CHARLES STURT
UNIVERSITY

ENVIRONMENTAL MANAGEMENT PLAN

THURGOONA CAMPUS

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1. INTRODUCTION

Construction of the Thurgoona Campus of Charles Sturt University began in 1996 on an 87ha 'greenfields' site in the northern outskirts of Albury-Wodonga. The new campus has been developed in an environmentally sensitive manner with particular emphasis placed on passive energy design and low cost maintenance that is ecologically sustainable. Special attention was paid initially to providing a sound basis for the management of water resources. Subsequent emphasis will be placed on the progressive ecological rehabilitation of the campus, where possible, to restore habitats and species that would have occupied the site prior to European occupation. Such a development is expected to eventuate in an aesthetically pleasing environment that will be inexpensive to maintain and that will have considerable educational value.

The conceptual basis for the design, development and ongoing management of the Thurgoona campus is to assure the continuing welfare and sustainability of the environmental resources that contribute to its construction and maintenance. The same principles also underlie much of the educational philosophy of the courses taught on the campus in the School of Environmental and Information Sciences, leading to potential synergy between philosophical principles and management practice to the benefit of both.

The campus is both visionary and practical, building on past experience and breaking new ground. This development provides an excellent opportunity for the University to set examples of best practice in environmentally sensitive design, development and management.

The three main principles guiding the environmentally sensitive design and development of the campus as stated by Webster-Mannison (1998) are:

- Low energy consumption
- Responsible resource management
- Minimal environmental impact

2. PURPOSE AND SCOPE OF THIS DOCUMENT

From the onset of the planning process for the Thurgoona Campus, principles and objectives to guide development and design of the site were established and are laid out in early documents including:

- Webster-Mannison, M and McInerney, C (1998) *Charles Sturt University Thurgoona Campus Development Application Report.*
- Mitchell, D and Webster-Mannison, M (1998) *Charles Sturt University Thurgoona Campus Technical Report, Management of Water Resources.*

This environmental management plan aims to reinforce and support those principles and objectives by establishing guidelines for appropriate behaviour and activity on the campus that will ensure its development and management is environmentally sensitive, cost effective and ecologically sustainable.

The information and procedures presented in this document are therefore designed to provide clear guidance for staff, students and outside contractors ensuring that all activities, operations and uses of resources are environmentally appropriate. It incorporates appropriate procedures for the day to day maintenance of the campus and for its further strategic development. Both aim to ensure that management of the campus is ecologically sustainable.

Guidelines and recommendations to reduce or eliminate any potential environmental damage to the campus environs are provided. An important component of this is the provision of measures directed at minimising or mitigating any disturbance caused by development and by general operational activities. Information on environmental safeguards to protect sensitive areas of the campus is specified. Summarised management procedure tables are provided at the end of each relevant section. All of these tables are brought together in Appendix 1 for ease of location.

3. DESCRIPTION OF SITE

The campus is bounded by Old Sydney Road to the east, Elizabeth Mitchell Drive to the west, Thurgoona shopping precinct, residential area and Leahy Avenue to the south and Six-Mile Creek to the north. Main entry into the campus grounds is from Elizabeth Mitchell Drive.

The campus grounds were initially dominated by poor quality pasture consisting of introduced grasses, several weed infestations and, some small patches of native grasses. Prior to the University purchasing the land the area was primarily utilised for grazing (Webster-Mannison 1998). A number of mature eucalypts are scattered around the site mostly in the northern section of the campus grounds. Two areas of eucalypt woodland planted 20 years previously are located in the south eastern and south western areas of the campus. Twelve European and eight Aboriginal heritage sites, of varying degrees of significance, are located within the campus grounds (Appendix 10a and 10b).

Buildings are situated either side of a pedestrian walk which follows the contour of a hill, reducing the need for extensive earthworks while providing a pleasant linking of buildings and facilities. Rammed earth buildings, solar power, low energy heating/cooling and extensive use of recycled and energy efficient materials are all environmentally sensitive aspects of the building design.

Dry composting toilets have been installed in all buildings on the non-sewered, northern aspect of the site, thereby avoiding the generation of 'blackwater'. Three artificial wetland systems have been constructed to treat greywater generated on-site. Run-off from rainfall is directed into three reservoirs located in the northern section of the campus. Water from these reservoirs is pumped into two hilltop supply reservoirs for use as irrigation water on the University grounds. The three retention reservoirs are valuable wetland habitat and provide a pleasing aesthetic quality to the campus environs.

The landscaping of the campus emphasises low maintenance and low water use through predominant planting of native species. An exception to this is the pedestrian spine interconnecting the distinct precincts of the University, landscaped as an arboretum of ecologically similar plants grouped according to the phytogeographic regions of the world from which they originate.

4. ONGOING DEVELOPMENT OF THE SITE

The conservation of biological diversity is a foundation of ecologically sustainable development. Sustainable land management principles and practices will enhance landscape and biodiversity values of the campus. Future landscaping development of the site will involve returning the land to a stable, self-sustaining and self-optimising condition through regeneration and revegetation practices. This will require formulation of a strategy to convert the current pasture dominated landscape, which is largely vegetated with plants that are not native to the area, to one that provides for multiple purpose use based on vegetation native to the area. A major part of the campus should be restored progressively to a state approaching its original condition and high levels of human activity confined to areas around buildings and other university teaching facilities. An indication of the vegetation developments that are envisaged in this regard are set out in Section 6.1.3

The establishment of locally native vegetation is an essential precursor to the re-establishment of fauna native to the area and the consequent further improvement of biodiversity and ecological sustainability. This process may be encouraged by a planned introduction of selected herbivorous animals that would replace the need to slash grassy areas, such as small wallabies. Initial trials of such introductions could occur in the hill top section of the campus, the fence line will need to be extended to encompass the majority of this area and the fence increased in height. Careful management and ongoing monitoring will be required to ensure an optimum carrying capacity is achieved. Plans to give effect to this are being formulated in the School of Environmental and Information Sciences.

The campus has been divided into six indicative management zones to give effect to these concepts (Figure 1, Table 1). These provide a basis for the formulation of a strategy for ongoing development of the campus. The zones should also assist in the clarification of differential management to meet the various purposes of the campus. Ongoing development of the campus based on these management zones must be continuously integrated with the environmental management procedures described in this document and summarised in the tables located in each relevant section and brought together in Appendix 1.

Further building development on the campus must be planned in accordance with this Environmental Management Plan to minimise on-site and off-site environmental damage.

Page for A3 Management Zone Map

Page for A3 Management Zone Map

Page for A3 Management Zone Map

TABLE 1. INDICATIVE CAMPUS MANAGEMENT ZONES

OBJECTIVES	PRIMARY ACTIVITIES
ZONE 1 *Northern section of campus, including reservoirs.* This zone offers the best opportunities for rehabilitation to conditions close to those that originally occurred here naturally. A number of possibilities should be explored and assessed. The area around the water reservoirs and along the creek could be developed as wetland, shoreline and riparian systems. The remaining restored to grassy woodland. Staff of the Herbarium are evaluating these possibilities in consultation with others. Agreed recommendations will then be used to formulate a strategy for the restoration of the zone to something approaching its original condition. In the meanwhile the primary activities identified for this zone should guide its management.	• Grazing by animals on agistment in this zone should be rotated in relation to stocking density so as to encourage regeneration of native herbs and grasses. Existing fenced demarcation into paddocks should assist in this. Such grazing will need to be gradually phased out as the area is progressively rehabilitated. (6.3) • All fallen vegetation in this zone should be left where it falls and not gathered into piles or tidied up. This will aid in increasing habitat value and biodiversity on campus. (6.1.1) • Limbs and branches of fallen or removed vegetation from other areas on campus should be relocated into this zone. (6.1.1) • Until the area around the reservoirs has been further developed, a strip of vegetation of various widths around the shores should not be slashed to provide protective cover for fauna.(6.2.1) • A pest animal control program must be implemented to reduce pest species preying on wetland fauna. (7.5) • Existing weed infestations should be controlled to prevent further spread, particularly Phalaris. Any new weed species found on campus should be removed when first noticed to prevent an infestation occurring.(7.1) • A control strategy for noxious weed species must be implemented, particularly for Patterson's Curse and Blackberry. (7.2) • Swales should be regularly examined for any signs of erosion and problems treated when first noticed.(8.1,8.5) • Run-off from construction sites and carparks should not be directed into swales or reservoirs.(8.1) • No stockpiles should be placed in close proximity to swales or reservoirs to avoid sediment entering these areas.(8.7) • Refuelling must not occur in close proximity to swales or reservoirs to avoid chances of spill and should only take place in the designated area.(8.8)
ZONE 2 *Buildings, carparks, high usage areas.* This zone poses a particular challenge to maintain the principles of environmentally sensitive management aiming at ecological sustainability while addressing the Universities responsibilities for “duty of care” to all people working on, or visiting, the campus. The latter will entail assessment of risk and occupational health and safety issues.	• Water usage should be minimised by only watering grounds when necessary. (5.4) • Watering of the grounds and garden beds should be done in early mornings or late evenings when evaporation is low. (5.4) • When mowing around student residences a catcher must be used to reduce the amount of grass trodden through cottages. • An annual check of vegetation should be conducted to identify any potential hazards, e.g., dead or dying limbs of trees in carpark areas. A member of the OHS committee should be consulted to assess risk before any lopping or removal is undertaken. Consultation should occur with appropriate staff member of the SEIS or Herbarium for assessment of habitat and educational value. (6.1.1) • This zone must be monitored for any signs of erosion and problems treated when first noticed, ie, swales, walking tracks, roads and pathways.(8.1) • Turfed areas should be monitored for the presence of any weed species and removed when first sighted.(7.1) • The native plants on campus should not require any permanent irrigation, however, in times of drought, stressed plants should be watered to maintain their health and aesthetic appeal.(6.1.3.1) • No known environmental weeds should be planted in this zone, to prevent their spread into other areas of the campus. • All Feather Grass (Pennisetum sp.) must be removed from ornamental garden beds and follow up control conducted (7.3.2)

ZONE 3 *Greywater Treatment Wetland Systems.* These systems require access for operational activities. Ideally they should blend into the landscape and this will require judicious establishment of vegetation around the margins of this zone	• An informal tour and information session should be conducted at the beginning of each new University year for those students living in the cottages to educate them about the nature of the campus and the greywater treatment system. This will aid in the wise use of the facilities. (5.3) • Regular mowing/slashing should occur in areas around treatment ponds to control weed seeds from entering ponds and reduce the possibility of snakes. (7.1, 9.2) • Some thinning around the residential treatment wetland system to increase sunlight and evaporation should occur. • Chemical sprays must not be used in close proximity to ponds. (9.2) • Weed species in the ponds should be removed by hand pulling or using a trowel. (9.2) • Clippings from ponds should be composted. (6.1.4.1) • No stormwater run-off from construction sites, carparks or any disturbed land should be directed towards ponds. (9.2) • No stockpiles should be placed in close proximity to treatment ponds. (8.7) • Refuelling must not occur in close proximity to treatment ponds to avoid chances of spill. Refuel only in a designated area.(8.8) • See 'operation and maintenance' document for maintenance requirements (Appendix 8 of EMP).
ZONE 4 *Area of vegetation in south eastern section of campus behind State Forests building.* The primary management objective for this zone is to control weeds and replace them with a mix of native understorey species, in order to improve structural complexity and biodiversity of the vegetation in this area.	• A long-term control program must be instigated to control the spread of St John's Wort. (7.2.2) • The invasion of Cootamundra Wattle should be tackled by: preventing its further spread, planting a mix of indigenous understorey species and removing the weed once these plants are established. Follow up control may be required as soil will have a substantial seed bank.(7.3.1) • Some thinning should occur along with additional planting of understorey species to aid in increasing the structural complexity of the vegetation and improve habitat value. Consultation should occur with appropriate staff members of Herbarium or SEIS. (6.1.3) • Control of existing weed infestations in this area must be undertaken to prevent spread into 'clean' areas on campus. Any new weed species must be removed when first noticed to prevent an infestation occurring. (7.1)
ZONE 5 *Vegetation around residential greywater treatment ponds* The principal objective should be to undertake some judicious thinning to improve structural complexity. This should be complemented with a program of improving the understorey diversity.	• Thinning the vegetation and planting a mix of understorey species should take place to enhance structural complexity and improve habitat value. Consultation should occur with appropriate staff members of the Herbarium or SEIS. (6.1.3) • Once understorey species are established, Cootamundra Wattle should be removed. Follow up control will be required as soil will have a substantial seed bank.(7.3.1) • Control of existing weed infestations in this area must occur to prevent spread into 'clean' areas on campus. Any new weed species must be removed when first noticed to prevent an infestation occurring. (7.1,7.2)
ZONE 6 *Hilltop area including turkey nest dams* This prominent zone provides an ideal opportunity to highlight research activities directed to ultimate improvement of biodiversity and ecological sustainability of the whole campus.	• A trial introduction of selected native animals that would replace the need to slash this grassy area should be conducted. Plans to give effect to this are being formulated in the School of Environmental and Information Sciences. (4). This trial will require that the current fence line be extended as far as possible to encompass the majority of the hill top area and the fence increased in height. The optimum carrying capacity will need to be determined and ongoing management will require active monitoring of this which may lead to some reduction in numbers by culling or giving away some animals.
ZONE 7 *Small area located in the eastern section of campus adjacent to Old Sydney Road* The purpose of this zone is to provide a designated area for burial of material from the composting toilets.	• Compost material should be deeply buried to decrease availability of nutrients to weed species that favour such conditions. • The area should be monitored for weed infestations and control undertaken as necessary.

5. WISE USE OF BUILDINGS

The buildings on the Thurgoona campus are unusual in their environmentally sensitive development and design. For the buildings to operate efficiently and effectively the occupants must have an understanding of their design, and an understanding of how each individual can contribute to using and occupying the buildings wisely. Accordingly, education and training programs should be developed to inform staff and students about the sensitive nature of the campus and to encourage the wise use of its facilities (Table 2).

Open discussion sessions should be held for new staff and students to enable them to gain a thorough understanding of the buildings and facilities, including the wetlands and water management systems, and reinforce the overall objectives and principles of the campus.

SEIS office building with Lecture Theatre Complex in background

Lecture Theatre Complex

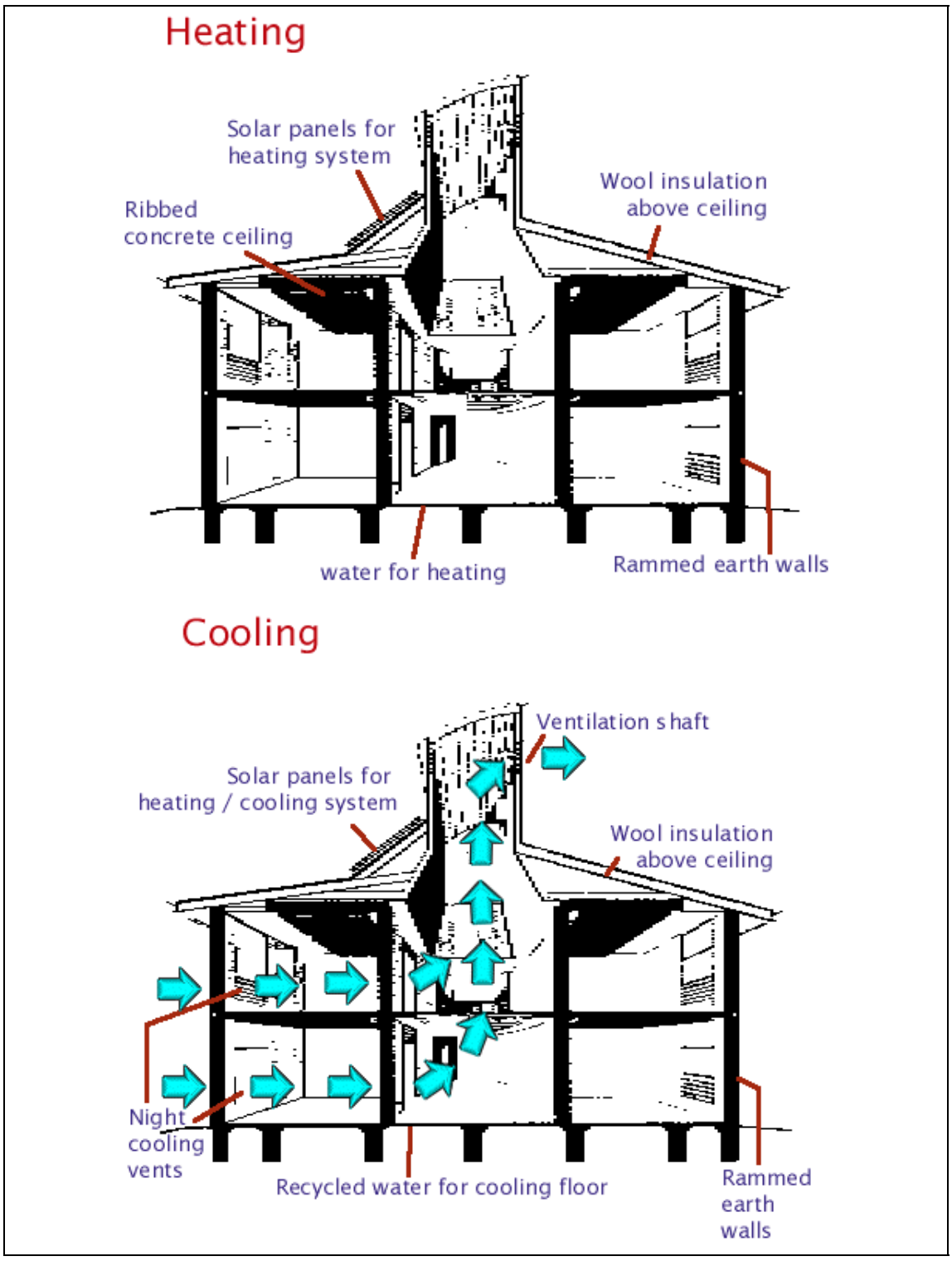
5.1 BUILDING DESIGN

Rammed earth was chosen for the wall construction due to its thermal characteristics and sound environmental qualities. A high level of insulation, natural ventilation and optimisation of windows for heat loss/gain are additional features used to stabilise internal conditions (Webster-Mannison 1998). Low energy systems are used to heat and cool the buildings. In winter, water is heated as it passes through solar collectors on the roof and stored in tanks, this water is then circulated through the floor and ceilings, heating the buildings as warmth rises.

During summer months the solar collectors work in reverse, the water is passed through the collectors at night to dissipate the heat. Night cooling during warmer weather is further aided through automatic operation of louvres below the windows and high level louvres in the thermal chimneys (Webster-Mannison 2000). When outside temperatures drop below those within the buildings, the louvres open automatically, allowing hot air to leave through the thermal chimney and be replaced by cool air entering through the low level louvres. (Figure 2.)

Internal lighting has been designed to optimise use of natural light and reduce dependence on artificial lighting. Recycled materials have been used wherever possible. The use of non-toxic materials such as timber treatments, non-toxic paints, natural fibre carpets and the avoidance of materials that emanate off-vapours that could have an adverse effect on human health, contribute towards a healthy building environment. Procedures for managing the environmentally sensitive buildings on campus are laid out in Table 3.

FIGURE 2. Environmental Design of Office Buildings



5.2 GUIDELINES FOR OCCUPANTS TO MAXIMISE EFFICIENCY OF ENVIRONMENTALLY FRIENDLY ASPECTS OF BUILDINGS.

- Louvres above each internal door should normally be open to allow for effective air circulation. This is essential in summer to assist with night cooling.
- During warmer months, obstructions to airflow through the louvres below external windows must be removed to allow for effective operation.
- All doors and windows leading to the outside should normally be kept closed to maintain warmth/coolness in the buildings (Croft *et al.* 1999). Periods during which windows are open should be kept short, or the room concerned should be isolated by closing the door and internal louvres.
- Overhead fans have been installed featuring two settings: winter and summer. The winter setting aids in drawing air up and circulating the warmth rising from the floor heating. In summer, the fan operates in reverse to direct air downwards cooling the occupant. The fan should be used in preference to opening windows, especially on hot days.
- Maximise use of natural light. Upon entering an office, blinds should be opened to allow in natural light and therefore, on many occasions, reducing the need for artificial lighting.
- Minimise energy consumption. When leaving the office for extended periods of time turn off computer and lights.
- Lights in corridors should only be switched on when required.
- Any office equipment that is not in use but which must be left on overnight should be on an energy saving setting (eg. photocopiers.).
- It is important for both staff and students to be very careful of what they put down the sinks and basins and to exercise similar caution about the cleaning products or any other chemicals (eg. hair dye) used in showers or laundries. Each individual should be aware that all wastewater is treated on campus and recycled wherever possible. None enters the city council sewer mains. Section 9 describes the water management system on campus.
- Readily compostable food scraps should be placed into a compost bin provided in each kitchen. These should have a lid to avoid attracting rodents. Compost can be disposed of into composting toilets or compost bins provided in the permaculture garden. (Compostable material being disposed of into the toilets should not contain tea bags, citrus peel or coffee grounds).
- Environmentally friendly cleaning products should be given purchasing preference.
- The use of chemical cleaning products should be minimised wherever possible.
- A notice listing these guidelines should be placed in each office/room for the attention of the occupant. Appendix 2

5.3 RESIDENTIAL COTTAGES

"Welcome to the Rothwell's"(Mitchell 2000) is an introductory document purposefully developed for occupants of the cottages, providing more detail concerning design features and wise use of those buildings (Appendix 3). It is recommended that:

- "Welcome to the Rothwell's" continue to be handed out to all new students residing in the cottages.
- The document should be periodically reviewed and updated.
- As part of the education and training program recommended in the introduction to section 5 and outlined in Table 2, an informal tour and information session should be conducted at the beginning of each new University year by an appropriate individual. The session should aim to provide an introduction to the unique design and development of the University, educate new students about the cottages and in particular the greywater management system operating on campus. An understanding of the design features will aid in wise use of the facilities. A further session/sessions should be held about one month afterwards to discuss the experiences of the residents and to deal with any questions and suggestions.
- The University should supply the cottages with environmentally friendly cleaning and laundry products to minimise toxic chemicals being placed down drains and entering into greywater treatment wetlands.

5.4 WASTE MINIMISATION

Waste can be minimised through making a purchasing policy that favours recycled or recyclable products, reusing or recycling on site and using improved technology.

The University has been very pro-active in sourcing recycled materials for use in construction of the Thurgoona campus buildings. A continuation of this environmentally conscious purchasing decision should flow on to encompass all aspects of the University's operation and management. The University should actively seek out opportunities to reduce waste, this includes waste generated on campus and in the wider Albury-Wodonga region, ie through purchasing recycled products from local business. Procedures for waste management are laid out in Table 4.

Hierarchy of waste minimisation principles (Joy1990, Healey 1999):

1. Waste avoidance and/or reduction
2. Reuse
3. Recycling
4. Disposal

- An environmentally conscious purchasing policy that encompasses all sections of the University should be developed.

- Recycled paper products should be given purchasing preference. Photocopy paper, notepads, toilet paper and paper towels are examples of everyday products that are possible to be purchased made from recycled material.

- Preference should be given to materials without packaging or in reusable or recyclable packaging or containers.

- Unnecessary packaging should be eliminated from materials/information distributed by the University.

- Every office/room must have a paper recycling bin in addition to a refuse bin.

- Where it is necessary for recycling bins to be lined with a plastic garbage bag, for easy removal by cleaning staff, only the contents of the bag should be emptied into a recycling bin. The plastic bag should not be placed in the recycling bin but reused to line the bin, unless too soiled to do so.

- The efficient use of paper is very much in the hands of staff and students. Paper should be used on both sides before being placed in the recycling bin. Draft copies can be printed on the back of already used paper.

- A printer that can perform double-sided printing should be purchased or made available in each section/department of the University. The double-sided printing function should be set as default for all computers.

- Envelopes should be opened carefully so that they can be re-used (Lord 1990).

- Office paper usage should be minimised by choosing to email memos and letters rather than distributing in paper form (Gell and Beeby 1989).

Minimising the use of paper products is not the only area on campus that waste minimisation can be implemented. Being aware of water usage and potential savings of this and other resources, both environmentally and economically, is also an important element.

- Taps should not be left running unnecessarily.

- Dripping taps and water leaks should be reported and fixed immediately. If left unreported litres of water can be wasted each week (Croft *et al.* 1999).

5.5 RECYCLABLE MATERIALS

- To ensure only authorised materials are placed in recycling bins a list of recyclable materials should be placed on or above appropriate recycling bins.

Authorised materials that can be placed into the yellow lid recycling bins for collection by the local council (Cleanaway 2000) are as follows:

- Magazines and newspapers,
- Paper and cardboard, including items such as telephone books and boxes (not waxed),
- Rinsed milk and juice cartons,
- Rinsed plastic containers and bottles with a recycle symbol, no lids if possible,
- All clean/rinsed green, clear and amber glass bottles and jars only, no lids if possible, and
- Rinsed aluminium and tin cans.

The recycling bins collected by the Albury City Council are taken to a recycling plant where the items are hand sorted. To make the sorting job easier and safer Ecorecycle (2000) provide a checklist for recycling:

- Yes to all material above, as these are authorised by the local recycling contractor.
- No plastic wrap or plastic bags
- No ceramic cups and plates, tiles, mirrors, window glass or light globes,
- No food stuffs, batteries, nappies or general rubbish,
- No waxed cardboard.
- No paints, chemicals or oils.

TABLE 2. MANAGEMENT PROCEDURES FOR INFORMATION AND TRAINING SESSIONS

TIME	NEW RESIDENTIAL STUDENTS	NEW NON-RESIDENTIAL STUDENTS	NEW STAFF	TEMPOARY/ PART TIME STAFF	CASUAL STAFF	INVITED AND CASUAL VISITORS	MAINTENANCE STAFF
Situational			Conduct information session and tour as appropriate.	Conduct information session and tour as appropriate.	Conduct information session and tour as appropriate.	Conduct information session and tour as appropriate.	Conduct information session and tour as appropriate.
January							
February	Conduct information session and tour and hand out “Welcome to Rothwell’s” document	Conduct information session and tour					
March							
April	Questions and suggestions session						
May							
June							
July							
August							
September							
October							
November							
December							

TABLE 3. MANAGEMENT PROCEDURES FOR BUILDINGS

TIME	COMPOSTING TOILETS	HEATING/COOLING SYSTEM	ROOM INFORMATION AND FACILITIES	WOODEN COMPONENTS
Situational	**Maintenance** • Investigate all problems as they occur. • Remove and bury composted material as required. • Bury composted material in designated zone. See management zone map.	**Maintenance** • Investigate problems/malfunctions as they occur.	Each room should have: • Occupant guidelines • Refuse and recycling bin • "Campus charter" – principles for attainment of environmental sustainability	
January				
February				
March				Oil exposed wood surfaces
April		Switch building operation mode to winter setting, when appropriate.		
May				
June				
July				
August				
September				
October		• Switch building operation mode to summer setting • Remove all obstacles blocking louvres		
November				
December				

TABLE 4. PROCEDURES FOR WASTE MANAGEMENT

TIME	RECYCLING	WASTE MINIMISATION	GARBAGE DISPOSAL	ORGANIC WASTE
Situational	**Purchasing** • All goods and service contracts should include environmentally sensitive specifications. • Recycled paper products should be given purchasing preference. • Preference should be given to materials without packaging or in reusable or recyclable packaging or containers. • Printing equipment that can print double sided should be purchased or made available to each department. Double-sided printing should be set as the default option for all computers **New Buildings** • Every office/room should have a paper recycling bin in addition to a refuse bin. **Maintenance** • Only the recyclable contents of the bin liner should be emptied and bag reused. Do not place plastic bag in the recycling bin. **Overall** • Paper should be used on both sides before being placed in the recycling bin. • Envelopes should be reused. • Email should be used in preference over paper. • Printing should only occur when necessary.	**Maintenance** • Dripping taps and water leaks should be reported and fixed immediately. **Overall** • Taps should not be left running unnecessarily.	**Overall** • Place only authorised materials in yellow lid recycling bins. **Authorised Items:** - Magazines and newspapers, - Paper and cardboard, including items such as telephone books and boxes (not waxed), - Rinsed milk and juice cartons, - Rinsed plastic containers and bottles with a recycle symbol, no lids if possible, - All cleaned green, clear and amber glass bottles and jars only, no lids if possible, and - Cleaned aluminium and tin cans. **Non-Authorised:** - No plastic wrap or plastic bags - No ceramic cups and plates, tiles, mirrors, window glass or light globes, - No food stuffs, batteries, nappies or general rubbish, - No waxed cardboard. - No paints, chemicals or oils.	**Maintenance** • Where appropriate fallen branches and ground litter should be left where they fall and not gathered into tidy piles. • Create habitat by placing fallen/pruned branches and limbs around campus in suitable locations. • Mulch/chip plant matter on site for use on grounds and/or use suitable limbs and branches as borders for garden beds. • Compost smaller green waste items and kitchen food scraps. • Remove composted material from composting toilets as required. • Bury material from composting toilets only in designated zone.
January	Develop Purchasing Policy			
February	Prepare/Review Action Plans	Prepare/Review Action Plans	Prepare/Review Action Plans	Prepare/Review Action Plans
March				
April				
May				
June				
July	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.
August				
September				
October				
November				
December				

6. FLORA AND FAUNA

A flora and fauna survey of the new Thurgoona campus was undertaken in January 1996 prior to construction commencing. King and Asmus (1996) divided the study area into 5 vegetation types based on plots planted by the Albury-Wodonga Development Corporation in 1977, 1978 and 1983. No rare or threatened plant species were detected. However, *Amphibromus fluitans* has since been recorded on the mud flats above the first reservoir. A total of 39 bird species and 592 individuals were recorded over the four-day survey with two significant species detected.

The Painted Honeyeater (*Grantiella picta*), listed as vulnerable under the *Threatened Species Conservation Act 1995 (NSW)*, was recorded three times in the vegetation plot in the south west of the campus. Another significant recording was that of the Latham's Snipe (*Gallinago hardwickii*), this migratory species is listed under two agreements, Japan-Australia Migratory Birds Agreement (1987) and China-Australia Migratory Birds Agreement (1987). The birds listed under these agreements are deemed to be a matter of 'national environmental significance' under the *Environment Protection and Biodiversity Act 1999 (ACT)* (Environment Australia 2001).

King and Asmus (1996) noted that there were limitations to the survey: it was conducted in mid summer, with the average daily temperature exceeding 30º, and only for a short time period, 4 days and 3 nights. Consequently, the survey was limited in its ability to detect rare, endangered or threatened flora and fauna that potentially may require special or additional management practices.

Fauna species known to occur in the local region may use the campus grounds as part of a larger foraging range. Similarly, plant species occurring nearby may potentially germinate in the campus grounds as seed may be spread via animals and wind.

A list of threatened rare and endangered flora and fauna species known to occur in the local region that may potentially inhabit the campus are provided (see Appendix 4.). Further flora and fauna surveys should be conducted at different times of the year on a regular basis, possibly as part of a teaching course.

6.1 DEVELOPMENT AND MANAGEMENT OF VEGETATION

Procedures for managing the vegetation on campus are set out in Table 6.

6.1.1 General Principles

The landscaping of the campus emphasises low maintenance and low water use through predominant planting of native species. An exception to this is the proposed phytogeographic pedestrian spine interconnecting the distinct precincts of the University, which may require a higher level of maintenance.

- The native plants on campus should not require permanent irrigation. However, the health of native plants should be monitored. In times of drought, stressed individuals should be watered, particularly plants in high usage areas to maintain aesthetic appeal. Any endangered species planted as part of future landscaping, should also be watered in times of drought.

- Watering of the campus grounds and garden beds should be done preferably in early mornings or late evenings when evaporation is low.

- Watering of the grassed areas surrounding the buildings should only be undertaken when necessary. *Paspalum distichum* cultivar *dryana* is an Australian native and chosen by the University for it's low maintenance and drought tolerant features.

- The application of fertiliser is not necessary for any native plant species on the campus. The only area that may require this is the phytogeographic arboretum.

- Vegetation that has fallen, eg. branches and limbs, should either be left where it falls, if appropriate, or relocated to an appropriate area (Figure 1). Fallen branches and ground litter are valuable habitat for a range of fauna. In certain designated "natural" areas, such litter should be left and not gathered in tidy piles.

- An annual check of all vegetation on the campus grounds should be undertaken to identify any potential problems and health and safety issues that may arise. As an example, trees in the car park areas should be checked for any dead or dying limbs and branches that may be considered a potential hazard. Any potential hazards should be reported to the campus Occupational Health and Safety Committee for their assessment of risk. Where necessary, those in high usage areas (Figure 1) should be removed following consultation with appropriate personnel in the School of Environmental Sciences, since some of these tree limbs may have an important habitat and educational value. It is recommended that a checklist and recording sheet be developed so as to provide a record of the annual vegetation monitoring program.

6.1.2 Minimising Damage To Existing Flora

It is inevitable that some vegetation may need to be removed as the development of the campus proceeds. However, as much vegetation as possible should be retained to aid in minimising erosion and movement of sediment. Vegetation should only be removed where absolutely necessary. To safeguard against damage to vegetation in the form of breakage of branches and soil compaction, the following measures should be taken:

- Any vegetation to be retained in or around a construction site, including trees, shrubs and grasses, should be protected by a suitable barrier taking into account areas of root zone to minimise soil compaction of these sensitive areas (Albury City Council n.d). No vehicles should be parked in these areas.

- Any machinery to be left on site should be parked in designated areas. Parking areas for heavy machinery and work vehicles should be chosen so as to not disturb or compact soil, particularly under any trees. Soil compaction can affect the long-term health of plants.

- Defined roads should be formed where vehicles are frequently driven.

- University vehicle movements around the campus should avoid damaging existing vegetation, vehicles should keep to defined roads and tracks and minimise the creation of new tracks.

- Any vehicles parking in undesignated areas and causing damage to vegetation should be required to park elsewhere. Temporary fences and signs may need to be erected.

- Pedestrian traffic should be directed around vegetated areas to reduce soil compaction. Where pedestrians have created short cuts, across garden beds for example, pathways should be created or barriers erected to prevent soil erosion and compaction.

6.1.3 Landscaping Program

Initial landscaping plans for the campus included a Murray Valley arboretum designed as a teaching resource consisting of species from successive ecological regions through which the Murray River flows (Webster-Mannison 1998). The arboretum was planned to be situated along the different drainage lines of the campus grounds. Further examination of this plan by staff of the herbarium and SEIS concluded that many of the plant species would struggle with the climatic conditions outside of their ecological range. An alternative landscaping plan has been developed (Appendix 5).

The phytogeographic arboretum outlined earlier will be an important aesthetic and educational feature of the campus landscape. It will consist of ecologically similar plant species grouped according to the regions of the world from which they originate and will be located along the pedestrian spine connecting the distinct precincts of the University. This pedestrian spine is a focal feature between buildings and provides an aesthetically pleasing walkway.

One section of this arboretum has already been planted in the SEIS precinct. Further landscaping and planting of the arboretum will occur as the campus develops further. Although the plants chosen are from areas of the world with similar climatic conditions, additional watering and mulching may be required to keep the plants healthy and growing vigorously.

A permaculture garden has already been established on the western side of the student residences and to the north of the "student pavilion". Effective ongoing management of the garden requires enthusiastic participation from students (who initially pressed strongly for its establishment). However, during vacations and periods when enthusiasm for gardening is low such as during examination periods it will be necessary for University garden staff to provide a minimum level of necessary maintenance. As students in the residences are in closest proximity and stand to benefit the most from the garden it is highly desirable that they have a primary role in managing the garden while they are living in the residences.

For future landscaping the following guidelines are recommended:

- Implementation of the landscaping/planting plan prepared by Herbarium staff. The plan includes detailed lists of species, locations in which to plant and planting density (Appendix 5).

- The use of native grass species in lawn areas, as done around the SEIS buildings, should be continued.

- Weed control should be undertaken prior to planting to reduce competition for resources. Follow up weed control may be necessary.

- A variety of species that are native and indigenous to the area should be planted, as listed in landscaping plan. These species should be planted in an ecologically sensible combination of trees, shrubs, herbs and grasses to provide a range of different habitats in an aesthetically pleasing landscape. The plants required for this should be of local provenance and sourced from local native nurseries. An excellent reference guide for local plant information is:

    - Stelling, F (1998) *South West Slopes Revegetation Guide*. Murray Catchment Management Committee and Department of Land and Water Conservation, Albury.

- Every attempt should be made to create a natural appearance when planting trees and shrubs by planting them in clumps rather than evenly spacing them. Planting in straight lines should not occur, though in some areas line ripping may need to take place for larger scale plantings. In these situations, the ripping line should curve as much as possible and plants should not be evenly spaced.

- Planting should be carefully carried out so as to ensure healthy vigorous growth of plants, using appropriate soil preparation and watering upon completion of planting.

- Recently planted vegetation should be monitored to ensure they are healthy and growing vigorously. Young plants should be watered occasionally in dry periods to maintain their health.

- Any plants that die or are vandalised should be replaced.

- Mulch will be beneficial to young plants to aid in survival and weed control, reduce evaporation and improve soil condition (Clayton 1994).

- Mulch should be kept clear of plant stems to avoid collar rot.

6.1.3.1 Wetland Landscaping

Australia's wetland areas have suffered considerably since European settlement, many have been lost due to water diversion upstream, damming and irrigation (Kingsford *et al*. (1997). This disturbance has resulted in a huge loss of habitat. The reservoirs in the northern section of the campus have the potential to become significant wetland habitat for many species, increasing biodiversity both on the campus and in the local region.

- The wetland landscaping plan prepared by staff of the herbarium and SEIS (Appendix 5) should be implemented as soon as possible. The plan provides a species list and description of planting densities and zones to achieve a stable wetland and provide a mix of both vegetated and open areas to create a valuable habitat and aesthetically pleasing landscape.

- A bird hide should be built for teaching purposes. A large number of bird species have already been sighted on campus, particularly in the wetland area. University staff and students with expertise in wildlife ecology and management should be consulted in order to plan the location of the hide and travel routes to it.

Wetland Habitat

6.1.4 Removal Of Vegetation

- A campus wide risk analysis should be undertaken to divide the campus into zones of different occupational risk, according to usage. This will provide the basis for a strategic framework for vegetation development and management. Guidelines for removal of hazardous vegetation should then be developed for each zone.

- Consultation should occur with an appropriate staff member from the SEIS, including a check for any fauna inhabiting the vegetation, prior to removal or lopping of any mature trees.

- Mature trees with hollows are a rare resource on the campus, and every effort should be made to avoid their removal (whether dead or alive). Planting prickly indigenous plants underneath those trees deemed a risk can be used as a means to keep people away.

- Any vegetation that may require removal should either be mulched on site for use on the campus grounds, or relocated to appropriate areas on campus to provide potential habitat and increase biodiversity (Figure 1). Any vegetation that must be removed should be done carefully to avoid damage to neighbouring plants.

- Trees and shrubs that have been removed should be replaced with indigenous species in suitable locations.

- Wherever possible green waste material should be composted and the end product used on the campus grounds.

At present the University has no facilities for composting green waste or mulching larger items. All green waste on the campus is stockpiled for removal to the Albury Garbage Depot (Hume,I. 2001 March 30, pers com.). As future development takes place it is inevitably that some existing vegetation, typically trees, will need to be removed. The University has three options to deal with this type of larger green waste. Table 5 shows advantages and disadvantages of each option.

Options B and C are preferable and recommended over option A. Green waste should be seen as a valuable resource and keeping it on campus is consistent with the campus principles for environmentally sensitive design, development and management.

6.1.4.1 Composting Green Waste

Smaller amounts of green waste, such as clippings from the greywater treatment ponds and general garden maintenance, should be composted if possible. Compost is an excellent soil conditioner as it not only improves the structure of the soil but will also hold water and nutrients where they are most needed; the roots of the plants (Bewick 1980). The addition of valuable nutrients to the soil via compost greatly diminishes the need for application of commercial fertilisers, saving money and reducing nutrient loading on the catchment. Reusing green waste is consistent with the principles for development of the campus.

Compost should not be added to areas identified for rehabilitation of woodland understorey, as exotic weed species will utilise added nutrients at the expense of native species. Ideally, all compost should be spread in areas with developed horticultural plantings.

The student permaculture garden is an ideal location for compost bins. In addition to green waste from the campus grounds, students living in the residences can provide kitchen scraps for composting.

Commercial composting bins, which are very low in maintenance requiring only the occasional turn of the composting matter, can be purchased from local hardware stores or nurseries. It is recommended that the compost bins have vents small enough for aeration but not for access by rodents. Compost bins are available on stands making it easy to roll the bin and turn the compost. It is important that the bin has a cover to keep water out and heat in however if the compost is too dry it should be sprinkled with water. Problems will occur if the compost is too wet (Gell and Beeby 1989).

Most kitchen waste and garden waste can be composted, ie fruit and vegetable scraps, egg shells, tea bags, grass clippings, leaves, bark and flowers. Even items such as vacuum cleaner dust, torn up newspaper and hair are suitable materials for composting (Healey 1999).

Avoid adding weed species heavily laden with seeds as some seeds may survive the heat in the compost pile (Starbuck 1998). Not adding weed seeds to the compost will aid in reducing the spread of weed species around the campus grounds.

TABLE 5. OPTIONS FOR DEALING WITH LARGE GREEN WASTE ITEMS

(For example: trees and fallen branches.)

OPTIONS	ADVANTAGES	DISADVANTAGES
A) Stockpile green waste for removal to Albury tip.	• Staff time saving by not reusing material on campus.	• Adds to regions waste problem. • Removes valuable resource from campus. • Time and energy of University staff to transport waste to garbage depot
	COMMENTS This option removes a valuable resource from the campus and adds to the region's waste problem. Although green waste is mulched at the Albury Garbage Depot it stays on their site and the mulched material is not reused outside the depot. The time and energy of University staff in transporting the vegetation to the stockpile and then onto the garbage depot is considerable. This time and energy could be used to keep the vegetation resource on campus.	
B) Mulch/chip plant matter on site for use on grounds and/or use suitable limbs and branches as borders for garden beds.	• Cost saving by not buying mulch. • Keeps resource on campus. • Reusing material, consistent with campus principles. • Reduces amount of organic waste carted and removed from site.	• Hiring or buying mulcher/chipper • Staff time spent mulching/ cost of contractor to mulch material.
	COMMENTS: Option B will provide an economical saving to the University. Although there is the initial cost of either hiring or buying a mulching machine there will be considerable savings by not buying mulch. By stockpiling vegetation to be mulched, a mulcher can then be hired for only a short time, thereby reducing cost. Benefits of adding mulch to the garden beds include weed control, improved soil condition, reduced water evaporation and therefore less water consumption (Clayton 1994). Using suitable limbs and branches as borders for garden beds keeps the resource on campus and provides microhabitat for some fauna.	
C) Create habitat by placing branches and limbs around campus in suitable locations.	• Increases biodiversity on campus • Keeps resource on campus • Consistent with principles of campus	• Staff time relocating material (Note: this would occur even if material were to be transported to the green waste stockpile).
	COMMENTS: Option C will not require any machinery to be hired or purchased. The time and energy staff would have spent transporting plant matter to the green waste stockpile could be redirected to moving vegetation to suitable areas of the campus to increase habitat and biodiversity. (Figure 1). Logs should not be sawn into small lengths but kept as large and natural as possible.	

TABLE 6. PROCEDURES FOR MANAGEMENT OF VEGETATION

TIME	SLASHING	WEED CONTROL	PLANTING	MAINTENANCE	PRUNING/REMOVAL	WATERING
Situational	**Maintenance** • Clean slashing machinery when moving between weed infested areas and 'clean' area. **Contractors** • Slashing contractors to clean their equipment before coming onto the grounds to minimise the introduction of new weed species.	**Maintenance** • Upon detection of any new weed species prepare and implement control strategy. • When small numbers of weeds are first sighted in 'clean' areas, weed control should be conducted immediately to prevent further spread. • Remove weed species growing in native turf areas as soon as sighted. • Where appropriate, alternative methods of weed control should be given priority over herbicide. • Do not spray in close proximity to water bodies or wetlands. Do not spray native plants. • Limit movements of vehicles from infested areas to 'clean' areas. • Circulate illustrations of weeds likely to infest the campus among all site staff **Overall** • Where appropriate, conduct weed control in partnership with TAFE.	**Maintenance** • Plant indigenous species according to landscape plan. • Avoid planting in lines. • plant trees and shrubs in clumps, not evenly spaced. • Plant a mix of trees, shrubs herbs and grasses. • Use mulch to control weeds. • Replace any plants that die or are vandalised. • Control weeds until plants are established. • Water young plants during dry periods.	**Maintenance** • Fertiliser is not necessary for any native plants. **Overall** • Fallen branches and ground litter should be left where they fall, or relocate. Do not gather into tidy piles and/or remove.	**Maintenance** • Garden waste should be composted or mulched for use on the campus grounds. • Larger green waste items should be suitably located around the campus to increase biodiversity and habitat value. **Overall** • Any fallen vegetation should be left where it falls, where appropriate, or relocated. Do not tidy into piles or remove from the campus (Figure 1) • Only remove/ fell vegetation that is absolutely necessary. Consult with OH&S committee for their assessment of risk, and appropriate staff from SEIS or Herbarium for assessment of habitat and educational value • Prior to removal conduct check for fauna. Upon detection the animal(s) should be suitably relocated. • Any hollows that absolutely must be removed should be removed in tact, suitably relocated and secured to a mature tree. • Upon detection of native bird species nesting in vegetation to be removed, removal should be delayed until nesting is complete, wherever possible.	**Maintenance** • Water grounds and garden beds when evaporation is low (early mornings, late evenings.) • Young plants and stressed individuals should be watered occasionally during dry periods to maintain health
January		Prepare/review work plans and control strategy for weed species, particularly noxious weeds. (Paterson's Curse, St Johns Wort, and Blackberry	Prepare/review landscaping plan in consultation with appropriate SEIS and Herbarium staff.	Prepare/review work plans		
February		Conduct summer survey of weed species. Map and monitor movements.		Conduct annual health and safety check of vegetation		
March				Conduct any works arising from vegetation check.		
April						
May						
June						
July	• Submit budget. • Identify savings in cost and resources	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.	• Submit budget. • Identify savings in cost and resources.
August	Slash Paterson's Curse before it flowers to prevent setting seed.					
September	Conduct follow up slashing of Paterson's Curse	• Conduct spring survey of weed species. Map and monitor movements. • Evaluate weed control strategies.				
October						
November						
December						

6.2. MANAGEMENT OF NATIVE FAUNA

All native species are protected by legislation. Procedures for managing native fauna are laid out in Table 7.

- To aid in responsible management of the natural resources on the campus a comprehensive fauna survey is recommended every 2-5 years. This survey will be useful in monitoring and providing an indication of biodiversity on the campus.

- Students should be given the opportunity to assist with the survey to gain valuable field experience.

- Incidental sightings of fauna species should be recorded in an incident diary/Log Book kept in the SEIS staff room (Table 9).

- Nest boxes should be placed in appropriate areas on the campus to increase habitat value and provide breeding sites.

- A bird hide should be constructed for teaching purposes.

- The Wildlife Information Rescue Service (WIRES) should be contacted on 0427 493 716 and informed about any injured native fauna that is found on the campus.

6.2.1 Disturbance To Native Fauna

The most significant impact to the fauna on campus will be removal of their habitat. Vegetation should only be removed where absolutely necessary. As noted elsewhere in this document, consultation should occur with an appropriate member of staff from the School of Environmental Sciences or Herbarium prior to any lopping or removal of mature trees.

- Following consultation and prior to removal, a check should be undertaken to locate any fauna that may be inhabiting tree hollows. Upon detection of any fauna, a suitably qualified person should remove the animal. The hollow limb or section of trunk should be kept in tact, relocated and securely positioned in a suitable mature tree nearby. The animal should be released into the hollow.

- Removal of vegetation, in which native birds are found to be nesting, should normally be delayed until nesting is completed.

- If any rare, endangered or threatened fauna are found to be nesting or inhabiting the vegetation to be removed, the NSW National Parks and Wildlife Service should be notified.

- For any native birds found nesting on the ground in the vicinity of the work area, marker posts should be erected at a safe distance so that the nest can be visibly located to avoid disturbance.

The wetland areas on campus, especially in the vicinity of the reservoirs, provide valuable habitat to many species of bird life.

- Any works carried out in the vicinity of these areas needs to be conducted in a sensitive manner. Any native fauna nesting in the area should not be disturbed.

- Until the wetland areas in the northern section of the campus have been suitably landscaped to increase habitat value for fauna, a strip of pasture about 5 metres wide should not be slashed in some areas surrounding the reservoirs so as to provide nesting areas and protective cover.

6.3 AGISTMENT OF NON NATIVE ANIMALS

There are clear benefits to be gained from the current agistment of sheep, cattle and horses on those parts of the campus which have not been rehabilitated by plantings of native vegetation. Not only does the University earn money, it also saves money that would have to be spent on slashing pastures of non native grasses and weeds. Further benefits can be gained by judicious rotation of grazing to avoid damage to the growth of native plant species that may be naturally regenerating and a sensible policy to achieve this should be formulated.

However, as the campus is progressively planted with trees and shrubs that are native to the area, the agistment practices will need to be modified to complement the planting program.

TABLE 7. PROCEDURES FOR MANAGEMENT OF FAUNA

TIME	FAUNA	WATER FOWL	HABITAT	VERMIN CONTROL
Situational	**Overall** • Record incidental sightings of fauna in log book • Contact the Wildlife Information Rescue Service (WIRES) about any injured native fauna found on campus. **Maintenance** • Before any vegetation is removed (pruning, felling) conduct check for fauna that may be inhabiting resource. Upon detection the animal should be suitably relocated. If the animal is a rare, threatened or endangered species the NSW National Parks and Wildlife service should be notified • Upon detection of native bird species nesting in vegetation to be removed, such removal should be delayed until nesting is complete. • Marker posts should be erected at a safe distance around any native birds found nesting on the ground in the vicinity of a work site. • Native birds found nesting in vegetation in close proximity to a work site should not be disturbed and the area fenced off, until nesting is completed.	**Maintenance** • Any works conducted in the wetland areas of the campus should be conducted in a sensitive manner. Do not disturb nesting native waterfowl. • Areas in a strip of pasture 5m wide on the margins of the reservoirs that provide protective cover for waterfowl should not be disturbed until the wetland areas are suitably landscaped. **Construction** • Design and construct a bird hide suitable for teaching purposes. Consult with appropriate SEIS staff as to suitable location and access route.	**Maintenance** • Place nest boxes in appropriate locations around the campus grounds • Prior to removing any vegetation, a check should be undertaken to locate any fauna that may be inhabiting the resource, particularly tree hollows. • For any vegetation containing a hollow, that absolutely requires removal, the hollow section should be kept intact, relocated and securely positioned in a suitable mature tree nearby.	**Maintenance** • Preference should be given to environmentally sensitive control methods e.g. mouse traps instead of poison which may travel through the food chain. • Seek professional advice in developing pest control strategies for rabbits, foxes and hares. • Encourage local effort with neighbouring landholders when planning and implementing control strategies.
January				Prepare/review vermin control plan
February		Conduct maintenance check of bird hide.		
March				
April				
May				
June				
July				
August				
September	Conduct annual fauna survey.			
October				
November				
December				Evaluate vermin control plans

7. PEST PLANTS AND ANIMALS

7.1 WEED CONTROL

The Thurgoona campus is dominated by introduced pasture and weed species. While these may never be completely eliminated from the grounds, emphasis should be placed on controlling further spread and preventing new invasions from taking place (Table 6). Principles for weed control on the campus are:

- Where appropriate, alternative methods of weed control should be given priority over herbicide application. For example, hand pulling or using a trowel to remove small numbers and individual weeds. It is recognised that this approach is not practical for widespread weeds like Paterson's Curse.

- When using herbicide to control weed species it is important to be selective in its application. Care should be taken not to spray any native vegetation, damage animal habitats or contaminate soil or run-off.

- In situations where herbicides are necessary, use should be in strict accordance with the manufacturers instructions.

- Upon detection of any new weed species on the University property, particularly noxious and environmental weeds, a control strategy should be implemented to prevent further spread. See section 7.2 below.

- All weed species growing in the native turf areas surrounding the buildings should be removed as soon as possible to prevent weeds from out-competing and invading these native grass areas.

- Vehicles and machinery can increase the spread of existing weed species around the campus grounds. Limit movement of vehicles from infested areas to 'clean' areas on campus, especially during times of flowering. Where appropriate, vehicles and machinery should be limited to existing roads and tracks.

- The University should require all mowing/slashing contractors to clean their machinery before coming onto the University grounds to minimise the introduction of new weed species.

- An annual survey of weed species should be undertaken to monitor movements and to note any new infestations requiring control.

- No environmental weed species should be used in landscaped garden areas.

7.2 STRATEGY FOR CONTROL OF NOXIOUS WEED SPECIES.

Under the *NSW Noxious Weeds Act 1993* landowners have the responsibility to control noxious weeds on their land. Four noxious weed species are known to occur on the campus grounds,

- Paterson's Curse (*Echium plantagineum*),
- St Johns Wort (*Hypericum perforatum*),
- Blackberry (*Rubus fruticosus*),
- African Lovegrass (*Eragrostis curvala*).

A strategy for control of noxious weed species is outlined below. Other likely invaders are:

- Lippia spp
- Serrated Tussock (*Nassella trichotoma*)
- Chilean Needle Grass (*Nassella nessiana*)
- African Boxthorn (*Lycium ferocissimum*)

Clear illustrations of these plants should be circulated to all site staff.

- Priority should be given to preventing the spread of noxious weed species into 'clean' areas on campus.

- When first sighted in 'clean' areas, individual plants or small clumps should be hand removed using a trowel to include the root system. Spot spraying may be more appropriate for larger clumps that occur. It is important to keep on top of these new invasions to control further spread.

- Mowers and slashers that have operated in weedy areas should be cleaned to remove weed seeds before allowing machinery to operate in 'clean' areas on campus.

- Minimise vehicle movements around campus grounds, in particular from weedy areas to 'clean ' areas, especially when species are in flower.

7.2.1 Paterson's Curse (*Echium plantagineum*)

Paterson's Curse may never be fully eradicated from the campus grounds, particularly in areas where it has dominated and persisted for many years. However, a long-term control program will be necessary to comply with the *NSW Noxious Weeds Act 1993*. To avoid spraying herbicide over a large area of the campus in which paterson's curse is present, slashing is recommended as an alternative environmentally sensitive means of control.

- Slashing should occur when the Paterson's Curse plants first send up their flower stalks and begin to flower in late winter/ early spring. Slashing in this early stage of flowering will aid in preventing the plant from setting seed. Slashing will need to be undertaken a few times during the flowering season as plants will keep trying to flower and set seed.

A large quantity of Paterson's Curse seeds will be present in the soil on campus. It may take many years before this source is reduced. Seeds may lay dormant in the soil for at least five to ten years(Parsons & Cuthbertson 1992). A control program of slashing will reduce additions of seeds to the seed bank in the soil. By minimising soil disturbance, future establishment will be minimised.

Paterson's Curse is best controlled by promoting competitive grass species which will prevent growth and development of this weed. A long-term strategy of promoting native grass species across the campus will help control this noxious species. As soil disturbance is reduced and a good litter layer is developed, Patterson's Curse will often disappear (though still in the seed bank.) It is a pioneer species and needs bare ground. Biological control organisms are available and should be investigated as a means of an integrated control method as it is not successful on its own.

7.2.2 St Johns Wort (*Hypericum perforatum*)

Patches of St Johns Wort persist in the south-eastern section of the campus in close proximity to the State Forests building and in the south western planted forest area. A survey of the campus grounds, as recommended earlier, will locate other infestations of this weed that will need to be controlled. It is possible for eradication of this species to be achieved within a few years if a conscious effort is made. Priority should be given to preventing further spread (see above guidelines).

As the patches of the weed occur in a well-treed area, slashing may be difficult. Spot spraying at flowering will be essential and can be very effective. There may also be a large seed source in the soil as with Patterson's Curse. A long-term control program is necessary with the priority of preventing the spread of the species to 'clean areas' by removal of any new individuals as soon as sighted.

7.2.3 Blackberry (*Rubus fruticosus*)

Blackberry occurs in the northern section of the campus and in the south western corner behind the student accommodation. Blackberry is a very invasive plant, easily spread by birds and animals that eat the berries and can provide an ideal harbour for pest species. The seed can also be spread a considerable distance by creeks (Parsons and Cuthbertson 1992). It is most important that further infestations of this plant be prevented, particularly near the reservoirs and Six-Mile Creek, from where it may spread into areas outside the campus. A long-term control program should be initiated with the aim of eliminating this very undesirable species from the campus. The plant can be removed using a mattock to remove the crown. For larger clumps it may more desirable and practical to apply herbicide. A biological control known as 'rust' is available but at best will only defoliate the plant.

7.2.4 African Lovegrass (*Eragrostis curvala*)

African Lovegrass has been sighted on the western side of the campus south of the lecture theatre and along the adjacent roadside. Repeatedly mowing the grass may reduce the spread of seed. Herbicide will give total control but it is important to plant out the area, as soon as practicable, with native indigenous species to provide a good vegetation cover to reduce competition.

7.3 STRATEGY FOR CONTROL OF ENVIRONMENTAL WEED SPECIES

An environmental weed is a plant that is deemed to be in some way deleterious to the environment. Environmental weed species that invade the campus will have a negative effect on rehabilitation of the grounds. Environmental weeds that may potentially invade the campus include but are not limited to:

- Bridal Creeper (*Myrsiphllum asparagoides)*
- Genista (*Genista monspessulana*)
- Cotoneaster (*Cotoneaster sp*)
- Broad leaf Privet (*Ligustrum lucidum*)
- Small leaf Privet (*Ligustrum sinese*)
- Tagasaste (*Cytisus palmensis*)
- Hawthorn (*Ctrataegus sp*)

Clear illustrations of these plants should be circulated to all site staff.

7.3.1 Cootamundra Wattle (*Acacia baileyana*)

Cootamundra Wattle is not classed as noxious but is considered to be a serious environmental weed. Although an Australian native, it does not naturally occur in the Albury-Wodonga region. This species was planted 20 years previous by the Albury Wodonga Development Corporation in the south-eastern and south western sections of the campus. Since that time it has reproduced and increased in number.

It is recommended that over time it be replaced with endemic wattle species. As the Cootamundra Wattle may have some habitat value, replacement plantings should occur, be allowed to establish and then the weed removed. As the soil will have a large seed bank long term control will be required. Young individuals can be hand pulled. Larger individuals should be cut and poisoned. Priority should be given to preventing the spread of this species into 'clean' areas on campus.

7.3.2 Feather Grass (Pennisetum sp.)

Feather grass has been widely planted in the ornamental plantings, particularly around the SEIS buildings and the western roadside entrance. Many species of the Pennisetum genus are declared noxious as well as being noted as environmental weeds. This species has already demonstrated its ability to spread into the nearby lawns and should be removed as soon as possible from all garden areas. No more plantings should be undertaken. Germination of seedlings will need to be carefully monitored.

7.4 AQUATIC WEEDS

Reservoirs and other water bodies should be closely monitored to check for any invasion of aquatic weeds. There is the potential for any aquatic weeds in the reservoirs to spread into Six Mile Creek during overflow events. Any occurrence of aquatic weeds should be controlled in an environmentally responsible manner.

The Clean Waters Act 1970 ensures that weeds are controlled in a manner that prevents or minimises the pollution of waters. The EPA defines the application of herbicide in or near water as an act of pollution, thus requiring a licence. However, the EPA does not consider all weed control operations near water as requiring a licence, as most control programs can be carried out in an environmentally responsible manner. If the need arises to spray herbicide to control aquatic weeds in a water body on campus a pollution licence may be required.

7.5 PEST ANIMAL CONTROL

For situations where control of pest species such as cockroaches, alien bees and wasps is necessary, application of pesticide should be selective. Non toxic control methods should be given priority where appropriate (Table 7).

Control of rodents should be implemented in an environmentally sensitive nature. Traps should be given preference over baiting, where appropriate, to reduce the risk of poisons being passed through the food chain. Many birds of prey have been sighted on the campus grounds and may potentially prey on poisoned rodents as a food source.

Rabbits, foxes and hares have been sighted on the campus grounds on several occasions. Rabbits may potentially cause damage to future plantings and the regeneration of native vegetation that may occur (Olsen 1998). Foxes may pose a threat to species inhabiting the campus, particularly those that may be breeding on site.

The wetland areas on campus are likely to attract pest species to the campus, especially in dry periods. Professional advice should be sought in controlling these species. If control is to be successful a neighbourhood approach may be needed. A local effort should be encouraged, especially with the neighbouring Riverina TAFE campus.

If a baiting program commences the University community should be fully informed and signage displayed in appropriate locations.

8. LAND DISTURBANCE

Most land disturbance that occurs on campus will be a result of construction activities. An emphasis has been placed on describing management practices that can minimise any environmental hazards associated with construction activities. Many of the recommended management practices are also relevant to general day to day operational and maintenance activities undertaken by the University community and should be adhered to where appropriate (Table 8).

Wetland Construction

Measures to manage land disturbance effectively during construction activities should be included in the initial site planning and design phase.

Contract developers should be required to prepare an environmental management site layout plan for all construction works. This should be overseen by the University to ensure adequate measures will be taken by the contractors to minimise any impact to the campus environment. The site layout plan need only be a basic map but nonetheless it will be critical in controlling any adverse effects to the campus. The map should clearly identify:

- All areas to be protected, particularly vegetation to be retained,
- The location and type of all stormwater management, erosion and sediment control measures,
- Placement of stockpiles and storage facilities,
- Waste disposal sites e.g. for unused mixed cement prior to removal,
- Haulage routes and site access, and
- Refuelling sites.

Measures to manage stormwater and to control erosion and sediment movement on a construction site should be given priority and installed prior to commencing construction. Minimal impact to the site will ultimately reduce post construction revegetation and site rehabilitation time, energy and costs.

Special attention should be paid to preventing adverse effects to the wetland areas on campus. Disturbance to these areas can lead to increased turbidity and sedimentation, decline in water quality and adverse effects to flora and fauna (Hunt, 1992). The greywater treatment wetlands on campus should be protected at all times from any type of land disturbance.

In addition to the development of a site plan contractors should be required to become familiar with the Environmental Management Plan, particularly the sections covering flora, fauna and land disturbance. Appendix 6 provides a checklist of activities to be undertaken prior to, during and after construction activities. The University should ensure the checklist is completed and follow up on all necessary activities and measures that have not been adequately handled.

A construction diary/log book will ensure that all construction works and site modifications are documented (Table 9).

8.1 STORMWATER MANAGEMENT AND EROSION CONTROL

Some erosion and sediment will be generated during construction activities. Disturbance and changes to land surfaces not managed correctly can alter site drainage and may lead to serious erosion problems. It is preferable to prevent erosion rather than to treat the resultant problems (EPA 1996). Eroded soil from disturbed land can wash away and contaminate stormwater adding to it nutrients and pollutants washed from the land surface. Sediment control measures are described in section 8.3.

It is important for contractors to be aware that the majority of stormwater on campus is collected in waterways flowing north directing the water into wetlands at the bottom of the slope. This water is recirculated into hilltop storage reservoirs and used as irrigation water on campus. Stormwater on the southern and western sides of the campus is directed into waterways leading to smaller wetland ponds.
Hunt (1992) suggests three basic principles for managing stormwater within a development site:

- Control the flow volume.
- Control the flow path.
- Reduce run-off velocity

Erosion control is of primary importance and more effective and desirable than sediment control which involves trapping soil particles that have already eroded. The most cost-effective form of erosion control is established vegetation (Goldman *et al*., 1986; Hunt 1992). Vegetation prevents erosion from occurring and is a more desirable control measure than silt fences, straw bale filters, sediment traps and the like. Preventing erosion from the outset eliminates the need for such structures.

The following measures should be adhered to where appropriate to minimise land disturbance on the campus.

- Land clearance should be kept to a minimum to reduce the erodeable surface. Retaining and preserving as much vegetation cover as possible will aid in preventing erosion, reducing sediment run-off and control dust. Measures to protect vegetation from disturbance and damage are listed in section 6.1.2.

- Areas of exposed soil should be as small as possible and be exposed for the shortest possible time. Revegetation of cleared areas should be planned prior to clearing and initiated as soon as possible in order to reduce potential erosion.

- Vehicles and construction machinery should be kept to well defined haul routes to minimise damage to vegetation and limit soil compaction. Existing roads on campus should provide a basis for the majority of machinery access.

- Vehicle movements should be minimised during wet weather or when the site is muddy.

- Stockpiles of any material that may be used on site should be located away from drainage lines, depressions or watercourses. Ensure that the stockpile cannot be washed onto a roadway, into a drainage line or depression and especially not into a watercourse.

- Clean 'run-on' stormwater should be diverted away from areas where soil is exposed. Taking care that such a diversion does not create flooding or erosion. Appendix 7 shows measures to control stormwater.

- Shallow guttering has been erected around the perimeter of sealed carparks. However, in times of high rainfall, water often overflows from the carparks. It is therefore important to ensure that ground cover vegetation be retained around the perimeter to reduce the risk of initiating erosion during high intensity rain storms.

- Run-off water from carparks should not be directed into swales or wetland areas. There is the potential for oils, toxins and sediments to be washed into the sensitive wetland areas. Run-off water from carparks should be directed to flow over well-vegetated areas to provide maximum opportunity for the removal of potentially harmful toxins and sediments.

- No stormwater or run-off water from anywhere on campus should be directed into, or allowed to flow in close proximity to, the greywater treatment wetlands.

- Erosion safeguards to protect aquatic ecosystems (namely Six-Mile Creek) that satisfy DLWC and EPA guidelines should be adopted during construction.

8.2 DE-WATERING CONSTRUCTION AND OTHER WORK SITE

After rain, pooled water may need to be pumped off the work site. As this water is likely to be contaminated with suspended sediment, it is essential that it does not contribute to water pollution and it should therefore be pumped to an appropriate area. Wherever practicable, this area should be vegetated and of sufficient size to remove suspended soil. Pooled water should not be pumped directly into, or in close proximity to, reservoirs or greywater treatment ponds.

8.3 SEDIMENT CONTROL DEVICES

Sediment control devices should be planned and installed in the initial site design stages and should be regularly inspected and cleaned to ensure effective operation. Sediment control measures will vary depending on the construction activity. Possible methods are listed below. Sediment traps,

- Sediment basins,
- Sediment filters comprised of silt fences and straw bales.

Diagrams of sediment control devices are supplied in Appendix 7.

8.4 POST CONSTRUCTION SEDIMENT AND EROSION CONTROL

After construction works are completed, site revegetation will be necessary to prevent soil eroding from disturbed areas. If all measures are taken to reduce impact and disturbance to the site prior to and during construction, then the need for expenditure on post construction site rehabilitation will be minimised.

- Grass is effective for initial site stabilization, as it grows quickly and provides complete ground cover (Goldman *et al.* 1986).
- If the site has been heavily compacted, site preparation will be necessary to prepare the soil for planting. Depending on size and scale of planting, ripping the soil to aerate and break up compacted soil may aid in plant establishment.
- Guidelines for landscaping and planting are addressed in section 6.1.3.
- Appropriate University staff should be consulted on suitable indigenous plants with which to revegetate the site.
- The application of mulch to the planting site will protect disturbed soil from erosion forces until the plants are established enough to do this.

8.5 EXISTING EROSION

Erosion problems on the campus, that have not been corrected and have been left untreated, will inevitably worsen and become more expensive and time consuming to remedy. Any erosion problems currently existing on campus should be given priority. Erosion on campus may be caused not only by forms of land disturbance mentioned above but from existing structures. Erosion problems have already been experienced with a swale constructed early in the development of the campus. The swale receives run-off water from the north western side of the campus, areas that include the lecture theatre buildings and the western SEIS offices and teaching block. Work undertaken to correct this problem will need to be carefully monitored for several years.

Works should be scheduled for dry summer months of the year. This will allow for plantings to become established and stabilise the eroding area.

Erosion in Six-Mile Creek

8.6 DUST CONTROL

Dust movement may create an unacceptable hazard to staff, students, university equipment and contribute to sedimentation in wetland areas on campus. Measures should be taken to reduce exposed surface areas and minimise airborne movement of sediment. It is preferable to prevent the creation of dust than to apply suppression methods (EPA 1996)

- Areas of cleared land must be minimised.

- Vehicles should use defined paved haulage routes. Unnecessary unsealed vehicle tracks should not be created.

- In situations where unsealed access tracks are required it may be necessary during times of frequent haulage and dry weather to water these routes. The amount of water should be determined by weather and soil conditions.

- On site water should be used for dust control (from reservoirs) to eliminate the use of town water

- Where water is used for dust suppression care should be taken to ensure it does not create contaminated run off water, particularly in close proximity to wetlands (Hunt1992).

- Temporary wind fences may need to be installed wherever appropriate.

8.7 MANAGEMENT OF STOCKPILES/PLACEMENT OF STOCKPILES

The Albury and Wodonga City Councils code of practice for soil and water management of building sites states that stockpiles must be located at least 2 metres from any hazard areas including, gutters, swales, footpaths and standing vegetation. The EPA (1996) suggests stockpiles should be located at least 10 metres from waterways.

- It is recommended that any stockpiles on campus be placed as far from waterways and wetland areas as possible, preferably extending on the EPA guide to a distance of at least 15 metres.
- The number of stockpiles and the time they are exposed should be minimised to reduce water and wind erosion.
- Sediment controls around stockpiles must be established (EPA 1996).
- Stormwater diversion controls should be constructed around stockpile areas prior to their use, keeping in mind that no stormwater should be diverted towards or into greywater treatment wetlands.
- Stockpiles are potential source of dust and, when feasible should be covered with an appropriate material. If they are causing dust problems they may be watered.
- Stockpiles should not be placed on or near vegetation that is to be retained. As noted in section 6.1.2, all vegetation to be retained should be suitably fenced off and protected.
- Relocation of existing stockpiles to meet these criteria should be considered as a matter of urgency.

8.8 STORAGE OF TOXIC PRODUCTS.

- Only small quantities of chemicals, fuel and other toxic substances should be stored on the campus.
- Storage of chemicals or fuel should not be allowed anywhere near the wetland areas on campus.
- Refuelling of machinery within the campus grounds should be carried out only at designated sites. These may need to be bunded to prevent the escape of accidental spills.

8.9 ACCESS TO CONSTRUCTION SITES

- Access to construction sites must be strictly controlled and limited to those who need to be there.
- Fences must be erected to exclude the public, minimise vandalism and ensure safety of any visitors..

8.10 NOISE

- Operating times of noisy equipment should be limited when in close proximity to residences and classes.
- Any undue noise or disturbance cannot be allowed in close proximity to residences or classrooms during exam periods.
- Initial planning should consider noise disturbance and plan timing of works accordingly.

8.11 INSPECTIONS/MONITORING

An inspection schedule should be prepared as part of the environmental management site layout plan required by contractors for each construction site. Frequent monitoring of environmental safeguards is necessary to ensure measures are operating effectively. Forethought should be given to any potential problems that may occur and remedial action plans developed.

Construction of Residential Cottages

8.12 WASTE MINIMISATION FOR CONSTRUCTION SITES

- Ensure recycling bins are provided in site office and lunch areas.
- All materials should be recycled where possible.
- Ensure a high level of housekeeping to ensure litter is disposed of in a responsible manner and not left where it can be blown or washed away.
- Where possible obtain construction materials, paints, lubricants and liquids etc in reusable packaging or containers and ensure proper storage

8.13 CAR PARKS

- Vehicles should only be parked in designated car park areas.

- Additional car parking spaces should be sufficient to accommodate cars for all occupants of the residential precinct and some visitors. Parking should be restricted to these spaces.

8.14 ROADS/TRACKS

The University should consider creating permanent gravel vehicle tracks for staff access to facilities within the campus grounds to minimise erosion and dust. Current dirt tracks created for ease of access to sites are not necessarily located in the most appropriate positions in terms of minimising environmental damage or aesthetic placement and should be reviewed. A campus site plan of vehicle access routes is recommended before current tracks become a serious problem.

TABLE 8. MANAGEMENT PROCEDURES FOR LAND DISTURBANCE/CONSTRUCTION SITES

TIME	SITE MANAGEMENT	STORMWATER MANAGEMENT	EROSION CONTROL	ROADS/CARPARKS
Situational	**Planning** • Contract developers to prepare an environmental management site layout plan for all construction works addressing: - All areas to be protected, particularly vegetation to be retained, - The location and type of all stormwater management, erosion and sediment control measures, - Placement of stockpiles and storage facilities, - Waste disposal sites e.g. for unused mixed cement prior to removal, - Haulage routes and site access, and - Refuelling sites. **Construction Site** • Locate stockpiles away from drainage lines, depressions and watercourses. Do not locate on vegetation to be preserved. • Establish erosion and sediment control measures around stockpiles. • Do not store chemicals or fuel anywhere near swales or wetland areas. • Only refuel at designated sites. • Ensure high level of site housekeeping, provide recycling bins.	**Overall** • Clean 'run-on' stormwater should be diverted away from disturbed areas • Polluted stormwater from disturbed sites should not be directed into swales or wetland areas.	**Overall** • Keep land clearance to a minimum • The interval between clearing and revegetation should be kept to a minimum. • Vehicles to be kept to well defined haul routes • Minimise vehicle movements in wet weather. • Clean 'run-on' stormwater should be diverted away from exposed areas. • Retain as much vegetation as possible.	**Planning** • Review current locations of vehicle access tracks. • Prepare campus site plan of vehicle access routes taking into consideration aesthetic placement and the need to minimise environmental damage. • Revegetate unnecessary vehicle tracks.
January	Prepare/review work plans	Prepare/review work plans	Prepare/review work plans	Prepare/review work plans
February				Update campus signage
March				
April				Biannual repainting of parking spaces
May				
June				
July	• Submit budget • Identify savings in cost and resources.	• Submit budget • Identify savings in cost and resources.	• Submit budget • Identify savings in cost and resources.	• Submit budget • Identify savings in cost and resources.
August		Monitor stormwater management control measures during rainy season.	Monitor erosion control measures during rainy season.	
September				
October		Commence works to remedy stormwater management problems.	Commence works to remedy erosion problems	
November				
December				

TABLE 9. MANAGEMENT PROCEDURES FOR DOCUMENTATION

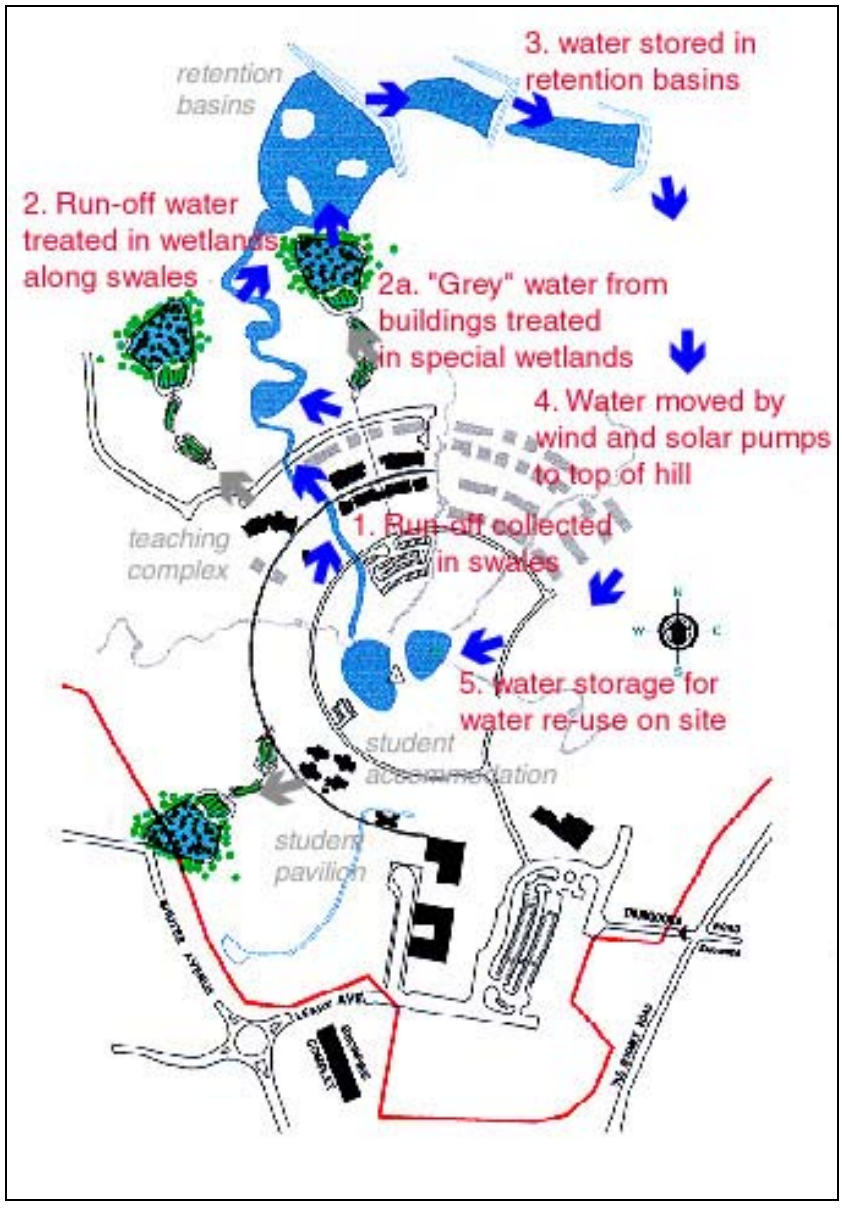
TIME	ECOLOGICAL INCIDENT DIARY/LOG BOOK	CONSTRUCTION DIARY/LOG BOOK	LANDSCAPE DEVELOPMENT DIARY LOG BOOK	VISITORS BOOK
As required	• An ecological incident refers to an event such as fauna species nesting on campus or a sighting of significant species. • All species sighted on campus should be recorded to aid in providing an indication of biodiversity over time. • The diary/log book may be kept in the SEIS staff room.	• The construction diary/log book will provide a record of what works have been carried out on the campus. This may include minor maintenance to construction of buildings and facilities. • The diary/log book will enable works on the campus to be reviewed and potential cost savings identified. • Locate diary/log book with Buildings and Grounds Department	• Record all site modifications (roads, erosion control etc.) • Record all plantings including species, amount and location. • Locate diary/log book with Head Gardener	• Will provide a record of VIP visitors and purpose of visit to campus. • Locate visitor books with Pro-Vice Chancellor and University Public Relations Staff.

9. MANAGEMENT OF WATER RESOURCES

Particular attention has been paid to the development and sustainable management of water resources on the Thurgoona campus, with the aim of minimising waste and maximising holistic use and potential reuse (Mitchell, *et al.* 2001). A total water harvesting strategy has been implemented. Stormwater is collected through a series of waterways and directed through constructed in-stream wetlands designed to retain some nutrient and sediment before the water flows into three retention reservoirs located in the north of the campus. In times of high rainfall, water from the lower reservoir may flow into Six-Mile Creek.

A solar pump and windmill circulate the water from the lower reservoir into two hill top supply reservoirs from which it is used to irrigate the campus grounds. Mitchell (1998) notes that the continuing circulation of water through the system should minimise the creation of mosquito breeding grounds.

FIGURE 3. Water Management System



The installation of composting toilets has eliminated the generation of "blackwater". "Greywater" generated from wash hand basins, kitchen sinks, showers and laundries is treated using gravel based, intermittently-loaded, root zone treatment artificial wetlands (Croft 1999). Three greywater treatment wetland systems are located on campus treating greywater from the SEIS buildings, lecture theatre precinct and residential cottages. A small amount of drainage from the composting toilets is also treated in the greywater treatment wetlands.

Each greywater treatment system consists of two primary ponds, one secondary pond, an evaporation mound and ephemeral wetland (Diagram 2). The primary ponds fill alternately, while one is filling the other is holding greywater before being discharged into the secondary pond where it is retained for an additional time period and then released into the evaporation mound. The amount of time the greywater is held in each pond varies from 5-9 days with a total residence time in the whole system of at least 2-3weeks.

- A manual for operation and maintenance of the greywater treatment wetland systems is included as Appendix 8.

- Procedures for managing the campus water resources are located in Table 10.

9.1 WATER QUALITY

The retention reservoirs located in the northern section of the campus play an important role in trapping sediment and recycling nutrients from storm water run-off. The wetlands act as natural filters improving the quality of irrigation water used on campus and of water that flows into Six-Mile Creek during times of high rainfall. Crabb (1997) notes that excessive pollutants will degrade or destroy wetlands. Cautious management of potential pollutants that may affect these sensitive areas is extremely important.

It is clearly important for the University to establish a sensible long-term strategy for the management of nutrients on the campus. The ultimate aim of the strategy should be to develop a means of balancing the addition of nutrients to the necessary uptake for good plant growth. Most Australian soils are nutrient poor and native Australian plants are adapted to such low nutrient status. (The best check on success in achieving this balance would be the nutrient content of water draining from the catchment into Six Mile Creek). It follows that special care must be taken to ensure additions of nutrient to the catchment do not exceed requirements for desirable plant growth. Such additions come about from organic and inorganic fertilisers on lawns and garden beds and from the faeces of non native grazing animals. This is clearly relevant to careful management of current policy for agisting sheep and cattle on campus grounds.

Water quality in the greywater treatment wetlands is monitored every three months through sampling of various parameters (Appendix 9). Reports are produced which are then distributed to the NSW EPA, Department of Health, Albury City Council and Department of Land and Water.

- A schedule for water quality monitoring on the campus is provided in Appendix 9. This document currently requires reviewing and furthermore will need to be regularly reviewed as the campus development proceeds.

- Procedures for monitoring the water management system are provided in Table 11.

Establishment of SEIS Greywater Treatment Wetlands. The wetland is flooded above the gravel for initial planting to take place. Note the outlet sump in foreground.

Core Precinct (Lecture Theatre) Greywater Treatment Wetlands growing towards maturity

9.2 GUIDELINES FOR PROTECTING WETLAND AND WATER MANAGEMENT AREAS ON CAMPUS

As stated in section 5, it is recommended that an education and training program be developed. This will provide an essential means of educating staff and students as to the sensitive nature of the campus, particularly the wetlands and water management areas, and in turn lead to the wise use and management of these facilities.

It is essential that new students living on campus be provided with appropriate information and educated about the greywater treatment systems, as addressed in section 5.3.

The following guidelines for protecting the wetland and water management areas should be read in conjunction with 8.1 which addresses stormwater management, particularly that relevant to land disturbance.

- All staff, students and contractors should be aware of what they put down all sinks and drains on campus. Absolutely no toxic chemicals should be poured down drains and no containers of any type of chemical should be rinsed out over drains Do not clean tools and equipment that have been used with chemicals over sinks or drains.
- No herbicides are to be sprayed in close proximity to greywater treatment wetlands or reservoirs. Hand pull or use a trowel to remove weed species in ponds. Any spraying that takes place on campus should only be conducted on calm days to reduce spray drift. All chemicals used on the campus should strictly adhere to the manufacturer's recommendations.

- Regularly mow/slash areas around treatment ponds to control weed seeds from entering ponds.

- Run off water from construction sites and carparks should not be directed into greywater treatment wetlands or stormwater collection swales and wetlands.

- Do not allow water used for widely different purpose to mix

- Compost removed from composting toilets should only be buried in the designated zone (see management zone map) and kept well away from wetlands or waterways.

- Water usage on the campus should be minimised, see section 5.4 for more detail.

9.3 GROUNDWATER

Two Piezometers were installed within the campus grounds in 1999 to a depth of approximately 15 metres (Figure 1). The piezometers are regularly checked as part of the water quality monitoring program. To date no groundwater has been detected.

9.4 COMPOSTING TOILETS

- Any problems should be reported to the University Buildings and Grounds Department.

- The frequency of removal of composted material depends on usage, the minimum composting period required is at least twelve months. Written approval from the Albury City Council and Centre for Public Health is required for removal of only partially composted material.

- The composted material must be disposed of by burial within the university grounds in soil that is not intended for grazing or cultivation of vegetables. A management zone has been designated for burial of this compost material (see management zone map). Minimum soil cover must be 100mm. It is recommended that the material be buried much deeper than this to avoid the growth of weed species that will utilise and flourish on the nutrients.

- Only bury composted material in designated zone.

FIGURE 4. GREY WATER TREATMENT WETLANDS

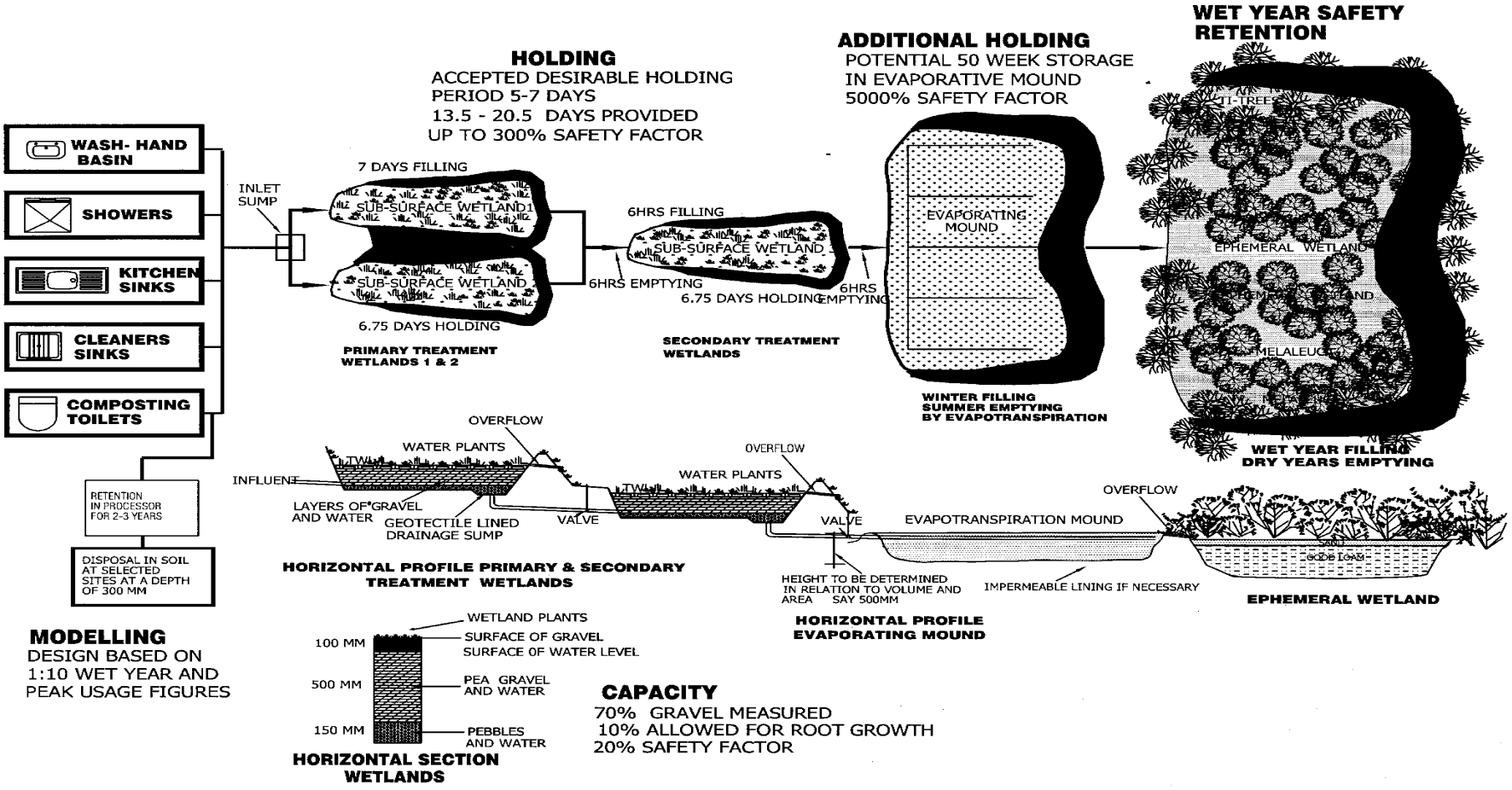

WASH- HAND BASIN
SHOWERS
KITCHEN SINKS
CLEANERS SINKS
COMPOSTING TOILETS
RETENTION IN PROCESSOR FOR 2-3 YEARS
DISPOSAL IN SOIL AT SELECTED SITES AT A DEPTH OF 300 MM
MODELLING
DESIGN BASED ON 1:10 WET YEAR AND PEAK USAGE FIGURES
HOLDING
ACCEPTED DESIRABLE HOLDING PERIOD 5-7 DAYS
13.5 - 20.5 DAYS PROVIDED
UP TO 300% SAFETY FACTOR
INLET SUMP
7 DAYS FILLING
SUB-SURFACE WETLAND1
SUB-SURFACE WETLAND
6.75 DAYS HOLDING
PRIMARY TREATMENT WETLANDS 1 & 2
6HRS FILLING
6HRS EMPTYING
SUB-SURFACE WETLAND
6.75 DAYS HOLDING
6HRS EMPTYING
SECONDARY TREATMENT WETLANDS
ADDITIONAL HOLDING
POTENTIAL 50 WEEK STORAGE IN EVAPORATIVE MOUND
5000% SAFETY FACTOR
EVAPORATING MOUND
WINTER FILLING
SUMMER EMPTYING
BY EVAPOTRANSPIRATION
WET YEAR SAFETY RETENTION
TI-TREE
EPHEMERAL WETLAND
MELALEUCA
WET YEAR FILLING
DRY YEARS EMPTYING
OVERFLOW
WATER PLANTS
TWL
INFLUENT
LAYERS OF GRAVEL AND WATER
GEOTECTILE LINED DRAINAGE SUMP
VALVE
OVERFLOW
WATER PLANTS
TWL
VALVE
EVAPOTRANSPIRATION MOUND
HORIZONTAL PROFILE PRIMARY & SECONDARY TREATMENT WETLANDS
HEIGHT TO BE DETERMINED IN RELATION TO VOLUME AND AREA SAY 500MM
IMPERMEABLE LINING IF NECESSARY
HORIZONTAL PROFILE EVAPORATING MOUND
OVERFLOW
SAND
GOOD LOAM
EPHEMERAL WETLAND
WETLAND PLANTS
SURFACE OF GRAVEL
SURFACE OF WATER LEVEL
100 MM
500 MM
PEA GRAVEL AND WATER
150 MM
PEBBLES AND WATER
HORIZONTAL SECTION WETLANDS
CAPACITY
70% GRAVEL MEASURED
10% ALLOWED FOR ROOT GROWTH
20% SAFETY FACTOR

TABLE 10. MANAGEMENT PROCEDURES FOR WATER RESOURCES

TIME	GREYWATER TREATMENT WETLANDS	RESERVOIRS	HILL TOP DAMS	SWALES	INSTREAM WETLANDS
Situational	**Maintenance** • Operate treatment ponds as required. • Report any problems immediately. **Overall** • No chemicals should be used or stored in close proximity to wetlands. • No stormwater or run-off water from construction sites or car parks should be directed into or towards wetlands.	**Overall** • No chemicals should be used or stored in close proximity to wetlands. • No stormwater or run-off water from construction sites or car parks should be directed into or towards wetlands	**Maintenance** • Monitor water levels • Minimise water use, water grounds and garden beds when evaporation is low.		
January	Prepare/review work plans	• Prepare/review work plans • Prepare/review wetland landscaping plan. • Monitor reservoirs for signs of algal blooms	Prepare/review work plans	Prepare/review work plans	Prepare/review work plans
February		Monitor reservoirs for signs of algal blooms			
March					
April					
May					
June					
July	• Submit budget • Identify savings in cost and resources	• Submit budget. • Identify savings in cost and resources	• Submit budget. • Identify savings in cost and resources	• During rainy season identify any actual and potential erosion problems. • Submit budget. • Identify savings in cost and resources	• Submit budget. • Identify savings in cost and resources
August	Harvest pond vegetation in sections, allow for some regrowth before further harvesting.	Conduct maintenance check of windmill and solar pump.			
September	Undertake weed control				
October				Conduct works to remedy and prevent erosion problems.	Monitor plant growth, some thinning may need to be undertaken
November					
December		Monitor reservoirs for signs of algal blooms			

TABLE 11. PROCEDURES FOR WATER MANAGEMENT SYSTEM MONITORING

TIME	TREATMENT WETLANDS	COMPOSTING TOILETS	RESERVOIRS	GROUND WATER
Situational	**Maintenance** • Maintain operational log book. • Report and investigate all malfunctions/problems immediately.	**Maintenance** • Investigate all problems as they occur. • Dispose of mature compost, as required. • Rake compost chambers as required.	**Water quality** • Monitor reservoirs for algal blooms and report upon detection. **Maintenance** • Investigate all problems relating to the windmill and solar pump as they occur.	
January	• Review water monitoring program. • Identify cost savings.	• Review performance • Identify cost savings	• Review water monitoring program. • Identify cost savings. • Conduct annual maintenance check of windmill and solar pump.	
February	Conduct three monthly water monitoring program.		Conduct three monthly water monitoring program.	Measure and record ground water depth.
March				
April				
May	Conduct comprehensive annual water monitoring program		Conduct comprehensive annual water monitoring program.	Measure and record ground water depth
June				
July				
August	Conduct three monthly water monitoring program		Conduct three monthly water monitoring program.	Measure and record ground water depth
September				
October				
November	Conduct three monthly water monitoring program		Conduct three monthly water monitoring program.	Measure and record ground water depth
December				

10. HERITAGE SITES

In 1995 the University commissioned an historical and archaeological site survey of the Thurgoona campus grounds. In total, 12 European heritage sites were found, the majority being former house sites. Two sites were deemed significant, a standing building and bottle/rubbish dump. Eight Aboriginal heritage sites were found comprising of one 'very significant' scarred tree and seven isolated artefacts. A location map of historical sites and summation of the significance of each site is included in Appendix 10. Spennemann (1995) makes several recommendations for management. For further historical information and recommendations refer to:

Spennemann, D (1995) *Archaeological Site Survey of the new Charles Sturt University Campus Thurgoona, NSW*. Johnstone Centre Report no.44.

Spennemann, D (1995) *Historical Site Survey of the new Charles Sturt University Campus Thurgoona, NSW*. Johnstone Centre Report no.45.

Spennemann, D (1995) *Archaeological Site Survey of the new Charles Sturt University Environmental Study Area, Thurgoona, NSW*. Johnstone Centre Report no.46.

Spennemann, D (1995) *Historical Site Survey of the new Charles Sturt University Environmental Study Area, Thurgoona, NSW*. Johnstone Centre Report no.47.

11. OCCUPATIONAL HEALTH AND SAFETY ISSUES

The operation of the environmental management plan must be consistent with the University policy and management procedures with Occupational Health and Safety. Where necessary consultation with the OHS committee must occur.

Particular issues that are relevant to this plan and the work of the committee include

- Fire management,
- Public safety,
- Unsafe tree growth,
- Control of access to specific areas such as research sites, teaching sites, and areas of particular ecological sensitivity.

It is recommended that the OH&S committee divide the campus into zones of different levels of risk under OH&S protocols. It would be helpful if these were based on the management zones depicted in Figure 1 and described in Table 1, but that would not be essential. Appropriate work practices could then be developed for each zone.

12. CONTINGENCY PLANS

Contingency plans for the greywater treatment wetlands are located in the document:

- Mitchell,D and Webster-Mannison,M (1998) *Charles Sturt University Thurgoona Campus Technical Report, Management of Water Resources.*

Additional contingency plans should be developed to deal with foreseeable environmental problems of a serious nature such as:

- Fuel spills, particularly in close proximity to wetland areas,
- Algal blooms,
- Vandalism,
- Bush fires.

All contingency plans should be periodically reviewed and updated.

13. INITIAL IMPLEMENTATION OF THE PLAN

Ultimate responsibility for accepting and implementing the Environment Management Plan for the Thurgoona Campus lies with the University Authorities. The process of implementation would need to be carefully planned on the basis of clear, achievable objectives and sensible performance criteria. Responsibilities for these achievements would also need to be assigned and accepted.

While the plan is designed to emphasise low-cost management and measure long-term savings to the University, there are likely to be some initial expenses in setting it up, and these must be estimated and budgeted.

These essentially bureaucratic processes, necessary as they are, need to be balanced against the awareness that the continuing application of the plan requires the co-operation, understanding and commitment of the people who live and work on the Thurgoona site. While understanding can promote motivation, continuing commitment to participation in applying the Environmental Management Plan will require regular positive feedback. An effective way of achieving this would be to equip all buildings on the Thurgoona campus with meters that measure energy and water consumption. Reductions in energy and water consumption by each section or department of the University could be compared through the computer network. Providing access to saved funds would reward good performance and strengthen motivation further.

The involvement of all personnel on the campus in the application of the plan would make it desirable for the plan to be coordinated from the Head of Campus' Office under the auspices of the Vice-Chancellor. The establishment of an Environmental Liaison Committee for the Thurgoona Campus with membership from teaching and administrative staff and from students could also be considered.

It will be necessary to initiate the plan formerly on a particular date (say at the start of teaching in 2002), once it had been accepted by the University. This event would require careful planning, involving the preparation of explanatory documents and well-designed briefing sessions. Such an event could have significant publicity benefits for the University as a whole and for the Thurgoona Campus in particular.

14 APPLICATION AND ON-GOING APPRAISAL OF THE PLAN.

The day-to day application of the Environment Management Plan to the management, occupation and use of the campus would be greatly aided by the establishment of the position of an Environmental Technical Officer. This officer would be required to liaise with the different groups of staff and students on the campus and with those University officers, who would be responsible for operating the Environment Management Plan in the discharge of their normal duties. This officer would need to be appropriately qualified to carry out the regular monitoring of facilities required by the Albury City Council, provide instruction on observation of the plan to staff, students and visitors on the campus, and undertake guided tours of the campus for particular visitors. In the event such an appointment could not be made, these tasks would have to be shared among existing staff in addition to their current responsibilities, though some additional training may be required.

In addition, the University should appoint an independent environmental auditor to oversee conformity to the procedures set out in this document by outside contractors. The auditor may be a member of staff from the School of Environmental and Information Sciences. This person would report to the Environmental Liaison Committee, if established, and to other stakeholders in the University.

During the first few years of the operation of the Environmental Management Plan, the Environmental Management Committee would also maintain a continuing critical appraisal of the operation of the Environmental Management Plan, with annual focussed reviews leading to revisions of the document, where necessary. Revisions would be facilitated by producing loose-leaf copies of the document for each officer concerned in applying the plan, in addition to the formal publication of the Plan as a report of the Johnstone Centre. After about five years, the plan would rewritten to take account of these progressive changes and republished.

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