths requiring closure; ii. areas where weeds have been controlled; and iii. other degraded areas requiring rehabilitation.	Medium	Ongoing	Campus Services
Protection of Greenstock	***S8*** Install tree guards as required.	High	Ongoing	Campus Services
	S9 Develop a feral pest control program in keeping with the ECU Procedure: Pest Management and Control (Appendix 5) in consultation with the City of Bunbury.	Medium	Once off	Facilities & Services
Public Feedback and Information	***S10*** Promote sustainability and environmental education throughout the campus and broader community through the installation of appropriate signage at rehabilitation sites.	High	Ongoing	Environmental Committee
Monitoring and Review	***S11*** Implement monitoring procedures to enable an assessment of the success of management measures.	Medium	Annually	Environmental Committee

7. WASTE MANAGEMENT PLAN

7.1 Introduction

There is currently no formally adopted Waste Management Plan for Edith Cowan University's South West campus facility and little or no published information on the types and quantities of waste produced at the Campus or how it is managed. Without access to good quality information on the waste streams and how they are managed, it is not possible to develop a comprehensive Waste Management Plan. As a consequence this initial draft plan is necessarily quite generic and makes recommendations in section 5.10 in regard to the further work that is required to develop a comprehensive plan.

7.2 Relevant Government Policy and Legislation

Little specific legislation currently exists in relation to waste management in Western Australia.

Table 14 lists the relevant legislation and its function.

TABLE 14
RELEVANT LEGISLATION

Legislation	Purpose
Health Act 1911	Grants control to local government over the collection, storage and disposal of all wastes. (Largely outdated and seldom used)
Environmental Protection Act 1987	Little or no specific content in relation to waste but provides head powers to allow regulation of specific waste types and licensing of waste facilities and transport operations
Environmental Protection (Controlled Waste) Regulations	Provides controls over the transport of specific liquid wastes and hazardous waste s
Environmental Protection (Asbestos) Regulations	Provides powers in relation toe h management, sale, transport and disposal of asbestos and asbestos containing materials

The State Government is well advanced with the drafting of new waste management legislation which will consolidate the powers currently vested in the Health and Environmental Protection Acts and will provide strong new powers to encourage waste avoidance and recycling in preference to disposal.

7.3 Responsible Agencies

The State Government has overall responsibility for the regulation of waste management in Western Australia. It sets policy at a state level and regulates waste transport and licences waste management facilities

Local government has responsibility for ensuring the provision of adequate waste management services within gazetted areas of municipal boundaries. As a result of this responsibility, local governments either directly provide waste collection services to householders and businesses or arrange this under contract.

The relevant local government servicing South West Campus is the City of Bunbury.

The State Waste Management Board was established in 2002 to provide advice to Government on strategic waste management policy settings and in particular on strategies to divert waste from landfill and reduce overall wast generation in the State.

7.4 Relevant Policy

The State Government has produced a range of policy documents relating to waste over the past decade and a number of these are listed below:

- *You Can Recycle It*, November 1989, Office of Cabinet.
- *Waste Management into the 21st Century*, 1991 Report, Health Department of Western Australia.
- *State Recycling Blueprint*, June 1993, Department of Commerce and Trade, Western Australian Municipal Association.
- *Select Committee Report on Recycling and Waste Management*, December 1995, Select Committee of the Western Australian Legislative Assembly.
- *Draft Western Australian Waste Management Strategy*, June 1997, Minister for the Environment.
- *Draft Western Australian Waste Reduction and Recycling Policy*, June 1997, Minister for the Environment.
- *Draft Strategy for the Management of Green and Organic Waste in Western Australia*, December 1997, Minister for the Environment.
- State Recycling Education and Promotion Program for Western Australia, December 2000, Minister for the Environment.
- *Towards Zero Waste, Waste 2020 Task Force Report and Recommendations*, January 2001, Minister for the Environment.
- *Waste 2020 Draft Action Plans*, January 2001, Minister for the Environment for:
    - Nitrite (NO_2-N)
    - Green and Organic Waste
    - Commercial and Industrial Waste
    - Construction and Demolition Waste
    - Controlled Waste
    - Municipal Solid Waste
    - Packaging Waste
    - Problematic Waste
    - Cleaner Production Statement
- Draft Strategy for the Management of Construction & Demolition Waste in Western Australia. 2002, Minister for the Environment.
- *Draft Waste Education Strategy*, February 2003, (Nolan ITU), Minister for the Environment.

The most recently published report is the *Statement of Strategic Direction* which was published by the State Waste Management Board in 2004 and sets out a Strategic Plan for the State to achieve a goal of zero waste to landfill by 2020.

7.5 Scope

This Waste Management Plan addresses the following:

- The generation of waste (types and quantities);
- Solid and liquid wastes generated within the confines the campus grounds;
- The collection, storage and disposal of solid and liquid wastes; and
- The infrastructure used for collection, storage and disposal of solid and liquid wastes generated within the campus grounds.

The design and management approaches proposed to minimise the potential for adverse health or environmental impacts arising from the management of solid and liquid wastes generated in the campus.

7.6 Structure of the Plan

The plan consists of four main parts:

1. a description of South West campus;

2. a description of the wastes that will be generated at the campus site;

3. a description of the waste management infrastructure and the features which limit the potential for adverse impacts; and

4. a description of the management philosophy adopted to minimise impacts.

7.7 Description of the Campus Facility

7.7.1 Utilities

The campus facility is fully serviced with:

- Power – the site is serviced by dedicated mains power with underground cable connection;
- Water – the site is serviced from the Water Corporation Water Supply network;
- Telecommunications - the site is fully serviced with underground telephone and data services;
- Sewerage – the site is connected to the Water Corporation Deep Sewerage System with all sewage piped off-site for final treatment;
- Stormwater - the site is serviced by Piped Stormwater Handling Facilities to the council stormwater system; and
- Road – the site is serviced by adjacent major roadways (Bussell Highway, Robertson Drive).

7.7.2 Assessment of Waste Generation

The major areas of waste generation on the Campus are:

- Used office paper from the administrative and teaching areas;
- Dry packaging waste from administration areas, food hall and engineering services areas;
- Food scraps, packaging and beverage containers generated by students and staff and deposited as litter or in waste bins;
- Green waste from gardening and landscaping activities;
- Building and demolition waste from construction activities; and
- Specialist wastes generated in teaching areas such as laboratories.

There is little available data on the volume and types of waste generated and it as a result one of the action items identified in this report is to undertake surveys or audits of the various waste streams so that targeted action can be implemented to minimise wast generation and improved recycling of wastes and recovery of resources.

Table 15 lists the waste streams identified from the campus and provides approximate estimates of the size of the various waste streams

TABLE 15
WASTE STREAM CHARACTERISTICS

Waste Stream	Point of Generation in the Campus	Approx volume* (m^3/Day or L/Day)	Method of Disposal
Solid Waste – Office Paper	Teaching areas, library and administrative area are the primary point of generation for this type of waste.	No Estimate currently available	Waste paper tends to be placed in bins or purpose provide recycling containers.
Solid Waste from litter bins within campus buildings and from bins along pedestrian pathways Consists primarily of packaging, beverage containers and food scraps.	Individual litter bins located within each room of the campus and recycling containers positioned in the grounds to encourage recycling of plastic glass and metal beverage containers.	300kg approx (based on 50kg of dry weight per 240L SULO bin on average)	Cleaners regularly empty litter bins at the end of the day into larger 240L SULO bins (approximately 6 per day), which are then collected by the City of Bunbury. The bulk storage bins are serviced regularly to ensure waste does not overflow and impact on stormwater quality. The lids on bulk storage bins will be kept closed except during loading operations.
Solid Waste from landscape maintenance.	The landscaped areas are maintained by a Grounds Person who weeds and prunes vegetation as well as fertilises, mows and maintains the garden areas.	$0.5m^3$ approx	All wastes generated from garden maintenance is stored or disposed of on-site.
Liquid Waste from Toilets and Ablution areas.	All liquid wastes generated in toilet/ablution areas throughout the facility are directed to sewer.	4,000L approx (based on 46 toilets, 4 showers and 7 urinals)	All wastes directed to sewer will flow by gravity to the Water Corporation sewer.
Liquid Waste from the food hall.	Most liquid wastes generated within the food hall are directed to the sewer. However, fats and oils from the cooking process are stored for removal by contractors.	<100L approx	Any food outlets where significant solids or grease loads are expected will be required to install and maintain a properly sized and designed grease trap. Traps will be fitted with tight fitting lids to prevent odours and sized and maintained to ensure they function correctly at all times and do not accumulate excessive quantities of grease or solids.
Potentially Hazardous Wastes Occasional small quantities of potentially hazardous wastes will be generated during the operation of the campus. These consist of typical household hazardous wastes	It is anticipated that these types of waste will be generated on a very occasional basis in small quantities throughout the campus (Industrial Waste Permit No. 11548).	$<0.1m^3$ approx	In view of the variable nature of this waste stream, it is not possible to provide dedicated facilities for management of these wastes. Instead the University can utilise the waste removal contractor to provide a service for correctly handling these wastes.

Waste Stream	Point of Generation in the Campus	Approx volume* (m^3/Day or L/Day)	Method of Disposal
including solvents, cleaning agents, small quantities of waste oil and printer cartridges etc.			

*Note: These figures are estimates only and based on information supplied by the South West campus

7.8 Waste Management Infrastructure

This section of the report briefly describes the current infrastructure provided for management of waste generated within the South West Campus.

7.8.1 Litter Bins

Litter bins are placed strategically throughout the campus to provide ease of disposal for staff and students and minimise the problems associated with windblown litter. These bins are regularly serviced by contractors and/or employees to ensure that they do not overflow and contribute to windblown litter or contamination of stormwater in external areas of the facility.

7.8.2 Recycling Bins

Recycling bins are located at strategic points within the campus (eg. at the food hall or adjacent to drink vending machines to encourage recycling of beverage containers).

Adjacent to photocopiers and printers and in office areas.

The contents of these bins are segregated from the rest of the waste stream and directed for recycling through the City of Bunbury.

7.8.3 Bulk Storage Bins

A bulk storage bin is stored currently located at the eastern car park of the campus. The bulk storage bin is free-standing with no enclosure, concrete floor or drainage to the sewer system.

7.8.4 Liquid Waste

All liquid wastes are directed to sewer for off-site disposal.

7.8.5 Stormwater Management

Stormwater from roofed areas within the campus is collected in gutters and piped into council stormwater system.

Stormwater generated from paved car park areas is also directed for disposal via the council stormwater system using a piped drainage system equipped with sediment traps.

The approach to managing waste (ie. storage under cover or in enclosed bins) will ensure that stormwater is not contaminated as a result of waste handling practices.

7.8.6 Management of Potentially Hazardous Wastes

The very small quantities of hazardous waste that are generated do not justify any specialised infrastructure for their management.

These wastes are removed from site by the approved waste contractor for disposal in the appropriate manner.

7.9 Waste Management Plan

7.9.1 Objective

The objective of this plan is to manage waste in accordance with Waste Management Hierarchy (See below).

Waste Management Hierarchy

The hierarchy is widely used commonsense tool that says that where possible we should avoid the production of waste (prevention) and then in order of preference minimise the production of waste, re-use or recycle waste with the least preferred options being recovery of energy or final disposal.

Implicit in the hierarchy is a requirement to manage wastes in a manner which minimises any adverse environmental impacts.

7.9.2 Solid Waste Collection

The University should incorporate waste and recycling bins throughout the campus to ensure that students and staff have easy access to recycle or dispose of waste.

Dedicated staff (eg. cleaners, Grounds Person) are employed to ensure that waste and recycling receptacles are emptied regularly and kept in a clean and tidy state. The same staff are responsible for collecting dropped and windblown litter for recycling or disposal as appropriate.

Waste derived from landscape maintenance should be directed for mulching or compositing either on-site or off-siet to recover this valuable organic material for re-use..

7.9.3 Solid Waste Storage and Disposal

There should be no circumstance where stored waste could potentially contaminate stormwater or be windblown affecting other parts of the environment. Therefore, a priority of the University should be to construct a designated bulk bin storage facility with the following attributes:

- A 1.8m brick wall on a bunded concrete pad;
- Within the bunded concrete pad, drainage can be trapped and directed to a grated inlet which is connected to the Water Corporation sewer;
- The storage area should have the capacity to contain fat storage drums which should be located in drip trays to contain spillages. Any spillages outside the tray would be captured by the floor grate directed to sewer. The fat storage drums should be equipped with funnel filling spouts to minimise the likelihood of spillage; and
- The bulk waste bins should be fitted with lids which will be kept closed except when waste is being placed in the bins or serviced regularly to prevent waste overflowing. Any spilled waste would be contained within the walled storage area.

Collected waste stored in and appropriate bulk storage area will minimise the potential for:

- Windblown litter;
- Contamination of stormwater;
- Odour; and
- Insects and vermin.

Bulk bins should only be located in the bin store and should be serviced daily by a contractor and no bin washing should be undertaken on the site. Where bins require washing the contractor (currently Cleanaway) should remove the bin from the site and provide a clean replacement.

Sufficient bin capacity should be available at all times to ensure that bins do not overflow and that waste is not stockpiled on the ground.

7.9.4 Liquid Waste

All liquid wastes on the site should be directed for disposal to the Water Corporation sewer. The food hall may potentially generate large quantities of contaminated waste water from sinks and cooking facilities. Therefore, the liquid waste should be directed to a correctly sized and designed grease trap. Grease traps should be fitted with lids and serviced regularly to prevent blockages and odours and ensure that vermin are not attracted.

7.9.5 Stormwater

Clean stormwater from roof areas should be captured in gutters and piped into the council storm water system for infiltration in dedicated sumps. This will ensure there is no possibility for contamination of roof water with waste products.

Stormwater from uncovered areas should be captured by kerbs and grates and directed to the council stormwater system. This part of the stormwater drainage system will incorporate sediment traps. The sediment traps should be regularly cleaned by a contractor.

7.9.6 Potentially Hazardous Waste

The campus does not generate significant quantities of potentially hazardous wastes except from laboratories where waste chemicals require specific management. The only types of materials that fall into this category would be:

- Laboratory wastes;
- Batteries (rechargeable and single use);
- Surplus cleaning fluids and solvents;
- Waste oils and ; and
- Surplus fertilisers or garden chemicals.

These wastes require specialist management and should be stored appropriately and removed from site by an approved waste contractor for recovery or disposal in an appropriate manner at a facility approved for the purpose.

7.10 Recommendations

With the current lack of information, it is not possible to develop a comprehensive Waste management plan for the campus. The following recommendations are made which will allow the staged development of a plan that is relevant to the scale of operations on the campus.

Task 1 - Waste Service Audit

The first task to be completed is to conduct and audit of the waste management infrastructure and services that exist on the campus and the main areas of waste generation. This could be completed in a 1 day site visit documented in a brief report.

The completion of this task is essential to provide baseline information on:

- what areas of the campus generate waste;
- what services currently exist; and
- what gaps there are in knowledge and infrastructure.

Task 2 - Waste Audit

In order to manage wastes effectively, it is necessary to quantify the various waste streams. This is normally done through a waste audit which can be completed by an external consultant who surveys the various waste streams and develops estimates of overall waste quantities.

Alternatively, this task could be complete by students as part of their course work.

Task 3 – Workshop- Needs/Gap Analysis

This task can be performed in parallel with the Waste Audit but is ideally completed once quality data.

The purpose of the workshop is to identify and agree the objectives of the Campus Waste Management Plan and then examine the resources and barriers to achieving the agreed objective. The workshop should be conducted with representatives from a range of groups including management within the campus. The final objectives should then be considered and endorsed by senior management to ensure that the will exists to resource the final plan

Task 4 – Develop Draft Waste Management Plan

Based on the outcomes of Tasks 1-3, it will be possible to develop a draft waste management plan which incorporates specific targets and costed actions that need to be implemented to achieve the agreed objective

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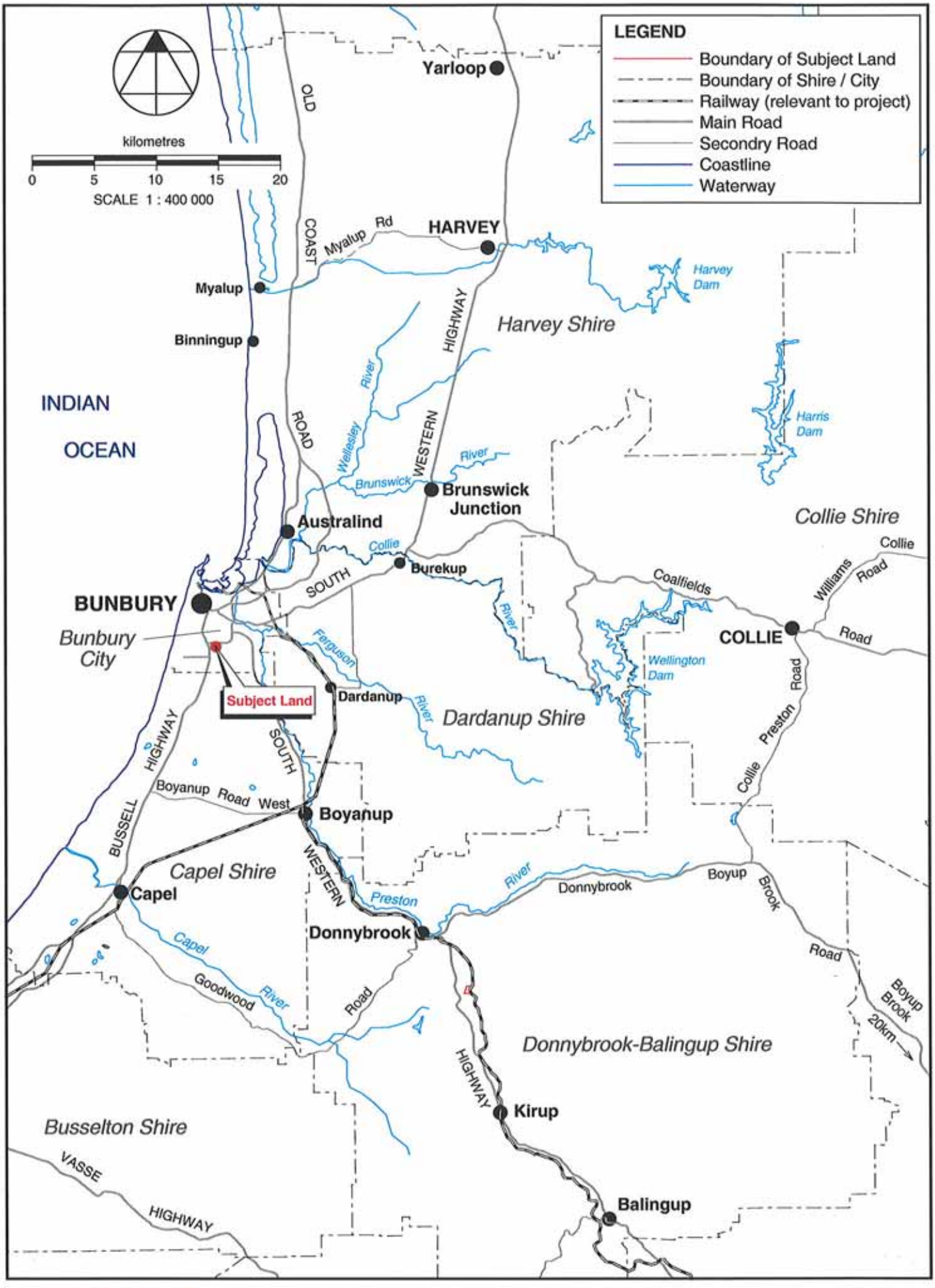
FIGURES



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ATA Environmental
environmental scientists

ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

REGIONAL LOCATION

FIGURE 1

PRINTED: Mon 21 Aug 06

Robertson

Drive

BUSSELL

S.W. HEALTH CAMPUS SITE

Student Housing

South West College of TAFE Building

ECU BUNBURY CAMPUS SITE

HIGHWAY

metres

0 50 100 150 200

SCALE 1 : 3 500

LEGEND

Study Area Boundary

BASE SOURCE: Edith Cowan University, November 2004.
AERIAL PHOTOGRAPHY SOURCE: Department of Land Information, November 2004.

ATA Environmental
environmental scientists

ENVIRONMENTAL MANAGEMENT
PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

STUDY AREA

FIGURE 2

ECU5-3/EMP/26_149f02.dgn DATUM: MGA DRAWN BY: TE 21-08-06 CHECKED BY: BvdW 21-08-06

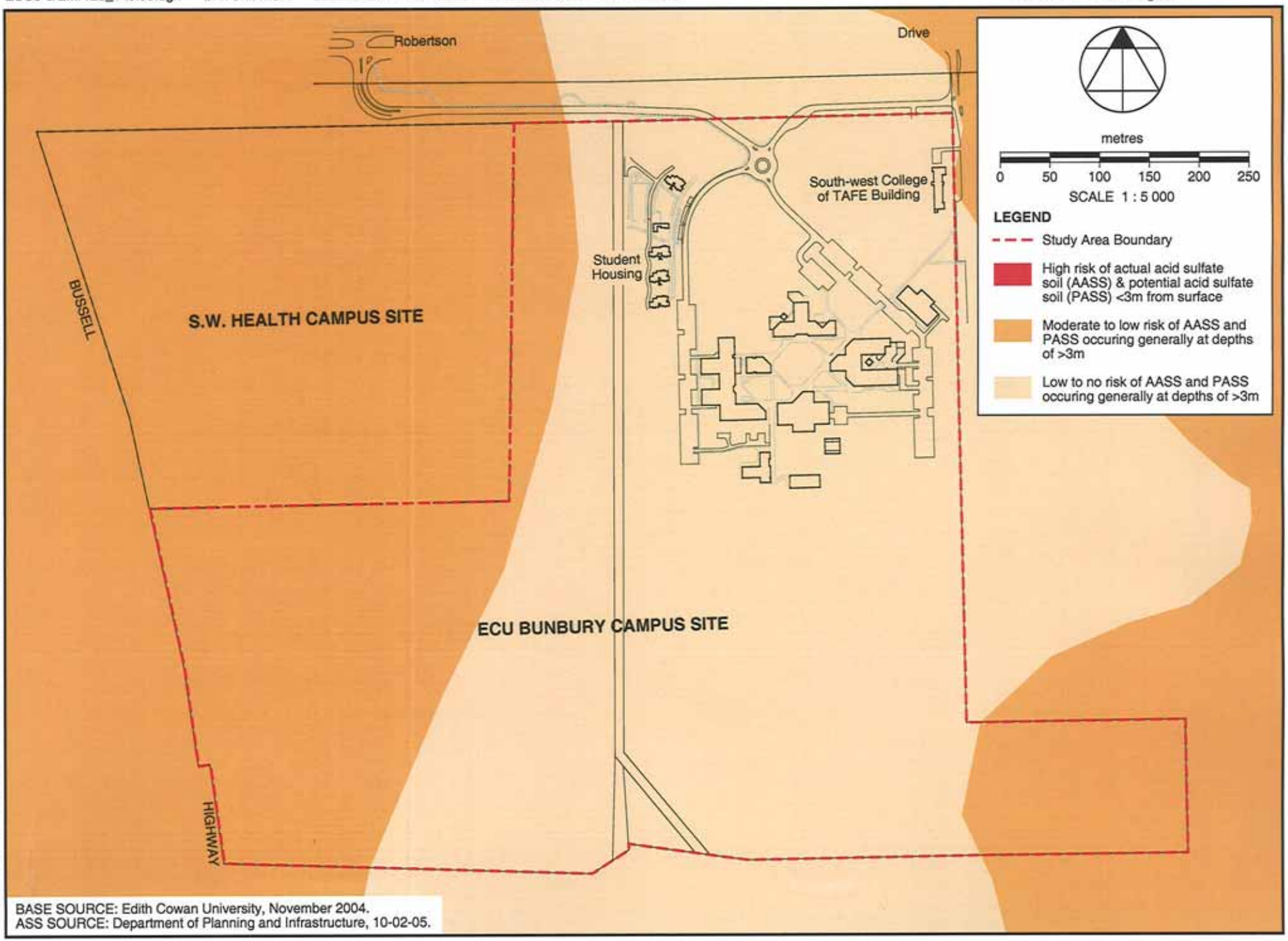
ECU5-3/EMP/26_149f03.dgn DATUM: MGA DRAWN BY: TE 21-08-06 CHECKED BY: BvdW 21-08-06 PRINTED: Mon 21 Aug 06

ATA Environmental
environmental scientists

ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

ACID SULFATE SOILS

FIGURE 3



BASE SOURCE: Edith Cowan University, November 2004.
ASS SOURCE: Department of Planning and Infrastructure, 10-02-05.

PRINTED: Mon 21 Aug 06

CHECKED BY: BvdW 21-08-06

DRAWN BY: TE 21-08-06

DATUM: MGA

ECU5-3/EMP/26_149f04.dgn

Robertson

Drive

BUSSELL

HIGHWAY

S.W. HEALTH CAMPUS SITE

ECU BUNBURY CAMPUS SITE

Student Housing

South west College of TAFE Building

EgEmCcBa G-VG

EgEmBaAf Deg

EgEmBaAf G

EgEmCcBa G-VG

MpMrEmCcBa Deg

MpMrEmCcBa G

EmCcBa Deg

EmCcBa G

EgEmCcBa G-VG

EgBaAf G-VG

EgEmBaAf P-G

EmCcBa VG

EmCcBa CD

EmCcBa Deg

EmCcBa VG

CD

metres

0 50 100 150 200

SCALE 1 : 3 500

LEGEND

Study Area Boundary

VEGETATION ASSOCIATION

EgBaAf	Tuart and Banksia Woodland over Peppermint Low Woodland
EgEmBaAf	Tuart Woodland over Jarrah/Banksia attenuata/ Peppermint Low Woodland
EgEmCcBa	Tuart/Jarrah/Marri Woodland over Banksia attenuata Low Woodland
EmCcBa	Jarrah/Marri Woodland over Banksia attenuata Low Woodland
MpMrEmCcBa	Melaleuca preissiana/Melaleuca rhaphiophylla Woodland over Jarrah/Marri/Banksia attenuata Woodland

VEGETATION CONDITION

P	**Pristine -** Pristine or nearly so, no obvious signs of disturbance
Ex	**Excellent -** Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive
VG	**Very Good -** Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
G	**Good -** Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Deg	**Degraded -** Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
CD	**Completely Degraded -** The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.
C	**Cleared -** No native vegetation remaining.

SOURCE: Bush Forever, Govt. of W.A., 2000

BASE SOURCE: Edith Cowan University, November 2004.
AERIAL PHOTOGRAPHY SOURCE: Department of Land Information, November 2004.

ATA Environmental
environmental scientists

ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

VEGETATION ASSOCIATIONS AND CONDITION

FIGURE 4

PRINTED: Mon 21 Aug 06

Robertson

Drive

BUSSELL

S.W. HEALTH CAMPUS SITE

Student Housing

South west College TAFE Building

HIGHWAY

metres

0 50 100 150 200

SCALE 1 : 3 500

LEGEND

- Study Area Boundary
- Firebreak/Track
- Buildings

TREE CONDITION

- Good
- Average to Good
- Average
- Poor to Average
- Poor
- Dead
- Armillaira Detected

BASE SOURCE: Edith Cowan University, November 2004.

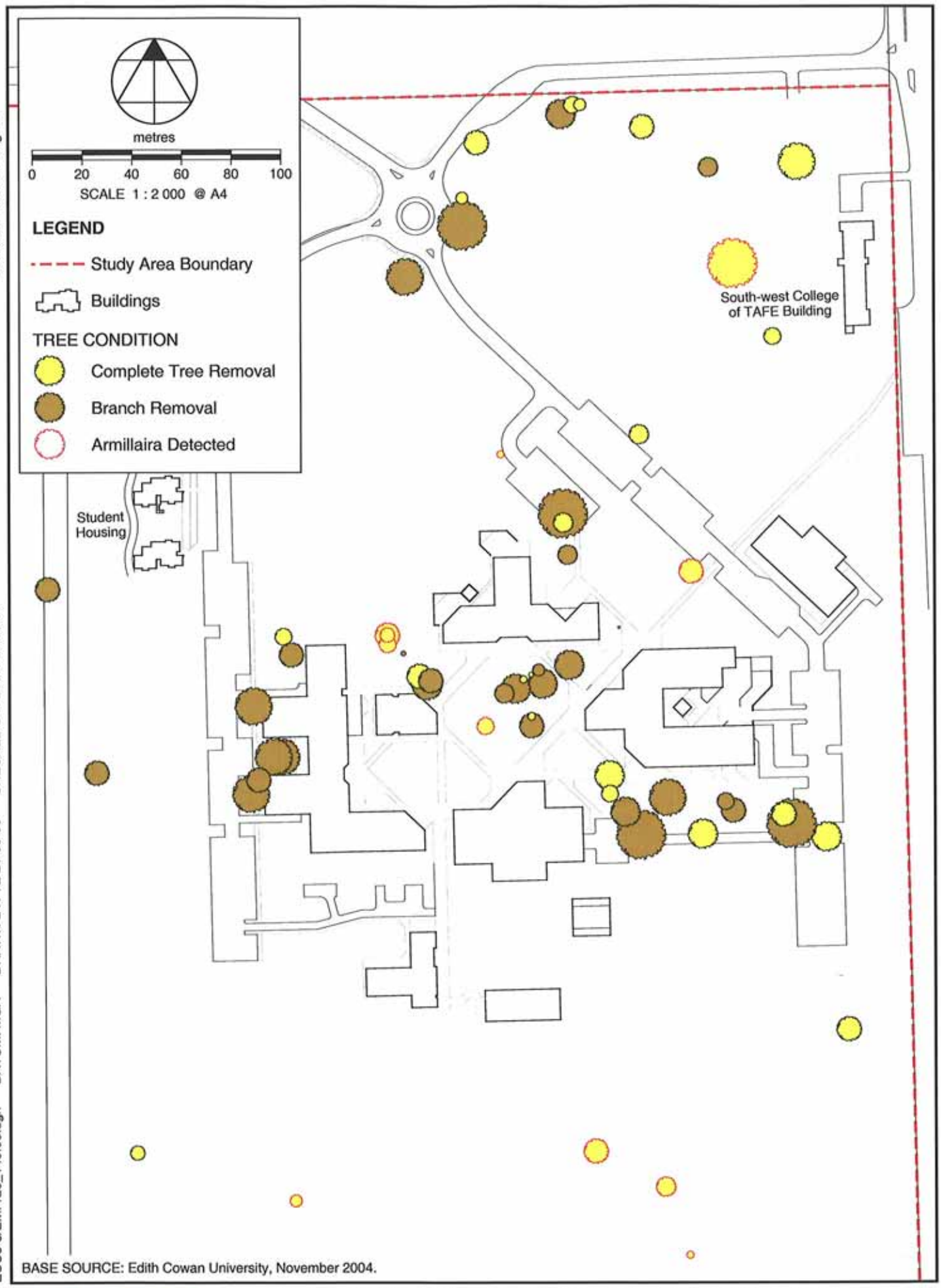
ATA Environmental
environmental scientists

ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

TREE CONDITION AND ARMILLAIRA DISTRIBUTION

FIGURE 5

ECU5-3/EMP/26_149f05.dgn DATUM: MGA DRAWN BY: TE 21-08-06 CHECKED BY: BvdW 21-08-06



PRINTED: Mon 21 Aug 06 CHECKED BY: BvdW 21-08-06 DRAWN BY: TE 21-08-06 DATUM: MGA ECU5-3/EMP/26_149f06.dgn

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ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

TREE/BRANCH REMOVAL RECOMMENDATIONS

FIGURE 6

PRINTED: Mon 21 Aug 06

Robertson

Drive

BUSSELL

HIGHWAY

S.W. HEALTH CAMPUS SITE

Student Housing

metres

0 50 100 150 200

SCALE 1 : 3 500 @ A3

LEGEND

- Study Area Boundary
- Firebreak/Track
- Buildings

TREE TYPE

- *Acacia* sp.
- *Agonis flexuosa*
- *Allocasuarina* sp.
- *Banksia grandis*
- *Banksia attenuata*
- Exotic *Eucalyptus* sp.
- *Eucalyptus marginata*
- *Corymbia calophylla*
- *Melaleuca preissiana*
- *Nuytsia floribunda*
- *Persoonia longifolia*
- *Eucalyptus gomphocephala*
- *Xylomelum ocidentale*

ATA Environmental
environmental scientists

ENVIRONMENTAL MANAGEMENT
PLAN IMPLEMENTATION SCHEDULE
SOUTH WEST CAMPUS, BUNBURY

TREE TYPE

FIGURE 7

BASE SOURCE: Edith Cowan University, November 2004.

ECU5-3/EMP/26_149f07.dgn DATUM: MGA DRAWN BY: TE 21-08-06 CHECKED BY: BvdW 21-08-06

APPENDICES

APPENDIX 1
FLORA SPECIES LIST

Family and Species	Tuart	Banksia/Jarrah	Marri/Jarrah	Marri	Melaleuca
ANTHERICACEAE					
Agrostocrinum scabrum	X	X	X		
Johnsonia pubescens		X			
Sowerbaea laxiflora	X	X	X		
Thysanotus dichotomus	X			X	
Thysanotus multiflorus		X	X	X	
Thysanotus patersonii		X	X	X	
Tricoryne elatior		X	X		
ASTERACEAE					
Brachycome ciliaris	X	X	X		
Brachycome iberidifolia	X	X			X
**Ursinia anthemoides*	X	X	X	X	X
CASUARINACEAE					
Allocasuarina fraseriana		X			
Allocasuarina humilis		X	X		
COLCHICACEAE					
Burchardia multiflora					X
Burchardia umbellata	X	X	X	X	X
CYPERACEAE					
Baumea juncea				X	X
Gahnia trifida					X
Lepidosperma longitudinale	X	X	X	X	X
Mesomelaena tatragona			X	X	X
DASYPOGONACEAE					
Calectasia cyanea		X			
Dasypogon bromeliifolius		X	X	X	X
Lomandra sp.				X	X
DILLENIACEAE					
Hibbertia hypericoides	X	X	X	X	
Hibbertia racemosa		X	X	X	
Hibbertia stellaris					X
Hibbertia vaginata		X	X	X	X
DROSERACEAE					
Drosera erythrorhiza		X	X	X	
Drosera macrantha		X	X	X	
Drosera menziesii		X	X	X	
EPACRIDACEAE					
Astroloma pallidum		X	X		
Conostephium pendulum		X	X		
Leucopogon verticillatus	X	X	X		
Lysinema ciliatum		X			

Family and Species	Tuart	Banksia/Jarrah	Marri/Jarrah	Marri	Melaleuca
GERANIACEAE					
**Erodium* sp.					X
**Pelargonium littorale*	X			X	
GOODENIACEAE					
Dampiera linearis		X	X	X	X
Goodenia filiformis					X
Scaevola calliptera		X	X	X	
HAEMODORACEAE					
Anigozanthos manglesii	X	X	X	X	
Anigozanthos preissii			X	X	X
Anigozanthos viridis					X
Conostylis aculeata		X	X	X	
Conostylis setosa			X		
Phlebocarya ciliata		X	X	X	X
IRIDACEAE					
Orthrosanthus laxus	X	X			
Patersonia occidentalis		X	X	X	X
**Romulea rosea*				X	X
JUNCACEAE					
Juncus pallidus					X
JUNCAGINACEAE					
Triglochin trichophora					X
LOBELIACEAE					
Isotoma hypocrateriformis		X			
Lobelia alata				X	X
LORANTHACEAE					
Nuytsia floribunda		X	X	X	X
MIMOSACEAE					
Acacia cochlearis	X				
Acacia flagelliformis					X
Acacia pulchella		X	X	X	X
Acacia saligna		X	X	X	X
MYRTACEAE					
Agonis flexuosa	X	X	X	X	
Astartea fascicularis					X
Baeckea camphorosmae		X	X		
Calothamnus quadrifidus			X	X	X
Calytrix flavescens		X	X	X	
Corymbia calophylla	X	X	X	X	X
Eucalyptus gomphocephala	X				

Family and Species	Tuart	Banksia/Jarrah	Marri/Jarrah	Marri	Melaleuca
Eucalyptus marginata	X	X	X	X	X
Hypocalymma angustifolium		X			X
Kunzea ericifolia		X	X	X	X
Melaleuca preissiana				X	X
Melaleuca rhaphiophylla					X
ORCHIDACEAE					
Caladenia flava			X	X	
Elythranthera emarginata		X	X		
**Monadenia bracteata*			X		
Pterostylis longifolia	X	X	X	X	
Pterostylis vittata	X	X	X	X	
Pterostylis recurva	X	X	X		
PAPILIONACEAE					
Bossiaea eriocarpa	X	X	X	X	
Daviesia angulata				X	
Daviesia divaricata	X	X			
Eutaxia virgata			X		X
Gompholobium tomentosum	X	X	X	X	
Hardenbergia comptoniana	X	X	X	X	
Hovea trisperma	X	X	X	X	X
Jacksonia furcellata		X	X	X	X
Kennedia prostrata	X	X	X	X	
**Trifolium fragiferum*					X
**Trifloium glomeratum*				X	X
**Viminaria juncea*				X	X
POACEAE					
**Aira caryophyllea*		X	X		
**Anthoxanthum odoratum*					X
**Arctotheca calendula*	X	X	X	X	X
**Avena fatua*	X	X	X	X	X
**Briza maxima*	X	X	X	X	X
**Briza minor*	X	X	X	X	X
**Bromus diandrus*	X	X	X	X	X
**Cynodon calycina*				X	X
**Ehrharta calycina*	X			X	X
**Lolium perenne*				X	X
POLYGONACEAE					
**Rumex* sp.				X	X
PITTOSPORACEAE					
Billardiera variifolia		X			
PROTEACEAE					
Adenanthos obovatus		X			
Banksia attenuata	X	X	X	X	
Banksia grandis		X	X		X

Family and Species	Tuart	Banksia/Jarrah	Marri/Jarrah	Marri	Melaleuca
Banskia ilicifolia		X			
Banksia littoralis					X
Conospermum boreale			X		
Dryandra nivea			X	X	
Hakea varia					X
Persoonia longifolia	X	X	X	X	
Petrophile linearis	X	X	X	X	
Stirlingia latifolia		X			
Synaphea spinulosa	X				
Xylomelum occidentale	X	X	X	X	X
RUTACEAE					
Boronia dichotoma		X	X	X	
SOLANACEAE					
**Solanum nigrum*		X		X	X
STACKHOUSIACEAE					
Stackhousia huegelii		X		X	
STYLIDIACEAE					
Stylidium brunonianum	X	X	X		
Stylidium calcaratum	X	X			
Stylidium hispidum	X	X			
Stylidium piliferum	X	X	X	X	
THYMELAEACEAE					
Pimelea imbricata			X	X	
Pimelea rosea		X			
TYPHACEAE					
**Typha orientalis*					X
XANTHORRHOEACEAE					
Xanthorrhoea preissii	X	X	X	X	X
ZAMIACEAE					
Macrozamia riedlei	X	X	X	X	
Note: * denotes weed species					

APPENDIX 2
CALM'S THREATENED AND PRIORITY FAUNA DATABASE SEARCH RESULTS

ECW – 4 – 2

Your Ref:
Our Ref: 2001F001096V08
Enquiries: Christine Freegard
Phone: (08) 9334 0579
Fax: (08) 9334 0278
Email: christinef@calm.wa.gov.au

DEPARTMENT OF
Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

Dr Scott Thompson
ATA Environmental
2 Bulwer St
PERTH WA 6000

Dear Dr Thompson

REQUEST FOR THREATENED FAUNA INFORMATION

I refer to your request of 26 July for information on threatened fauna occurring in the vicinity of Edith Cowan University, Bunbury (purchase order number 17857).

A search was undertaken for this area of the Department's Threatened Fauna database, which includes species which are declared as '*Rare or likely to become extinct* (Schedule 1)', '*Birds protected under an international agreement* (Schedule 3)', and '*Other specially protected fauna* (Schedule 4)'. Attached are print outs from these databases where records were found.

Attached also are the conditions under which this information has been supplied. Your attention is specifically drawn to the sixth point that refers to the requirement to undertake field investigations for the accurate determination of threatened fauna occurrence at a site. The information supplied should be regarded as an indication only of the threatened fauna that may be present.

An invoice for $150.00 (plus GST), being the set charge for the supply of this information, will be forwarded.

It would be appreciated if any populations of threatened fauna encountered by you in the area could be reported to this Department to ensure their ongoing management.

If you require any further details, or wish to discuss threatened fauna management, please contact my Senior Zoologist, Dr Peter Mawson on 08 93340421.

Yours sincerely

Freegard

.....

for Keiran McNamara
EXECUTIVE DIRECTOR

30 July, 2004

Attachment

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

THREATENED FAUNA INFORMATION

Conditions In Respect Of Supply Of Information

* All requests for data to be made in writing to the Executive Director, Department of Conservation and Land Management, Attention: Senior Zoologist, Wildlife Branch.

* The data supplied may not be supplied to other organisations, nor be used for any purpose other than for the project for which they have been provided without the prior consent of the Executive Director, Department of Conservation and Land Management.

* Specific locality information for Threatened Fauna is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information for Threatened Fauna may not be used in reports without the written permission of the Executive Director, Department of Conservation and Land Management. Reports may only show generalised locations or, where necessary, show specific locations without identifying species. The Senior Zoologist is to be contacted for guidance on the presentation of Threatened Fauna information.

* Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data, they may be present. The Department of Conservation and land Management accepts no responsibility for this.

* Receiving organisations must also recognise that the database is subject to continual updating and amendment, and such considerations should be taken into account by the user.

* It should be noted that the supplied data do not necessarily represent a comprehensive listing of the Threatened Fauna of the area in question. Its comprehensiveness is dependent of the amount of survey carried out within a specified area. The receiving organisation should employ a biologist/zoologist, if required, to undertake a survey of the area under consideration.

* Acknowledgment of the Department of Conservation and Land Management as the source of data is to be made in any published material. Copies of all such publications are to be forwarded to the Department of Conservation and Land Management, Attention; Senior Zoologist, Wildlife Branch.

33 °S 115.3333 °E / 33.83333 °S 115.8333 °E Edith Cowan University, Bunbury

Schedule 1 - Fauna that is rare or is likely to become extinct

Dasyurus geoffroii — Chuditch — *17 records*

This carnivorous marsupial occupies large home ranges, is highly mobile and appears able to utilise bush remnants and corridors.

* Date	Certainty	Seen	Location Name	Method
1986	1	1		
1987	1	1	Elgin	Dead
1987	1	1	CAMBRAY	Dead
1987	1	1	CAMBRAY	Day sighting
1989	1	1	HAPPY VALLEY	Night sighting
1990	1	1	MARYVALE	Dead
1993	1	1	UPPER CAPEL	Day sighting
1994	1	1	UPPER CAPEL	Day sighting
1997	1	1		Dead
1999	1	1		Caught or trapped
1999	1	2		Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	1	2	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	1	2	Gwindinup	Caught or trapped
1999	1	3	Gwindinup	Caught or trapped
2000	1	1		Dead

Macrotis lagotis — Bilby — *1 records*

This species shelters in burrows and occupies a range of habitats from grassland on clayey and stony soils or sandplains to mulga scrub and woodlands on red earths. It has suffered a large decline and contraction in distribution.

1972	3		Geographe	

Pseudocheirus occidentalis — Western Ringtail Possum — *6 records*

This species occurs in areas of forest and dense woodlands and requires tree hollows and/or dense canopy for refuge and nesting.

1991	1	11	Busselton	
1997	1	1		Dead
1998	1	2	Dalyellup	Night sighting
1998	1	1	Dalyellup	Night sighting
2000	1	10		Day sighting
2003	1	1	Davenport	Day sighting

Setonix brachyurus — Quokka — *2 records*

Mainland populations of this species are currently restricted to densely vegetated coastal heaths, swamps and riverine habitats where they are less vulnerable to predation.

1931	1		Busselton	Day sighting
1976	1	1	Gelorup	

Botaurus poiciloptilus — Australasian Bittern — *1 records*

This species inhabits beds of tall dense reeds and sedges in freshwater swamps.

1992	1	2	Benger Swamp Nature Reserve	Day sighting

33 °S 115.3333 °E / 33.83333 °S 115.8333 °E Edith Cowan University, Bunbury

*	Date	Certainty	Seen	Location Name	Method

Calyptorhynchus baudinii **Baudin's Black-Cockatoo** *3 records*

This species is a seasonal visitor to the northern forests and adjacent eastern edge of the coastal plain, feeding on the seeds of eucalypts and various proteaceous species. It breeds in spring/summer in the southern forests, nesting in tree hollows (primarily in Marri).

1939	2		Bunbury	Day sighting
1976	1		Whicher Range	Day sighting
1999	1	3	Bunbury	Day sighting

Calyptorhynchus latirostris **Carnaby's Black-Cockatoo** *1 records*

This species moves around seasonally in flocks to feeding areas in proteaceous scrubs and heaths and eucalypt woodlands as well as pine plantations. Breeding occurs in winter/spring, mainly in the eastern forests and wheatbelt where they can find mature hollow-bearing trees to nest in.

1999	2	7	Bunbury	Day sighting

Calyptorhynchus sp **White-tailed Black Cockatoo** *1 records*

These records pertain to either Baudin's Black-Cockatoo or Carnaby's Black-Cockatoo.

2004	1	20	Capel	Day sighting

Schedule 4 - Other specially protected fauna

Falco peregrinus **Peregrine Falcon** *1 records*

This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.

1994	1	1	Busselton	Day sighting

Priority One

Austromerope poultoni **Austromerope poultoni** *1 records*

This species of scorpion fly is associated with forest litter and appears to be active after rainy periods. Little else is known of its biology and habitat requirements.

1976	1	3	QUILERGUP	Caught or trapped

Priority Two

Ixobrychus flavicollis australis **Black Bittern** *2 records*

This species inhabits freshwater pools, swamps and lagoons, well screened with trees.

1931	1		Picton	
1931	1		Stirling Estate	

Priority Three

Phascogale tapoatafa tapoatafa **Southern Brush-tailed Phascogale** *11 records*

This arboreal marsupial occurs in forest and woodland where suitable tree hollows are available. Populations fluctuate dramatically in response to invertebrate prey abundance.

1992	1	3	Boyanup	Dead
1999	1	2		Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	1	2	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped

33 °S 115.3333 °E / 33.83333 °S 115.8333 °E Edith Cowan University, Bunbury

*	Date	Certainty	Seen	Location Name	Method
	2001	1	1	Ludlow	
	2003	1	1	Glen Iris	Night sighting
	2004	1	1	Busselton	Night sighting

Calyptorhynchus banksii naso **Forest Red-tailed Black-Cockatoo** *1 records*

This subspecies of the Red-tailed Black Cockatoo is restricted to the forests of the south-west. It requires tree hollows to nest and breed and is totally dependent on jarrah-marri forest.

1999	1	3	"Green Patch"	Day sighting

Galaxiella nigrostriata **Black-stripe Minnow** *4 records*

This species typically occurs in shallow isolated pools in peat flats surrounding forested areas.

2001	1	3	Wokalup	
2001	1	64	Wokalup	
2001	1	3	Wokalup	
2001	1	113	Wokalup	

Pachysaga munggai **Pachysaga munggai** *1 records*

A species of cricket found in slightly open vegetation where it lives in leaf litter by day and emerges at night to feed and sing from low vegetation.

1982	1	1	Yoganup	

Priority Four

Isoodon obesulus fusciventer **Quenda** *16 records*

This species prefers areas with dense understorey vegetation, particularly around swamps and along watercourses, that provides ample protection from predators.

1981	1	1	Wonnerup	
1998	1	2	Dalyellup	Day sighting
1999	1	1	Bunbury	Dead
1999	1	1	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
1999	2	0	Bunbury	Definite signs
1999	1	1	Gwindinup	Caught or trapped
1999	1	2	Gwindinup	Caught or trapped
1999	1	1	Gwindinup	Caught or trapped
2001	1	50	Ludlow	Caught or trapped
2001	1	1	Ludlow	
2001	1	1	Ludlow	
2001	1	1	Ludlow	
2001	1	1	Ludlow	
2001	1	1	Ludlow	

Macropus irma **Western Brush Wallaby** *2 records*

This species occurs in areas of forest and woodland supporting a dense shrub layer.

1975	1	1	Gelorup	
1999	1	1	Bunbury	Day sighting

33 °S 115.3333 °E / 33.83333 °S 115.8333 °E Edith Cowan University, Bunbury

*	Date	Certainty	Seen	Location Name	Method
Falsistrellus mackenziei			**Western False Pipistrelle**		*1 records*
This species of bat occurs in high rainfall jarrah forest and coastal woodlands. It roosts in small colonies in tree hollows and forages in the cathedral-like spaces between trees.					
		1	1	Ludlow	Caught or trapped
Hydromys chrysogaster			**Water-rat (Rakali)**		*1 records*
This species occurs in waterways and wetlands that support its main prey items such as molluscs and crustaceans.					
	2001	1	1	Ludlow	Caught or trapped
Ixobrychus minutus			**Little Bittern**		*1 records*
This criptic species inhabits dense reeds and rushes bordering swamps, lakes and watercourses.					
	1972	1	1	Benger Swamp Nature Reserve	Day sighting
Burhinus grallarius			**Bush Stonecurlew**		*1 records*
A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.					
	1939	1		Bunbury	
Charadrius rubricollis			**Hooded Plover**		*2 records*
This species frequents the margins and shallows of salt lakes, also along coastal beaches, where it forages for invertebrates along the water's edge.					
	1994	1	44	Yalgorup National Park	Day sighting
	1998	1	85	Leschenault	Day sighting
Numenius madagascariensis			**Eastern Curlew**		*5 records*
This species is a migratory visitor and has been observed on reef flats and sandy beaches along the West Australian coast and in coastal estuaries.					
	1939	1			Day sighting
	1998	1	15	Leschenault	Day sighting
	2000	1	7	Leschenault	
	2001	1	7	Leschenault	
	2002	1	1	Leschenault	
Falcunculus frontatus leucogaster			**Crested Shrike-tit (south-western ssp)**		*1 records*
This species is an uncommon inhabitant of woodlands.					
	1939	1		Bunbury	Day sighting
Psophodes nigrogularis			**Western Whipbird**		*1 records*
	1898	1	0	Bunbury	Eggs

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

APPENDIX 3
ECU PROCEDURE: PESTICIDES, HANDLING, STORAGE AND USE OF

Facilities and Services Centre

BUILDINGS AND SERVICES

Procedure: Pesticides, Handling, Storage and Use of

Ref: 2.6.7

1. Title:

Pesticides, Handling, Storage and Use of

2. Purpose:

The purpose of this document is to detail the procedure for the use of Pesticides where necessary to control pests on campus.

3. Organisational Scope:

Buildings and Services staff.

4. Statement:

4.1 Edith Cowan University supports a fully integrated pest management program which:

a) Provides and maintains a healthy work environment for its staff and students;

b) Consists of the balanced use of cultural, operational, biological, and chemical procedures that are environmentally compatible and economically feasible to reduce pest populations to tolerable levels;

c) Continues to improve the University's practice of controlling pests and will ensure that strict guidelines for the use of pesticides are adhered to and legislative requirements are met;

d) Emphasises the management of pest populations and the use of alternative methods of control in accordance with the guidelines; and

e) Employs procedures which are Occupational Safety and Health best practice.

4.2 The university also recognises its responsibility to ensure that:

a) no university activity adversely impacts on the wider community and the environment, and

b) all university activities meet environmental best practice objectives.

4.3 Edith Cowan University will provide the necessary resources to control the storage, distribution, application and disposal of pesticides

5. Definition:

Pest: An unwanted biological entity; including animal, plant, and microbe.

Pesticide: a chemical (or mixture of chemicals) intended to be used for the selective control of pests. A pesticide includes chemicals used by Buildings and Services staff for the control of pests in buildings, grounds and in air and water systems.

Pesticide operation: any or all of the processes of pesticide acquisition, storage, mixing, application (including supervision of an application undertaken by a private pest control firm), and disposal.

Pesticide application: the dispersal of a pesticide over a target area or volume.

Fumigant: a pesticide that has a significant vapour pressure at normal temperature and pressure.

Fumigation: the process whereby a fumigant is released within a controlled target volume; it is one type of pesticide application.

Authorised person: Persons appointed by the Director, Division of Facilities and Services as the most senior persons in the control and management of pests in the University. For pests located inside a building the authorised person is the Buildings Maintenance Manager, and for pests located in the grounds of the University, the authorised person is the Grounds Maintenance Manager.

Registered persons: Those people who have been approved by an *authorised person* to undertake pesticide related activities in the University, having been appropriately and adequately trained in the safe handing and use of pesticides.

Pest Control Operator: A licensed contractor engaged by the University to undertake pest control operations.

Material Safety Data Sheet (MSDS): An information document supplied by the manufacturer of a pesticide/chemical designed to provide workers and emergency personnel with the proper procedures for handling or working with that substance.

6. Principles:

Facilities and Services is responsible for maintaining the campus buildings, grounds and the campus environment. Buildings and Services is responsible for employing methods to control pests should or when the need arises. The chemical control of pests is required only when other forms of prevention or control are inadequate, ineffective or unavailable. Pesticides must be handled, stored and used in a safe and appropriate manner with respect to the user, the campus community, the public and the environment. No University activity should act adversely on the campus, the wider community and the environment.

7. Content:

All operations involving the storage, handling, preparation and application of chemicals to result in the control of pests within the campus shall comply with:

a) Occupational Safety and Health regulations (1996);

b) Occupational Safety and Health Act 1984, Western Australia;

c) the university's Hazardous Substances Policy;

d) specific regulations controlling the use of any pesticide necessary for control, and

e) Health (Pesticide) Regulation of 1956.

7.1 The need for the use of pesticide(s) shall be determined as an outcome of the Facilities and Services' Procedure - Pest Management and Control.

7.2 Choose the appropriate method by which chemical control is to be undertaken. This may be by using in-house labour (registered persons only) or the engagement of a pest control operator.

7.3 Choose the correct pesticide to achieve the desired control. Where a pest control operator is to be engaged, the pesticide proposed for use must be agreed to by the University. Correct pesticide selection maximises effectiveness of control whilst minimising human health risks and environmental affects. Factors to be considered in the selection of pesticides include:

a) The range of pesticides available;

b) The poison schedule rating;

c) Other toxicological information;

d) Specific regulations controlling the use of the chemical;

e) Longevity of the product after application;

f) Product specificity, and

g) Possible affects on non-target species.

7.4 An MSDS must be obtained by the University prior to the use of any pesticide. The MSDS must be made available to any persons involved in a pesticide operation and those persons must become fully familiar with the content of the MSDS prior to the pesticide operation.

7.5 Advise the campus of the proposal to use pesticide(s). Grounds maintenance staff shall advise:

a) The Campus Facilities Manager;

b) The relevant campus OSH representative;

c) Security (should the pesticide operation be undertaken outside of normal campus working hours), and

d) The F&S Call Centre.

Notification is achieved by emailing those staff listed on the Pesticide Use Notification Sheet.

7.6 All pesticide operations shall be undertaken in full compliance with the directions, instructions and safety precautions on both the pesticide label and MSDS. In addition the registered person undertaking the application shall be fully informed of the reason for the treatment (including the target pest and its biological stage if appropriate) and the reason for the choice of the particular pesticide being applied.

7.7 Storage of pesticides shall be in designated poison storage cabinets as provided by the University. All chemicals must be stored in their original containers (ie no decanting) and minimum quantities of pesticides should be stored. Where the need for broader pesticide operations is required, pesticides shall be purchased prior to the event in the quantity required to achieve the necessary control so as to minimise storage requirements.

7.8 The storage facility must be:

a) Dedicated to the storage of poisonous materials;

b) Ventilated;

c) Free of pervious materials within;

d) Lockable and kept secure at all times;

e) Adequately signed with appropriate signage (including Class 6.1(a) class label for poisonous substances, Class 3.1/2 subsidiary risk label for flammable liquids (if applicable), and **NO SMOKING**), and

f) Kept clean and tidy.

7.9 Transportation of pesticides within the University (except in the diluted state of a spray mix) should be avoided unless undertaken in accordance with the Dangerous Goods Regulations.

7.10 Personal protective equipment (PPE) shall be provided by the University to any registered person required to undertake a pesticide operation. The registered person shall wear any PPE as is deemed necessary according to the chemical label and MSDS for each component of the pesticide operation (mixing, application, cleaning).

7.11 Equipment to be used to undertake the pesticide application shall be clean prior to use, fully functional, mechanically sound and calibrated to ensure the correct application rates are achieved.

7.12 Preparation of spray mixes shall be undertaken in a designated area which shall be clear of building entrances, air conditioning/ventilation intakes and include a water supply point and wash down area.

7.13 Any spillages should be cleaned up immediately using an appropriate material.

7.14 Signage advising the community of the pesticide operation shall be placed around campus areas that are to have a pesticide applied. Signs should remain in position during and after the treatment, until the risk of exposure has passed.

7.15 Pesticide operations shall only occur during appropriate climatic conditions. Spray drift should be minimised in the application process. Any planned pesticide application that has inappropriate climatic conditions prevailing at the proposed time, should not proceed, and should be re-scheduled.

7.16 The times to undertake pesticide applications are when there is the least likelihood of exposure of students, staff and the general public to the chemical. For Grounds staff, the following times are applicable:

a) S6 schedule chemicals:

i. by boom spray on weekends or prior to 7.30am on weekdays

ii. by spot spray prior to 8.30am in populated areas of the campus or throughout the day in areas free of staff/students;

b) S5 schedule chemicals

i. by boom spray on weekends, prior to 8am on weekdays in populated areas of the campus or throughout the day in areas free of staff/students,

ii. by spot spray throughout the day with due regard to minimising contact with persons in the areas being treated;

c) Unscheduled chemicals may be sprayed at any time, and

d) Student Housing or Childcare Centres: Any pest control activities are to be arranged in consultation with the managers in charge of the facility and be carried out at the agreed time of most minimal impact.

7.17 Unused diluent should be applied to the area requiring treatment to eliminate the need for disposal. Rinsings of the empty container should be added to the spray tank and applied. Disposal of spilt material (and the absorbent material it may be contained within), other waste materials from the pesticide operation, empty containers and unwanted chemicals should be undertaken in an approved manner as specified on the corresponding MSDS. This may require consultation with Local Government Agencies and Government Authorities.

7.18 *Registered persons* are to maintain records indicating the details of all occasions when University staff have been involved in the application of pesticides. These records are to be referred to in the event of an occupational accident or injury.

7.19 Any event where first aid treatment is required as a result of any pesticide operation shall be reported using the Accident Report Form. The Authorised Person, OSH Representative and Campus Facilities Manager shall all be immediately notified.

8. References:

Code:	2.6.7
Owner:	Manager Grounds Services
Approved By:	Grounds Business Unit
Date Approved:	January 2006
Revision Date:	January 2008
Related Policies/Docs	University related policy available at http://www.ecu.edu.au/GPPS/policies HR116: Hazardous Substances Policy HR081: Occupational Safety and Health Policy HR101: Personal Protective Clothing and Equipment Hazardous Substances Procedure Manual F&S Procedure - Pest Management and Control at http://www.ecu.edu.au/fas/procedures/search.php

9. Contact Information:

Contact Person:	Carl Overbye, Manager Grounds Services
Telephone:	6304 2249
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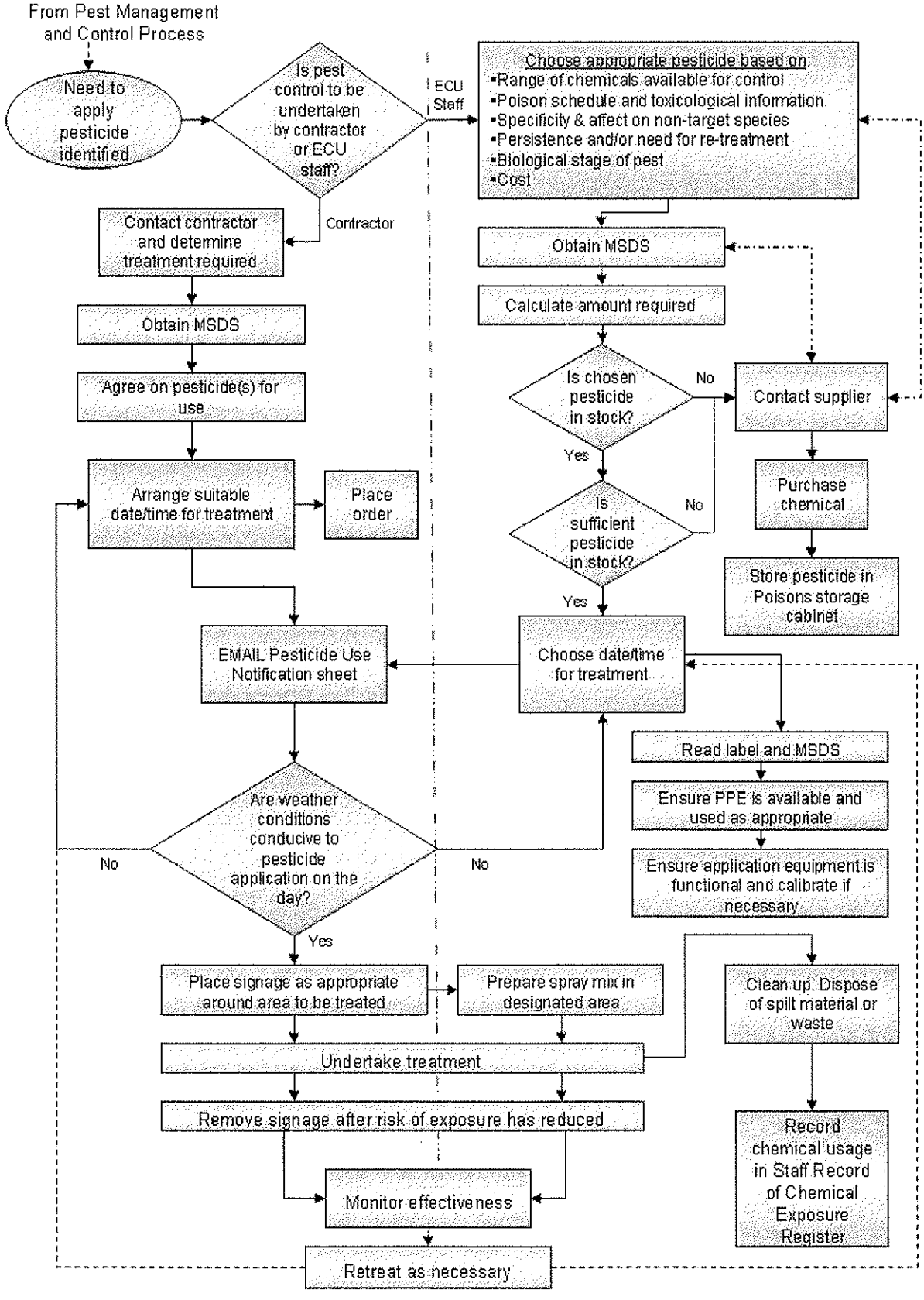
FACILITIES AND SERVICES
BUILDINGS AND SERVICES
Grounds
Flowchart for Pesticide Use



APPENDIX 4
WEED ERADICATION AND MANAGEMENT METHODS

WEED ERADICATION AND MANAGEMENT MEASURES

Botanical/Common Name		Comments	Method of Control	Weed Removal Techniques
Aira caryophyllea Silvery Hair Grass		Competes with small herbs.	1,3,4	No specific information on herbicide control. Suggest Fusilade or similar herbicide at 2L/ha.
Anthoxanthum odoratum Sweet Vernal Grass				
Arctotheca calendula Cape Weed		Mainly found in disturbed areas where extra water/nutrients encourage lush growth.	1,2,3	Glyphosate/Rndup knapsack 100mL in 15L water or strong solution on large plants.

Botanical/Common Name		Comments	Method of Control	Weed Removal Techniques
Avena fatua Wild Oat		Mainly found in highly disturbed areas. Competes with natives. Fire hazard.	3,4	Use 2L Fus/ha for blanket and spot spraying. Easy to control.
Briza minor Shivery Grass		Easy to control	1,2,3,4	Sertin or other similar herbicides at 2L ha.
Bromus diandrus Great Brome		Competes with natives.	1.2.3.4	Fusilade or similar herbicide at 2L/ha when actively growing.

Botanical/Common Name		Comments	Method of Control	Weed Removal Techniques
Cynodon dactylon Couch		Competes with native species. Mainly in highly disturbed areas.	3,4	Fus. 4L ha or similar herbicides eg Sertin, Targa, when actively growing late spring or autumn. Best after fire spraying young growth otherwise several applic. may be necessary. Glyph. can be used if you can avoid non target species.
Ehrharta calycina Veldt Grass		Smothers small plants and competes with natives. A serious fire hazard.	3,4	Easy to control with Fusilade 4L/ha or similar herbicides (eg Sertin, Targa). Spot spray at 2L to run off. Heavy infestations may require mop up spray the following year. Remove small infestations by hand, cut roots as close to culms as possible with a sharp knife.
Erodium botrys Long Storksbill		Difficult to control as it is so common.	1,2,3	No specific information on herbicide control. Suggest Glyp/Rndup or Sprysd/Try. Ally/Brush will control some species 5g/ha.
Lolium perenne Perennial Ryegrass		Common in disturbed areas. Some of the selective grass herbicides are far better than others in controlling Rye Grasses.	1,2,3,4	No specific information on herbicide control. Suggest Sertin, Targa and similar herbicide at 4L/ha before flowering.

Botanical/Common Name		Comments	Method of Control	Weed Removal Techniques
Pelargonium capitatum Rose Pelargonium		Smothers small native plants. Colonises natural bare sandy areas.	2,3	Pull plants in autumn/winter when soil is damp. Plant will reshoot if stem is broken at or below ground level. Secondary weeding is important. Suggest Ally/Brush 5g/ha. Glyph 1 in 100 in early September.
Ricinus communis Castor Oil Plant		Common in disturbed areas. Has been successfully controlled by slashing before flowering.	1,2,3	Remove small populations by hand. For larger plants use the cut stump method with Glyph. For large populations of seedlings spot spray with Glyph. 1 in 80.
Romulea rosea Guildford Grass		Mainly found in disturbed areas.	1,2,3	Glyph. 20-40 mL in 10L water + 0.25% wetter in mid winter. Glean, Ally/Brush give excellent control but should not be applied any later than early flowering for good control.
Rumex sp. Dock		Widespread	1,2,3	Suggest Rndup/Glyph. 150mL in 15L water when actively growing. Or Ally/Brush 0.05g in 10L water plus 0.25-0.5% wetter.
Solanum nigrum Blackberry Nightshade		Usually found in highly disturbed areas. Toxic. Annual or short lived perennial. Often best to hand weed.	1,2,3	Hand pull small populations. Spray seed 200, 10-20mL in 10L water using knapsack. Apply to seedlings. Also try Glyph/Rndup, knapsack 300mL in 15L water.

Botanical/Common Name		Comments	Method of Control	Weed Removal Techniques
Trifolium fragiferum Strawberry Clover		Found mainly in highly disturbed areas. Clovers are usually so abundant it is often only practical to control them in lightly infested areas.	1,2,3	Some species are known to be controlled by Glyph/Rndup 75-100m in 15L water, knapsack when actively growing.
Trifolium glomeratum Cluster Clover				
Typha orientalis Bulrush		Competes with other native plans. Fire hazard.	1,2,3	Difficult to dig out even small populations and reinfestation can be rapid. Remove flowers, seed source. Cut stems below water level in summer or just prior to recharge of wetland. Repeated cuttings requiring during growing season.
Zantedeschia aerthiopica Arum Lily		Replaces native species mainly in highly disturbed sites. Declared Plant	1,2,3	Glyph. 1 in 100 – June to October. Several applications may be necessary. Can also use Glean Ally/Brushoff. Difficult to dig out in most sites. On dry sites use a Peter lever. Spot spray from April to Nov. when plants are 8-12cm high. Respray 2 months later to get missed growth.

Adapted from Scheltema & Harris (1995)

Key to method of Control

1 Hand weeding, pulling, digging
2 Herbicide wipe, stem injection, cut stump
3 Spot spraying
4 Blanket spraying

APPENDIX 5
ECU PROCEDURE: PEST MANAGEMENT AND CONTROL

Facilities and Services Centre

BUILDINGS AND SERVICES

Procedure: Pest Management and Control

Ref: 2.6.4

1. Title:

Pest Management and Control

2. Purpose:

The purpose of this document is to detail the procedure for the reporting, management and control of pests within the University campus grounds and buildings.

3. Organisational Scope:

Buildings and Services Staff

4. Statement:

4.1 Edith Cowan University supports a fully integrated pest management program which:

a) Provides and maintains a healthy work environment for its staff and students;

b) Consists of the balanced use of cultural, operational, biological, and chemical procedures that are environmentally compatible and economically feasible to reduce pest populations to tolerable levels;

c) Continues to improve the University's practice of controlling pests and will ensure that strict guidelines for the use of pesticides are adhered to and legislative requirements are met;

d) Emphasises the management of pest populations and the use of alternative methods of control in accordance with the guidelines; and

e) Employs procedures which are Occupational Safety and Health best practice.

4.2 The University also recognises its responsibility to ensure that:

a) No University activity adversely impacts on the wider community and the environment, and

b) All University activities meet environmental best practice objectives.

5. Definitions:

***Pest*:** An unwanted biological entity; including animal, insect, plant, and microbe

6. **Principles**:

Facilities and Services are responsible for maintaining a safe campus environment. Buildings and Services staff are responsible for the identification, management and control of building, horticultural and nuisance pests.

7. Content:

The primary method of pest control is prevention. Wherever possible, infestation by pests should be prevented by eliminating the environment and conditions they prefer (including creating and keeping a hygienic environment) or by the creation of barriers.

Should there be a perceived need for pest control within or around the campus buildings and grounds, this may be reported by any ECU student or staff member (including Buildings and Services staff). It is the responsibility of the Senior Maintenance Officer or Senior Gardener to inspect any report of the presence of a pest and:

a) Identify the extent of the pest;

b) Determine whether the pest is a problem;

c) Determine whether control is/is not necessary, and

d) Effect the appropriate control of that pest should control be necessary.

The following procedures are offered to assist in the appropriate management of pests on campus:

7.1 Any pest on campus should be reported to Buildings and Services staff preferably by calling the F&S Call Centre (Ext. 5554)

7.2 For any pest identified/reported, the Senior Maintenance Officer (in the case of a building related pest) or the Senior Gardener (in the case of a grounds pest) shall determine what type of control is necessary (if any). Control methods should be considered with consideration to: availability; ease of implementation; effect on the environment; effect on non-target species; effectiveness; economic viability; and the ability to resource the treatment. The options for control include (in order of preference):

a) No control necessary (live with it and/or let nature take its course);

b) Change management practise (eg time of watering, ensuring food scraps are kept in sealed containers or disposed of regularly);

c) Physical control (eg remove food source or shelter, prevent breeding sites, physical removal, flyscreens);

d) Biological control (eg ladybirds, wasps, bacterial agents, DNA alteration), and

e) Chemical control.

It may be appropriate that a combination of control methods be employed to achieve the desired outcome.

7.3 Should the reported pest be an immediate hazard to people in the area (eg bee swarm) signs advising of the hazard should be displayed as soon as practicable and

before control methods are considered or, if deemed necessary, the area cordoned off.

7.4 The Senior Maintenance Officer/Senior Gardener should determine whether the control should be undertaken by the in-house labour resource or whether a pest control operator/contractor be employed to effect the treatment/control.

7.5 The Senior Maintenance Officer/Senior Gardener will implement the chosen control strategy/method with the assistance of staff or contractors as appropriate.

7.6 Should the need arise where chemical control is necessary, procedure The Use of Pesticides shall be referred to and followed.

7.7 As an essential ingredient in the pest management program, monitoring of the effectiveness of the control treatment should be undertaken and a determination made as to its effectiveness and whether further or alternative treatment may be necessary.

7.8 In the case of a pest being reported by a member of staff or student, that person should be advised of the outcome of their report/request and the action taken.

8. References:

Code:	2.6.4
Owner:	Manager, Grounds Services
Approved By:	Grounds Business Unit
Date Approved:	January 2006
Revision Date:	January 2008
Related Policies/Docs	Pest Management and Control flowchart F&S Procedure - Pesticides, Handling, Storage and Use of at http://www.ecu.edu.au/fas/procedures/listing.php?dvid=2

9. Contact Information:

Contact Person:	Carl Overbye, Manager Grounds Services
Telephone:	6304 2249
Facsimile:	6304 2787
Email address:	c.overbye@ecu.edu.au

Pest Management and Control