Sustainable Campus Report

University of Newcastle (Central Coast Campus)

December, 2007

Community Environment NETWORK

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

TAFE NSW HUNTER INSTITUTE

CENTRAL COAST

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1 PREAMBLE

The Community Environment Network was established in 1997 with the mission of *"supporting ecologically sustainable development and opposing threats to ecologically sustainable development"*. At the time, there was considerable effort being made by governments to encourage sustainability following the Rio Summit and adoption of Agenda 21 by local government.

In 2000, a following establishing an office on the campus, a Sustainability Forum was established to advise CEN and investigate a vision for sustainability on the Central Coast. As discussions and meetings unfolded it became apparent that the task was very large and would need considerable resources to articulate. The members of the Sustainability Forum then resolved to work on a more practical and achievable vision. This would be to identify what was needed to create a sustainable campus on the Central Coast. Members of the Forum at that stage included; John Asquith, Dr Brian Paterson, Jane Smith, Dr Glenn Albrecht, Dr Harry Recher, Dr Bill Gladstone and Barry Nancarrow on behalf of the Director of Campuses.

In 2004, Dr Fred Bell agreed to convene the Forum with a view to preparing a report for consideration by the Director of Campuses. With the assistance of the campus staff, a number of aspects to the sustainability of the campus were then documented. These investigations led to a number of reports which identified information available on sustainable features of the campus. This included presentations from the designers of the campus buildings and accessing traffic studies.

This report is a culmination of that work. It does not attempt to answer every question in regard to creating a sustainable campus. Rather the report seeks to outline the major issues and identify the initial areas to improve the sustainability of the campus.

John Asquith
Chairman CEN

2 EXECUTIVE SUMMARY

The report on the sustainability of the Central Coast campus at Ourimbah has been compiled as a voluntary effort to assist in identifying sustainability opportunities at the campus. The report comprises seven sections; introduction, property, biodiversity, water, energy, transport and waste. Each section considers existing attributes, sustainability, conclusions and recommendations. The recommendations are then prioritised according to the ultimate sustainability of the campus and the value of the Campus as an example to the broader community.

A summary of the current (2007) Campus sustainability is then tabulated for key parameters. This is then used to suggest targets of these parameters for a sustainable campus by 2030.

The report identifies the many existing attributes of the campus which give a natural advantage to developing a more sustainable campus. This includes;

- a natural environment in good condition with a self contained catchment;
- teaching courses on sustainable resource management;
- buildings designed in the main campus using sustainability principles;
- significant untapped water and solar resources available;
- access to technical skills available;
- the campus is growing, so there is an opportunity to include sustainability features.

It is anticipated that the report will inform future decisions in regard to the campus being seen as a model for sustainability in the Central Coast region and beyond. Being located between Sydney and Newcastle the campus is ideally located to serve as a demonstration of the practical application of sustainability.

3 INTRODUCTION

3.1 Sustainability: a serious issue?

An investigation of the sustainability of Ourimbah Campus is desirable and timely for the following reasons:

- The perceived significance of sustainability has been intensified recently by
  - (a) the latest report of the Intergovernmental Panel on Climate Change (IPCC 2007),
  - (b) the economic analyses of Sir Nicholas Stern (Stern 2006), and
  - (c) the film 'An Inconvenient Truth' promoted by Al Gore.
- The United Nations Decade of Education for Sustainable Development (2005-2014) is in progress and highlights the roles of educational institutions in alerting the world to the importance and problems of sustainability.
- There is increasing interest in the Talloires Declaration by senior academics (Box 1-1); more than 300 universities/colleges from about 50 countries have now signed this international agreement for universities to be '...world leaders in developing, creating, supporting and maintaining sustainability....'
- Most Australian universities now have environmental programs and/or management plans to promote and implement sustainability, and organisations such as ACTS (Australian Campuses Towards Sustainability) have been established to assist this. Although the University of Newcastle has taken some steps in these directions, there is a potential and need for more to be done, particularly at the Ourimbah Campus.

Apart from a small number of high school and university teachers, few people in Australia seem aware of the United Nations Decade of Education for Sustainable Development (UNESCO 2003 and the Talloires Declaration (ULSF 2006). These are important international initiatives that could considerably influence our future welfare, but the scant attention they have been given by educationalists, politicians and media suggest

sustainability has not really been a serious issue in Australia until quite recently.

Nevertheless, of the 300 + universities that signed the Talloires Declaration to March 2006, 10 were Australian. The University of Newcastle was not one of these.

Many concerned members of the general community now recognise that significant changes are needed in our lifestyles and economic activity if climate change and other threats to future sustainability are to be minimised. Most also recognise the formidable problems in making these changes, and they expect solutions to be found by governments and institutions such as universities, CSIRO, and community groups.

Universities, in particular, are expected to:

- Encourage and support appropriate experts to investigate and understand the problems, monitor developments elsewhere, and advise on measures to address the problems.
- Maintain and increase the appropriate expertise through courses of instruction and guided research.
- Ensure that other educational institutions, governments, the media and the community in general are properly informed of the problems and any changes in the circumstances relevant to the problems.
- Provide examples or models of the changes in behaviour, functions, facilities and materials needed to address the problems.

The last of the above expectations is the main

BOX 1-1

TALLOIRES DECLARATION

We, the presidents, rectors, and vice chancellors of universities from all regions of the world are deeply concerned about the unprecedented scale and speed of environmental pollution and degradation, and the depletion of natural resources. Local, regional and global air and water pollution; accumulation and distribution of toxic wastes; destruction and depletion of forests, soil, and water; depletion of the ozone layer and emission of 'greenhouse' gases threaten the survival of humans and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the heritage of future generations. These environmental changes are caused by inequitable and unsustainable production and consumption patterns that aggravate poverty in many regions of the world. We believe that urgent actions are needed to address these fundamental problems and reverse the trends. Stabilization of human population, adoption of environmentally sound industrial and agricultural technologies, reforestation, and ecological restoration are crucial elements in creating an equitable and sustainable future for all humankind in harmony with nature. Universities have a major role in the education, research, policy formation, and information exchange necessary to make these goals possible. Thus, university leaders must initiate and support mobilization of internal and external resources so that their institutions respond to this urgent challenge.

We, therefore, agree to take the following actions:

1. Increase Awareness of Environmentally Sustainable Development
Use every opportunity to raise public, government, industry, foundation and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future.

2. Create an Institutional Culture of Sustainability
Encourage all universities to engage in education, research, policy formation, and information exchange on population, environment, and development to move toward global sustainability.

3. Educate for Environmentally Responsible Citizenship
Establish programs to produce expertise in environmental management, sustainable economic development, population, and related fields to ensure that all university graduates are environmentally literate and have the awareness and understanding to be ecologically responsible citizens.

4. Foster Environmental Literacy for All
Create programs to develop the capability of university faculty to teach environmental literacy to all undergraduate, graduate, and professional students.

5. Practice Institutional Ecology
Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations.

6. Involve All Stakeholders
Encourage involvement of government, foundations, and industry in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with community and nongovernmental organisations to assist in finding solutions to environmental problems.

7. Collaborate for Interdisciplinary Approaches
Convene university faculty and administrators with environmental practitioners to develop interdisciplinary approaches to curricular, research initiatives, operations, and outreach activities that support an environmentally sustainable future.

8. Enhance Capacity of Schools
Establish partnerships with primary and secondary schools to help develop the capacity for teaching about population, environment and sustainable development.

9. Broaden Service and Outreach Nationally and Internationally
Work with national and international organizations to promote a worldwide university effort toward a sustainable future.

10. Maintain the Movement
Establish a secretariat and a steering committee to continue this momentum, and to inform and support each other's efforts in carrying out this declaration.

topic of the report to follow. Some aspects of the other expectations will be briefly discussed in 1.5 and 1.6 below.

3.2 Interpretation of sustainability

Since the United Nations 'Rio Conference' in 1992 (see Beder, 1996), the terms 'sustainability' and 'sustainable development' have become common currency, incorporated in the public relations policies of governments, government agencies and many institutions and corporations. Unfortunately, the interpretations of the terms have varied greatly, generally to suit the specific objectives and outlooks of the organisation concerned. This has occurred to such an extent that 'sustainable development' and 'sustainability' are now often cynically regarded as 'buzzwords' or 'weasel words' (Watson, 2004).

Our use of 'sustainability' in this report is compatible with the following practical definition:

> *Meeting present needs (a) without seriously compromising the ability of future generations to meet their needs, (b) with social equity and justice for both present and future generations, and (c) with minimum harm to other forms of life and to the ecological processes and media on which the various forms of life depend*.

The above definition expresses the basic ideas of sustainability, as developed at the Rio Conference from earlier proposals by Brundtland (1987). To satisfy the requirements of sustainability it is necessary to conserve resources, maintain clean air, water and land, avoid social disharmony (especially disharmony due to unfair distributions of resources and wealth), and ensure the healthy survival of the natural world.

In learning and thinking about sustainability, significant numbers of people are moved to regard it with profound respect. They tend to view it as an ultimate and essential long-term goal of human activities. It corresponds with an ideal world of secure, harmonious communities in which there is minimal suffering and distress for all forms of life. If this outlook proliferates, sustainability may eventually provide a rational and universal system of ethics to guide, constrain and even override the decision-making of governments and other major 'power groups'. An effectively constraining ethical system is now needed for such decision-making as its potential impacts in space and time are more far-reaching and devastating than ever before.

3.3 Threats to sustainability

Much of the recent intensification of interest in sustainability is due to community concerns about the detrimental effects of climate change caused by human-generated greenhouse gas emissions. These concerns have apparently forced the governments of U.S.A. and Australia to belatedly acknowledge the reality and seriousness of this global threat. However, climate change (and the associated droughts, floods, storms, heatwaves etc) is not the only threat to sustainability.

There are also shorter-term threats likely to cause serious problems within the next two decades. Such threats, as may be inferred from data on current trends, include the economic depletion of oil, water and seafood supplies, widespread degradation of agricultural land, severe urban air pollution, dangerous pollution of specific areas of land and water, disease pandemics, continuing acts of war and terrorism, and international crime.

Trend data and expert analyses also indicate longer-term, and even more catastrophic threats, namely extensive coastal inundation through relatively sudden sea level rise, global war with nuclear weaponry, and the eventual collapse of biodiversity. With regard to the latter, there is growing recognition that the options for renewable resources in the future will depend ultimately on the remaining biodiversity.

Alarmingly, the present accelerating decline in biodiversity seems unstoppable. It is also quite irreversible, as human destruction or domination of most habitats now virtually precludes the compensatory evolution of new species.

Many well informed and influential people find it difficult to accept that all the above threats are realistic and potentially very serious. They are aware that various predictions of catastrophic consequences from similar threats have been made in the past (since the famous essay of Thomas Malthus in 1797) and all have failed to eventuate. It may therefore seem reasonable to believe that the most recent predictions are unlikely to eventuate for similar reasons.

However, in examining these predictions in detail we see that they failed for one or more of four reasons: (1) relatively crude analyses and calculations were used, (2) migrations of large populations to new productive lands were not considered, (3) the discovery and development of large new supplies of resources were not taken into account, and (4) scientific and technological changes that occurred after the predictions were not foreseen.

Of the above four reasons, only the last two may still apply. We can earnestly hope that large new supplies of resources such as oil will be found and the required new scientific and technological advances will occur. But it is irresponsible to rely on these things happening without directing positive efforts towards making them happen. And it is irrational to dismiss the predictions for the other reasons that no longer apply.

3.4 Causes and contributing factors

As universities are expected to play major roles in the scientific and technological advances required to address the above threats it is appropriate to briefly consider the disciplinary areas of study and research that may be involved. In considering these we find that the problems of sustainability touch much of the disciplinary spectrum, as may be seen in the list of relevant topics in Box 1-2.

The grouping of factors in Box 1-2 is in line with

BOX 1-2 SOME SUGGESTED FACTORS THAT CONTRIBUTE TO THE THREATS

BIOPHYSICAL FACTORS

Atmospheric residues from the combustion of coal oil and other fuels
Volumetric expansion and carbon release from oceans with increasing temperatures
Melting of glaciers, ice sheets and permafrost
Increasing scarcity of potable water supplies and economically accessible oil supplies
Land clearing, especially in forested areas
Limited tolerances of humans and other life forms to pollutants in air, water and land
Agricultural practices that result in soil erosion and losses of soil fertility
Losses of habitat through urbanisation, land clearing and forestry
Spread of pest species of plants and animals.

ECONOMIC FACTORS

Direct high costs of remedial measures and changes to economic systems
The ignoring and undervaluing of indirect and longer-term costs because of their uncertainty
Promotion of economic growth and economic efficiency as goals and measures of progress
Highly competitive aspects of economic activity
Inequitable distributions of resources, wealth and power
Short-term and limited objectives of corporations and business
Globalisation of economic activities and trade
Transfer of services, responsibilities and resources from governments to the private sector
Increasing concentrations of populations and economic activity in urban areas
Productive people too occupied with short-term goals to be able to consider longer-term goals
Development and trade of low-cost and increasingly effective weaponry
Development of highly organised, large-scale criminal enterprises.

SOCIAL AND POLITICAL FACTORS

Continuing human population growth
Consumerism, particularly with regard to waste-generating goods and water use
Distortion of perceptions through advertising, lobbying and other techniques of persuasion
Rapid and enforced cultural and technological changes
Perceptions of greater uncertainty about the future
Historical and cultural influences on human attitudes
Perceived oppression and exploitation of various communities and cultural groups
Nature, limitations and variability of human thinking and behaviour
Stimulation of socially adverse human behaviour and failure to control or modify such behaviour
The 'my-little-bit-won't-make-any-difference' syndrome
Short-term goals of governments and the associated decline of longer-term planning
Revival of fundamentalism in religions, cultures and economic theory
Influence of economic fundamentalism on prevailing political ideologies and policies.

the 'triple bottom line' principle referred to by conservationists and others concerned with sustainability. This principle was advocated in Agenda 21 of the previously mentioned Rio Conference (see Bell, 1994) and stresses that sustainable development must take into account environmental, economic and social factors.

3.5 Analysis of sustainability

There are strong and complex interactions between the threats to sustainability and many of the factors listed in Box 1-2. It seems necessary to understand and be able to analyse these interactions with a scientifically appropriate methodology if effective measures for achieving and maintaining sustainability are to be found.

Significant difficulties are due to some key interactions extending well beyond the boundaries of traditional disciplinary areas, and the required methodology will therefore probably involve transdisciplinary concepts and techniques that have yet to be devised. This is impeded by the rather different disciplinary paradigms within which each of the biophysical, economic and social sciences has evolved.

There are also difficulties due to the reluctance of many leading academics and scientists to venture too deeply into areas outside the (usually quite narrow) fields in which they have gained their reputations.

The unprecedented scale, scope and portent of the problems of sustainability suggest the need for a new, solution-focused applied science. Most academic attempts to develop courses of study in this area result in loosely connected sets of broadly relevant topics from the traditional disciplines. In general, these are unable to provide the comprehensive, unencumbered system of knowledge and integrated practical measures needed to achieve and maintain sustainability.

To meet the specific needs, the required applied science should make full use of directly relevant theoretical concepts and also the practical, cause-effect techniques of the existing biophysical, economic and social sciences. Such a discipline may be conceived as a systematic approach to 'globalised risk management' (defining 'risk' rigorously in terms of adverse event magnitudes and their probabilities of occurrence). It would aim for optimal solutions to some problems but in other cases it would aim to provide sets of specific constraints or ethical guidelines for major decision-making, as suggested in 1.2 above.

As an applied science, the envisaged discipline would need to utilise both qualitative and highly quantitative techniques where appropriate. For example, it would be expected to make innovative use of advanced mathematical-physical modelling techniques expressing complex interactions of various factors in Box 1-2. Such modelling would involve expressions and components that could be deterministic or probabilistic or, more often, combinations of both.

Because of the breadth and depth of topics in such a discipline, its practitioners would need to have an exceptional range of aptitudes and interests. Also, as their work would be directed towards the future of humanity, their professional status should be consistent with this responsibility.

One of the few techniques developed to date for analysing sustainability, and which could be regarded as transdisciplinary, is the 'ecological footprint' (Lenzen and Murray, 2003). This is an overall measure of human impact on the environment expressed as an equivalent land area required to support a person or group or activity.

A number of different methods of calculating the footprint have been proposed but there is no agreement yet as to which is the most appropriate. Each method implies assumptions about soil productivity, climate, atmospheric carbon assimilation and similar factors that vary considerably from place to place. The calculated footprints may therefore vary by 50% or more depending on the method used. Nevertheless, the concept is useful in comparisons of sustainability if the same method is adopted for all items being compared.

No attempt has been made to calculate a footprint for Ourimbah Campus in this report but we consider sufficient information is provided to enable calculations of this type in the future, if required, when there will probably be wider agreement about the best method. It could also be quite useful then to assess changes and trends by comparing the calculated Campus footprints at those future times with the footprint of today.

3.6 Community expectations at Ourimbah

As indicated in 1.1, the general community expects universities to play major roles in educating, instructing and advising about sustainability, and universities are also expected to contribute in similar ways to the United Nations Decade of Education. Both expectations may be at least partially met on Ourimbah Campus through our Recommendation 1, as follows:

> **RECOMMENDATION 1:**
>
> Form a small committee to monitor and publicize, over the next three years, the University of Newcastle courses that deal in detail with the major problems of sustainability. A thorough review of these courses should then be made, with input invited from all interested staff, students and community members. The review should investigate whether the major problems of sustainability are adequately treated in each relevant discipline (especially in economics, business, management and the social sciences). It should also examine the possible rationalization of courses and the case for a professional multidisciplinary degree course directed particularly towards finding effective solutions to sustainability problems as suggested in 1.5

As mentioned previously and set out in Box 1-1, the Talloires Declaration recognises that people throughout the world expect universities to assume part of the responsibility of finding effective measures to achieve sustainability and to counter threats to sustainability. If senior academics of The University of Newcastle or Ourimbah Campus agree that universities have such responsibilities, we suggest that this be acknowledged through our Recommendation 2.

> **RECOMMENDATION 2:**
>
> Consideration be given to the endorsement of the Talloires Declaration by The University of Newcastle. Alternatively, consideration be given to endorsement of the Declaration by The Ourimbah Campus, as a separate collaborative tertiary institution.

Communities also expect universities to provide models or examples of sustainability. Ourimbah Campus is highly favoured to become such a model because it is a relatively new campus, has many environmentally-friendly design features, and is in a natural bushland setting.

3.7 Towards a sustainable campus

Following Recommendations 1 and 2 above, this report will include other recommendations, all directed towards Ourimbah Campus becoming a model of sustainability.

For this purpose it is useful to adopt a 'vision for the future' as now commonly used by business corporations in their motivational strategies. Accordingly, the ideal sustainable Ourimbah Campus in our vision would have the following features:

- a relatively stable population of students and staff of about 7,500 (see 2.2),
- at least half of the student population resident on the Campus or within walking distance to the Campus,
- a spatial boundary that corresponds closely with the catchment boundary of Campus Creek, having no enclaves of private property or non-university development inside this boundary (see 2.4),
- a large proportion of the Campus upstream of the Loop Road under a stable forest cover similar to the original forest prior to European occupation, and with viable populations of most of the original plant species, including rare and endangered species,
- parts of the campus forest cover contiguous with areas of similar forest on adjoining properties to provide viable habitats for spatially demanding native animals,
- a Campus completely self-sufficient with regard to water and stationary energy supplies,
- no greenhouse gas emissions from stationary energy use on Campus,
- cycling, train and bus facilities so convenient that very few people travel to and from the Campus by car,

- no landfill waste, and all other solid waste materials either reused on Campus or recycled through approved agencies or companies,
- waste water and sewage discharged through the sewerage system for recycling and power generation by the Council or other approved agencies or companies.

Although it would be possible for most of the above features to be achieved under present circumstances, we do not envisage them all as short-term objectives, as explained in Section 9. In view of the predicted climate change scenarios and the possibility of a sudden decline in oil production, we consider the University should aim to achieve most of them by about 2030.

Although these features would be expected to remain relatively constant after 2030, that would not preclude desirable changes in other characteristics of the Campus to meet new requirements and circumstances beyond 2030. Nor would it preclude 'continuing growth' as a Campus goal if 'growth' is not defined in crude physical terms such as student numbers and economic criteria. To be consistent with sustainability, 'growth' must be redefined in relevant functional terms such as research achievements, improvements in the quality of education, or improvements in the quality of life for the Campus population, and also for the community it serves.

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4 CAMPUS PROPERTY AND PLANNING

4.1 Function and development

The Ourimbah Campus is a collaborative and integrated institution where educational courses and community activities are conducted by:

The University of Newcastle

TAFE NSW - Hunter Institute

Central Coast Community College.

Central Coast Aboriginal Studies Unit

Central Coast Area Health Services

NSW Department of Sport and Recreation

Community Environment Network

It was developed in stages during the 1990s, and the part of the Campus now occupied by roads, buildings, car parks and other constructed facilities is about 45 hectares in area (Figure 1). The undeveloped part of the Campus is about 35 hectares in area with mainly forest or woodland cover in a relatively natural condition.

4.2 Present and proposed population

Because of the nature of its courses and activities the Campus population varies considerably from hour to hour, day to day and month to month. In 1999 more than 4,000 students and 320 staff were reported to spend significant time on the Campus (Stanger et al, 2000).

Recently we were informed by administrative staff that the 2007 Campus population was about 3,800 'enrolled students' and about 260 'equivalent full time staff'. We were also informed that tentative 'master plans' envisage an ultimate student population of 7,000 to 8000 (Campus Director's Office).

In a transport survey in 2004 it was found that over 4,000 people travelled to the Campus each week day and 93% of these arrived by private car (Transit Planners P/L, 2004). However, the same survey indicated that there were no more than 1,500 people on the Campus at any one time.

4.3 Geographical setting

The western boundary of the Campus property is close to the railway line and Ourimbah railway station which is about 11 km from Gosford and 12 km from Wyong.

The climate of this part of the Central Coast may be described in general terms as coastal humid at the temperate-subtropical interface. An official Bureau of Meteorology weather station with long records (No.61087) is at Narara, 5 km southwest, and an official rainfall station with long records (No. 61093) is at Dogtrap Road, about 2km west.

Temperature differences of 2 to 4 degrees between Narara and the Campus may be expected because of the microclimatic effects of topography and vegetation. However, little difference would be expected between the rainfall at Dogtrap Road and the rainfall at the Campus (see 4.2).

The Campus building complex is on relatively flat land in the valley of an ephemeral watercourse which, for the purposes of this report, we have named Campus Creek. This drains into Bangalow Creek, a tributary of the Ourimbah Creek system that flows into Tuggerah Lakes. From the edges of the flat land of the main Campus area, the valley slopes rise steeply to a ridge line with elevations up to 85 metres above the building complex.

The ridge line forms a pronounced topographic basin or catchment with a total area of about 150 hectares draining into Campus Creek. As shown in Figure 1, this drainage system passes through the building complex to the confluence of Campus Creek and Bangalow Creek.

4.4 Significance of topographic basin

Topographic basins or catchment areas are natural spatial units that confine and concentrate gravity-dependent movements of biophysical agents such as water, air, sediment, pollutants and plant propagules. Topographic basin characteristics, particularly vegetation cover and slopes, strongly influence the environmental conditions of the valleys and downstream areas through which the concentrated movements of these agents occur.

As the main area of the Campus is at the outlet of a topographic basin, a significant reduction in the present forest cover of the basin could have quite adverse effects on the Campus. Reduction of the cover would cause accelerated soil erosion, silting of the Campus waterways and ponds, higher and more frequent flood levels, and water pollution. Forest cover reduction would also result in some deterioration of the Campus microclimate. This is because extremes of temperature and humidity in the valley are considerably moderated by air interchange with the upslope forest.

Additional, longer-term adverse impacts could be expected with significant upslope forest clearing. These would include intractable weed invasions and reduced biodiversity, as explained in 3.5.

Unfortunately, the potential for severe disturbance of the forest cover is high. With the continually growing demand for both urban and semi-rural housing on the Central Coast, the parts of the topographic basin outside the present boundaries of the Campus are likely to provide commercially attractive development sites in the future (see Figure 1). If such development occurs it will result in further upslope clearing of the forest with the likely detrimental effects described above.

It would greatly favour the future sustainability of the Campus if the forest cover of the basin could be preserved in its present condition, as suggested in Recommendations 3 and 4. Further strong justification for these is given in later sections.

RECOMMENDATION 3:

Recognise the need to protect and maintain the present forest cover on the topographic basin upslope of the main Campus area and request Wyong Council to effectively limit further development in the entire Campus Creek basin and adjoining forested areas.

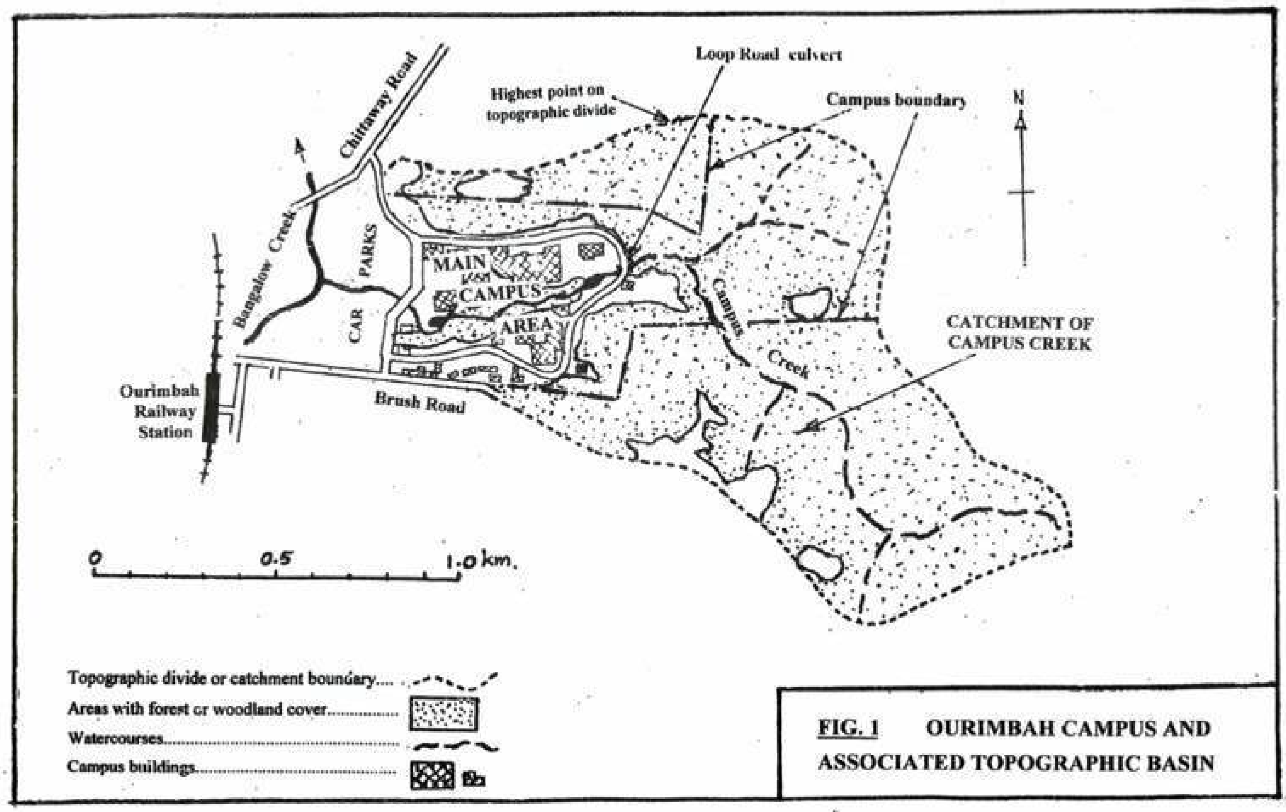

FIG. 1 OURIMBAH CAMPUS AND ASSOCIATED TOPOGRAPHIC BASIN

RECOMMEDATION 4:

In the Campus planning, consider acquisition of the adjoining properties in the topographic basin to ensure that land use on the properties remains completely compatible with the sustainability objectives of the Campus

4.5 Planning for the future

As suggested in 1.4 (Box 1-1), uncertainties about the future have recently increased, making planning more difficult than in the past. However, it is reasonably certain there will be continuing growth in population and urban development on the Central Coast for many years.

This growth, together with continuing measures to reduce coal-based electricity, petrol and water consumption, is likely to have the following consequences for the Campus:

- more students and staff,
- the need for more students and staff to travel to and from the Campus by public transport,
- the need for more students to live on or near the Campus,
- more urban development near the Campus.

At present, the number of people on the Campus at any particular time would rarely exceed 1600 (see 1.2 above), and surveys suggest that many lecture rooms are vacant for long periods. It is possible that significantly more students and staff could be accommodated with more efficient use of existing buildings. This suggests that the student population could possibly be stabilized at about 7500 with little increase in the area occupied by buildings.

As discussed in Section 6, planning for a larger student population in a possibly oil-depleted future should include measures to facilitate public transport to and from the Campus. At the same time there should be measures to discourage the use of private motor vehicles.

One of the original official Campus plans (Cox Richardson, 1994) shows a road to 'future student accommodation' in an area east of the present building complex. Such accommodation would favour Campus sustainability if a relatively large number of students could be satisfactorily housed with medium-density designed to minimise disturbance of the forest cover. There is at present a limited potential for students to find accommodation close to the Campus, the Ourimbah district being still largely rural. These circumstances seem likely to change in the near future, as suggested earlier.

Many properties in the Ourimbah district have been regarded by Wyong Council as unsuitable for urban development because of either steep topography or vulnerability to flooding. These constraints can now often be overcome with modern land reclamation and building methods, and such methods will undoubtedly be used to increase the supply of urban land when it is justified by the demand. This should also increase the potential for students to live near the Campus.

A substantial population of students residing on or near the Campus would also assist in creating a socially harmonious Campus community and improve the economic efficiency of recreational facilities, cafeteria, library etc.

RECOMMENDATION 5:

Stabilize Campus population at about 7,500 students and staff, with at least half of the students residing on or near the Campus. This may require the construction of high-rise student accommodation on Campus, and schemes to assist or encourage students to find other accommodation near the Campus.

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5 BIODIVERSITY CONSERVATION

5.1 Geology, terrain, soils and habitats

The biodiversity of an area depends essentially on the habitats and niches available to its plants and animals. In the natural world, the habitats and niches are usually closely related to the soils and terrain which may be regarded as products of geology-climate-time interactions.

Analyses of the relationships between these factors on the Central Coast have been made by McRae and Conacher (1980) and Benson (1986), and may be used to infer the original vegetation and potential biodiversity of the Campus site.

Accordingly, the Campus and its associated topographic basin (see 1.3 and Figure 1) may be regarded as a microcosm of the relatively undisturbed parts of the Ourimbah Creek catchment.

Two geological units are straddled by the Campus Creek catchment. The flat valley floor of the main Campus area is on Quaternary alluvial soils which are mainly silty loams. Around the edges of this, and in most of the catchment upstream of the Loop Road Culvert (see Figure 1) are hill slopes with medium to steep gradients on sandstones and shales of the Narrabeen series. The associated soils are mainly very shallow (skeletal) silts and fine to medium sand.

5.2 Original vegetation of valley floor

The alluvial valley floor is open to the west, and before European settlement probably supported several contrasting forest types.

One type would have had an open canopy dominated by large Sydney Blue Gums (*Eucalyptus saligna*), Turpentines (*Syncarpia glomifera*) and Swamp Mahoganies (*Eucalyptus* robusta), and would have been maintained by periodic burning by the local Aboriginal people.

In more sheltered positions there would have been patches of closed forest (rainforest) that did not readily burn and remained largely unchanged.

Prominent species in these would have been Coachwood (*Ceratopetalum apetalum*) and Lillypillies (*Acmena smithii*) with scattered Strangler Figs (*Ficus spp*), Red Cedars (*Toona ciliata*), White Beech (*Gmelina leichhardtii*), Native Tamarinds (*Diploglottis australis*) and large vines, with many smaller woody species. In the poorly drained areas there would have been Cabbage Palm (*Livistona australis*) and probably some dense stands of Paperbark (*Melaleuca* spp).

The borders between the fire-maintained open forest and the fire-suppressed closed forest would have varied in position over thousands of years, depending on such factors as drought, frost and grazing pressure from native wildlife, as well as the particular management practices of the Aboriginal population at the time.

During the early 1800s there was intensive timber cutting in all areas around Ourimbah by European settlers, resulting in almost complete removal of the most valuable timber trees (notably Red Cedar and White beech), and many of the other larger trees.

Later in the same century, most of the alluvial soils in the area were cleared for agriculture or horticulture (especially citrus orchards), and this would have included the site of the main Campus area. Residents report that this site was open pasture used mainly for grazing cattle and horses for many years before the Campus development commenced.

5.3 Original vegetation of hill slopes

Before European settlement, the hill slopes of the Campus Creek catchment would have supported an open-forest with a species composition not differing greatly from the present. On the steep slopes the prominent species apparently included Spotted Gums (*Eucalyptus maculata*), Grey Ironbarks (*E. siderophloia*) and Grey Gums (*E. punctata*). On the ridge tops, gentler slopes and valley floors, prominent species would have included Red Bloodwoods (*Eucalyptus gummifera*), Brown Stringybarks (*E. capitellata*), and Sydney Red Gums (*Angophora costata*). In the sheltered valleys there were probably also patches of rainforest with much the same species as the rainforest on the alluvial flats. Most of the forest of the hill slopes would have been periodically burnt in patches by Aboriginal people and on rare occasions it would have been severely burnt by wildfires.

After European settlement the periodic burning of forest by Aboriginal people ceased in this area but the frequency of burning by wildfire probably increased. As with the alluvial area, the largest and most valuable timber trees would have been removed from all parts of the hill slopes during the 1800s and early 1900s. During the 1900s before the Campus development commenced, a number of relatively small forest areas (totaling about 9 hectares) were cleared for grazing and rural residences around the ridge tops of the catchment, notably along Brush Road.

5.4 Present vegetation of valley floor

The alluvial soil underlying the main Campus area currently supports restored riparian vegetation along Campus Creek. Elsewhere in this area there remain a few relicts of pre-existing vegetation. These are species hardy enough to survive 200 years of logging, grazing and, more recently, the University development. The survivors include Sydney Blue Gums, Swamp Mahogany, Cabbage Palms and two Paperbarks, *Melaleuca biconvexa* and *Callistemon saligna*.

Along the waterway, other native species have been introduced or have recently spread downstream. These include Corkwood (*Duboisia myoporioides*), Bangalow Palm (*Archontophoenix cunninghamiana*), Black Wattle (*Callicoma serratifolia*), Euodia (*Melicope micrococca*), and Lillypillies (*Syzygium spp*).

On a single inspection, Drudge, Meldrum and Patterson (2004) identified 144 plant species, as listed in Table 3-1. Another 114 species known to be present in neighbouring areas and expected to be on the Campus are listed in Table 3-2.

Many species of exotic weeds can be found in the main Campus area and are controlled at present by the Campus ground staff. To do this effectively could become increasingly difficult, risky and costly if invasions from the upslope hilly terrain and watercourses become more frequent and persistent in the future.

5.5 Present vegetation of hill slopes

Although the open forest of the hill slopes probably still contains most of the native species it contained 200 years ago, some ecologically significant changes would have occurred. Because of past logging there is now little old-growth timber.

The giant Blue Gum, Turpentine, Blackbutt, Angophora and White Mahogany trees that were most likely once scattered throughout the area, are now largely absent. As these provided the hollows and other special niches that assist the survival of many animal species and some plant species (e.g. orchids, ferns, fungi, lichens and other epiphytes), the biodiversity of the area is now poorer than it was in the past.

Potential threats to the biodiversity and ecosystem integrity of the Campus should be recognised in the small cleared areas of grazing and residential land on the ridges of the catchment outside the Campus property, as mentioned in 3.3.

These areas are major sources of weed propagules and the nutrient rich runoff that enhances weed growth and kills some native plants. The vegetation in the cleared areas is largely exotic pasture grasses and weeds from which seeds and other reproductive material are washed into the watercourses and channels during rainfall events.

This material is then carried downstream into the native plant communities of the Campus. Here they compete with the native plants, tending to replace them with increasing vigour as the nutrient status of the land adjoining the waterway increases through nutrient-enriched runoff. The main sources of this nutrient enrichment are the grazing animals, fertilizers and related human activities in the cleared areas on the ridges.

5.6 Plant species absent or lost

Up to 200 years ago, the native ecosystems in the vicinity of the Campus had provided Aboriginal people with a diversity of plant and animal foods over some tens of thousands of years.

Whatever species may have been lost as a result of human intervention prior to European settlement, the effect was probably small compared to the huge impact that cultural change has had over the past 200 years. We now have an opportunity to care for the Campus in ways that may greatly reduce further losses of native species. We may even be able to re-introduce lost species still surviving elsewhere on the Central Coast.

An ultimate aim would be to increase the biological sustainability of the campus by introducing selected native species and by management practices that maximise the survival prospects of all native species in the Campus area.

On the alluvial soils, nearly all the larger fire-sensitive species (Strangler Fig, Red Cedar, White Beech, Native Tamarind, and the larger vines) have been eliminated by two centuries of logging and agriculture. These species still persist in isolated pockets in the Ourimbah area, although some may be on the brink of local extinction.

Some plants needing the shelter of a closed forest have also been lost or are very rare – several fern species, epiphytic orchids such as *Dendrobium gracilicaule* and *D. tetragonum*, and various forest floor plants such as Forest Lobelia (*Lobelia* trigonocaulis), and the diverse fungus flora that live in symbiosis with these and other plants.

Two particularly interesting species that persist near the main Campus, albeit precariously, are:

- Yellow Ash (*Emmenosperma alphitonioides*), a local rainforest tree. Two specimens have been discovered not far downstream of the Campus, on Bangalow Creek. These are isolated from other trees of the same species along Ourimbah Creek. Without intervention, it is doomed to local extinction but we could possibly ensure its conservation on campus as a genetically sustainable population.
- Christmas Orchid (*Calanthe triplicata*) which grows on more fertile soils in shady moist forests. It has been eliminated from most of the area as the more fertile soils have been developed for agriculture. It occurs in a few local gullies in genetically isolated groups. Again, the local genotypes of this species could be conserved on Campus.

It should be noted that a University of Newcastle grant was used recently to propagate seedlings of the Christmas Orchid from local surviving plants, as well as to investigate the fungus that lives in symbiosis with it (Patterson, 2005).

Other rare local species that could also possibly be preserved in the Campus Creek catchment are:

Acacia bynoena
Eucalyptus camfieldii
Syzygium paniculatum
Tetratheca glandulosa.

These have all been recorded recently in the Ourimbah Creek area (Schneider, 1999) and are officially classified as vulnerable or endangered under the Threatened Species Act 1995.

5.7 Past and present fauna

Despite the lack of old growth tree hollows there is reasonable habitat for many native birds, possums, reptiles, frogs and invertebrates. Such animals have frequently been observed but we are not aware of any systematic surveys to date to assess the species present in or near the Campus.

A survey of this type should be carried out at the earliest opportunity, and repeated about every 5 years to monitor significant changes in the Campus biodiversity.

It should also be useful to place a small number of nesting boxes and large pipes or similar items in selected parts of the forested area to compensate for the lack of tree hollows. If these are found to provide effective nests or shelters for appropriate native species, consideration should be given to placing more throughout the forested area.

The Ourimbah district is regarded as being very rich in faunal species, especially frogs and mammals. It also has a remarkable number of official recordings of endangered and vulnerable species as shown in Table 3.3. This lists 24 endangered and vulnerable vertebrates from the database prepared recently by National Parks and Wildlife Service (Schneider, 1999). Although none of these have yet been recorded in the close vicinity of the Campus it is likely that some would be present in the forested area or pass through it from time to time.

The long-term sustainability or viability of species such as those in Table 3-3 depends on their populations maintaining sufficient genetic diversity to cope with threats to their survival such as disease, habitat loss, climate change and competition from other species. To maintain this genetic diversity, it is probably necessary for the populations to comprise some hundreds of individuals able to interact with one another, and for each individual to have access to sufficient habitat area to provide food and other survival needs (Slatyer, 1977). Such requirements are unlikely to be met for many animal species in the relatively small forested area of the Campus property. If future losses of animal biodiversity are to be minimised, we will need to retain as much of the present Campus forest as possible, and also seek measures to ensure its present contiguity with larger areas of similar habitat.

The potential loss of essential habitat for survival is not the only threat to animal populations and biodiversity. Other threats include competition of native animals with feral animals such as rabbits, goats etc, and predation by foxes, dogs and cats. The desirability of limiting the potential impacts of dogs and cats provides additional reason for seeking measures to limit further agricultural or residential development in the entire Campus Creek catchment.

5.8 Conclusions and recommendations

It is fortunate that the Campus is located in a largely undeveloped topographic basin with good forest cover and a range of natural habitats. The biodiversity is therefore relatively rich although not as rich as pre-European occupation. There are good prospects of maintaining and possibly improving the vegetation biodiversity, and fair prospects of minimising future losses of animal biodiversity.

These objectives provide strong additional reasons for Recommendation 3 in 2.4, namely that the present forest cover of the topographic basin should be protected and maintained in its present condition.

A number of other suggestions have been made above to assist the conservation of Campus biodiversity. These are repeated below in Recommendations 6 to 9.

RECOMMENDATION 6:

Monitor changes in vegetation biodiversity by repeating the native plant species survey about every 5 years.

RECOMMENDATION 7:

Arrange a systematic fauna survey as soon as possible and repeat this every 5 years to monitor changes in faunal diversity.

RECOMMENDATION 8:

Establish a small number of nesting boxes and large pipes or similar items in selected areas of the forested part of the Campus for a trial period. If these are found to provide effective nests or shelter for native fauna consider placing many others throughout the area.

RECOMMENDATION 9:

If considered feasible, re-establish lost and endangered plant and animal species in appropriate locations on the Campus.

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TABLE 3-1: PLANT SPECIES IDENTIFIED ON CAMPUS GROUNDS 14/08/04

GENUS	SPECIES	FAMILY	COMMON NAME
Acacia	*irrorata*	*Mimosaceae*	Green Wattle
Acacia	*maidenii*	*Mimosaceae*	Black Wattle
Acacia	*prominens*	*Mimosaceae*	Gosford Wattle
Acacia	*fimbriata*	*Mimosaceae*	
Acmena	*smithii*	*Myrtaceae*	Lillipilly
Acrotriche	*divaricata*	*Epacridaceae*	
Adiantum	*aethiopicum*	*Adiantaceae*	
Adiantum	*hispidulum*	*Adiantaceae*	
Alectryon	*subcinereus*	*Sapindaceae*	
Allocasuarina	*torulosa*	*Casuarinaceae*	Forest Oak
Alocasia	*macrorrhizos*	*Araceae*	Cunjevoi
Alphitonia	*excelsa*	*Rhamnaceae*	Red Ash
Aneilema	*biflora*	*Commelinaceae*	
Angophora	*floribunda*	*Myrtaceae*	
Aristida	*sp*	*Poaceae*	
Archontophoenix	*cunninghamiana*	*Arecaceae*	Bangalow
Asplenium	*flabellifolium*	*Aspleniaceae*	
Backhousia	*myrtifolia*	*Myrtaceae*	Brush Myrtle
Billardiera	*scandens*	*Pittosporaceae*	Apple Berry
Blechnum	*cartilagineum*	*Blechnaceae*	
Breynia	*oblongifolia*	*Euphorbiaceae*	
Caladenia	*sp*	*Orchidaceae*	
Callicoma	*serratifolia*	*Cunoniaceae*	Black Wattle
Callistemon	*saligna*	*Myrtaceae*	Bottlebrush
Callistemon	*shiressii*	*Myrtaceae*	Bottlebrush
Calochilus	*robertsonii?*	*Orchidaceae*	Beardie
Canthium	*coprosmoides*	*Rubiaceae*	
Carex	*longebrachiata?*	*Cyperaceae*	
Centella	*asiatica*	*Umbelliferae*	
Cheilanthes	*sieberi*	*Adiantaceae*	
Cissus	*antarctica*	*Vitaceae*	Kangaroo Vine
Cissus	*hypoglauca*	*Vitaceae*	
Clerodendron	*tomentosum*	*Verbenaceae*	
Commelina	*cyanea*	*Commelinaceae*	
Comesperma	*sp*	*Polygalaceae*	
Commersonia	*fraseri*	*Sterculiaceae*	Brush Kurrajong
Cryptocarya	*glaucescens*	*Lauraceae*	Brown Beech
Cryptostylis	*erecta*	*Orchidaceae*	
Daviesia	*sp*	*Fabaceae*	
Davallia	*pixidata*	*Davalliaceae*	Haresfoot Fern
Desmodium	*rhytidophyllum?*	*Fabaceae*	
Dichelachne	*sp*	*Poaceae*	
Dichondra	*repens*	*Convulvulaceae*	
Digitaria	*sp*	*Poaceae*	
Dioscorea	*transversa*	*Dioscoreaceae*	Pencil Yam
Dodonaea	*triquetra*	*Sapindaceae*	Hop Bush
Doodia	*aspera*	*Blechnaceae*	Rasp Fern
Drosera	*sp*	*Droseraceae*	
Duboisia	*myoporoides*	*Solanaceae*	Corkwood
Echinopogon .	*sp*	*Poaceae*	

TABLE 3-1: PLANT SPECIES IDENTIFIED ON CAMPUS GROUNDS 14/08/04 (cont …)

GENUS	SPECIES	FAMILY	COMMON NAME
Elaeocarpus	*reticulatus*	*Elaeocarpaceae*	Blueberry Ash
Entolasia	*marginata*	*Poaceae*	Wiry Panic
Entolasia	*stricta*	*Poaceae*	
Eragrostis	*sp*	*Poaceae*	
Eucalyptus	*deanei???*	*Myrtaceae*	Dean's Gum
Eucalyptus	*pilularis*	*Myrtaceae*	Blackbutt
Eucalyptus	*robusta*	*Myrtaceae*	Swamp Mahogany
Eucalyptus	*saligna*	*Myrtaceae*	Sydney Blue Gum
Eustrephus	*latifolius*	*Philesiaceae*	Wombat Berry
Ficus	*coronata*	*Moraceae*	Sandpaper Fig
Ficus	*rubiginosa?*	*Moraceae*	Rusty Fig
Gahnia	*aspera?*	*Cyperaceae*	Cutty Grass
Galium	*sp*	*Rubiaceae*	
Geitonoplesium	*cymosum*	*Philesiaceae*	Scrambling Lily
Geranium	*homeanum?*	*Geraniaceae*	Cranesbill
Gleichenia	*dicarpa*	*Gleicheniaceae*	
Glycine	*clandestina*	*Fabaceae*	
Glochidion	*ferdinandii*	*Euphorbiaceae*	Cheese Tree
Goodenia	*heterophylla*	*Goodeniaceae*	
Guioa	*semiglauca*	*Sapindaceae*	
Gymnostachys	*anceps*	*Araceae*	Settlers Flax
Hibbertia	*dentata*	*Dilleniaceae*	Guinea Flower
Hibbertia	*scandens*	*Dilleniaceae*	Guinea Flower
Hydrocotyle	*geraniifolia*	*Umbelliferae*	
Hypolepis	*muelleri*	*Dennstaedtiaceae*	Downy Ground Fern
Imperata	*cylindrica*	*Poaceae*	Blady Grass
Kennedia	*rubicunda*	*Fabaceae*	
Juncus	*sp*	*Juncaceae*	
Lasiopetalum	*macrophyllum?*	*Sterculiaceae*	
Lepidosperma	*sp*	*Cyperaceae*	
Leptospermum	*polygalifolium?*	*Myrtaceae*	Tea Tree
Leucopogon	*lanceolatus*	*Epacridaceae*	
Lindsaea	*microphylla*	*Lindsaeaceae*	Lacy Wedge Firm
Livistona	*australis*	*Arecaceae*	Cabbage Tree
Lomandra	*longifolia*	*Xanthorrhoeaceae*	
Lycopodiella	*cernua*	*Lycopodiaceae*	
Marsdenia	*suaveolens*	*Apocynaceae*	
Marsdenia	*rostrata*	*Apocynaceae*	Common Milk Vine
Maytenus	*sylvestris*	*Celastraceae*	
Melaleuca	*biconvexa*	*Myrtaceae*	Paperbark
Melicope	*micrococca*	*Rutaceae*	Euodia
Microlaena	*stipoides*	*Poaceae*	
Microtis	*sp*	*Orchidaceae*	
Morinda	*jasminoides*	*Rubiaceae*	
Notelaea	*longifolia?*	*Oleaceae*	Olive Berry
Notothixos	*subaureus*	*Viscaceae*	Mistletoe
Oplismenus	*aemulus*	*Poaceae*	
Oplismenus	*imbecilis*	*Poaceae*	
Oxylobium	*Sp*	*Fabaceae*	
Ozothamnus	*diosmifolius*	*Asteraceae*	

TABLE 3-1: PLANT SPECIES IDENTIFIED ON CAMPUS GROUNDS 14/08/04 (cont …)

GENUS	SPECIES	FAMILY	COMMON NAME
Pandorea	*pandorana*	*Bignoniaceae*	Wonga Vine
Parsonsia	*straminea*	*Apocynaceae*	Common Silkpod
Phebalium	*sp*	*Rutaceae*	
Philydrum	*lanuginosum*	*Philydraceae*	
Persoonia	*linearis*	*Proteaceae*	
Pittosporum	*undulatum*	*Pittosporaceae*	Sweet Pittosporum
Pittosporum	*revolutum*	*Pittosporaceae*	Yellow Pittosporum
Platysace	*sp*	*Umbelliferae*	
Plectranthus	*parviflorus*	*Labiatae*	Cockspur Flower
Poa	*sp*	*Poaceae*	
Polyscias	*sambucifolius*	*Araliaceae*	Elderberry Panax
Pomax	*umbellata*	*Rubiaceae*	
Pomoderris	*sp*	*Rhamnaceae*	
Pratia	*purparescens*	*Lobeliaceae*	White Root
Pseuderanthemum	*variabile*	*Acanthaceae*	
Psilotum	*nudum*	*Psilotaceae*	Fork Fern
Pteridium	*esculentum*	*Dennsaedtiaceae*	Bracken
Pulteneae	*sp*	*Fabaceae*	
Rapanea	*howittiana?*	*Myrsinaceae*	Muttonwood
Rhodamnia	*rubescens*	*Myrtaceae*	Brush Turpentine
Rhodomyrtus	*psidioides*	*Myrtaceae*	
Ripogonum	*album*	*Smilacaeae*	Supplejack
Rubus	*hillii*	*Rosaceae*	
Rubus	*rosifolius*	*Rosaceae*	
Schelhammera	*undulata*	*Liliaceae*	Lilac Lily
Schizomeria	*ovata*	*Cunoniaceae*	
Schoenus	*melanostachys*	*Cyperaceae*	
Senecio	*sp*	*Asteraceae*	
Sigesbeckia	*orientalis*	*Asteraceae*	
Smilax	*australis*	*Smilacaceae*	Lawyer Vine
Smilax	*glyciphylla*	*Smilacaceae*	Sweet Sarsaparilla
Lagenifera	*stipitata*	*Asteraceae*	
Stephania	*japonica*	*Menispermaceae*	Snake Vine
Syncarpia	*glomulifera*	*Myrtaceae*	Turpentine
Synoum	*glandulosum*	*Meliaceae*	Bastard Rosewood
Syzygium	*paniculatum?*	*Myrtaceae*	Brush Cherry
Themeda	*australis*	*Poaceae*	Kangaroo Grass
Trochocarpa	*laurina*	*Epacridaceae*	
Vernonia	*cinerea*	*Vernonieae*	
Viola	*betonicifolia*	*Violacaeae*	
Viola	*hederacea*	*Violacaeae*	Creeping Violet
Wahlenbergia	*sp?*	*Campanulaceae*	
Wilkiea	*huegeliana*	*Monimiaceae*	
Zieria	*smithii*	*Rutaceae*	

TABLE 3-2: PLANT SPECIES EXPECTED ON CAMPUS GROUNDS 2007

GENUS	SPECIES	FAMILY	COMMON NAME
Acacia	*elata*	*Mimosaceae*	Cedar Wattle
Acacia	*schinoides*	*Mimosaceae*	Blue Skin
Acronychia	*oblongifolia*	*Rutaceae*	
Acronychia	*wilcoxiana*	*Rutaceae*	
Adiantum	*formosum*	*Adiantaceae*	Giant Maidenhair
Amyena	*congener*	*Loranthaceae*	a Mistletoe
Aneilema	*acuminatum*	*Commelinaceae*	
Aphanopetalum	*resinosum*	*Cunoniaceae*	
Asplenium	*australasicum*	*Aspleniaceae*	Birds Nest Fern
Azolla	*filiculoides*	*Azollaceae*	Water Fern
Baloghia	*lucida*	*Euphorbiaceae*	
Baumea	*articulata*	*Cyperaceae*	
Blechnum	*nudum*	*Blechnaceae*	Gristle Fern
Bolboschoenus	*caldwellii*	*Cyperaceae*	
Brachychiton	*acerifolius*	*Sterculealeae*	Flame Tree
Caladenia	*carnea*	*Orchidaceae*	Pink Fingers
Calanthe	*triplicata*	*Orchidaceae*	Christmas Orchid
Calochlaena	*dubia*	*Dicksoniaceae*	
Carex	*appressa*	*Cyperaceae*	
Cayratia	*clematidea*	*Vitaceae*	
Cephalaralia	*cephalobotrys*	*Araliaceae*	Climbing Panax
Ceratopetalum	*apetalum*	*Cunoniaceae*	Coachwood
Chiloglottis	*reflexa*	*Orchidaceae*	
Choricarpia	*leptopetala*	*Myrtaceae*	Brown Myrtle
Citriobatus	*pauciflorus*	*Pittosporaceae*	Orange Thorn
Citronella	*moorei*	*Icacinaceae*	Churnwood
Claoxylon	*australe*	*Euphorbiaceae*	Brittlewood
Clematis	*aristata*	*Ranunculaceae*	Old Mans Beard
Clematis	*glycinoides*	*Ranunculaceae*	
Corybas	*aconitifolius*	*Orchidaceae*	
Croton	*verrauxii*	*Euphorbiaceae*	Cascarilla
Cryptocarya	*microneura*	*Lauraceae*	
Cuscuta	*australis?*	*Convolvulaceae*	a Dodder
Cynodon	*dactylon*	*Poaceae*	
Cyperus	*brevifolius*	*Cyperaceae*	
Daucus	*glochidiatus*	*Umbelliferae*	
Decaspermum	*parviflorum*	*Myrtaceae*	
Dianella	*caerulea*	*Liliaceae*	
Diosporus	*australis*	*Ebenaceae*	
Diosporus	*pentamera*	*Ebenaceae*	
Diploglottis	*australis*	*Sapindaceae*	Native Tamarind
Dipodium	*punctatum*	*Orchidaceae*	
Doryphora	*sassafras*	*Monimiaceae*	Sassafras
Echinopogon	*caespitosus*	*Poaceae*	Hedgehog Grass
Ehretia	*acuminata*	*Ehretiaceae*	
Elaeocarpus	*obovatus*	*Elaeocarpaceae*	
Eleocharis	*sp.*	*Cyperaceae*	Spike Rush
Embelia	*australiana*	*Myrsinaceae*	
Emmenosperma	*alphitonioides*	*Celastraceae*	Yellow Ash
Endiandra	*discolor*	*Lauraceae*	

TABLE 3-2: PLANT SPECIES EXPECTED ON CAMPUS GROUNDS 2007 (cont ..)

GENUS	SPECIES	FAMILY	COMMON NAME
Endiandra	*sieberi*	*Lauraceae*	
Epilobium	*billardierianum*	*Onagraceae*	Willow Herb
Eupomatia	*laurina*	*Eupomatiaceae*	
Ficus	*obliqua*	*Moraceae*	Strangler Fig
Flagellaria	*indica*	*Flagellariaceae*	
Gahnia	*clarkei*	*Cyperaceae*	
Gmelina	*leichardtii*	*Verbenaceae*	White Beech
Hibiscus	*heterophyllus*	*Malvaceae*	Native Rosella
Hymenosporum	*flavum*	*Pittosporaceae*	Native Frangipani
Legnephora	*moorei*	*Menispermaceae*	Roundleaf Vine
Litsea	*reticulata*	*Lauraceae*	Bolly Gum
Lobelia	*trigonocaulis*	*Lobeliaceae*	Lobelia
Lomatia	*myricoides*	*Proteaceae*	
Ludwigia	*peploides*	*Onagraceae*	
Maclura	*cochinchinensis*	*Moraceae*	Cockspur Thorn
Malaisia	*scandens*	*Moraceae*	Burny Vine
Marsdenia	*flavescens*	*Apocynaceae*	Hairy Milk Vine
Melodinus	*australis*	*Apocynaceae*	
Neolitsea	*dealbata*	*Lauraceae*	White Bolly Gum
Notelaea	*venosa*	*Oleaceae*	
Omalanthus	*populifolius*	*Euphorbiaceae*	Bleeding Heart
Palmeria	*scandens*	*Monimiaceae*	Anchor Vine
Parsonsia	*velutina*	*Apocynaceae*	
Passiflora	*herbertiana*	*Passifloraceae*	Native Passionfruit
Pellaea	*falcata*	*Adiantaceae*	Sickle Fern
Pellaea	*paradoxa*	*Adiantaceae*	
Persicaria	*decipiens*	*Polygonaceae*	Water Pepper
Persicaria	*hydropiper*	*Polygonaceae*	Water Pepper
Persicaria	*orientalis*	*Polygonaceae*	
Persicaria	*strigosa*	*Polygonaceae*	Water Pepper
Planchonella	*australis*	*Sapotaceae*	Black Apple
Platycerium	*bifurcatum*	*Polypodiaceae*	Stagshorn Fern
Plectorrhiza	*tridentata*	*Orchidaceae*	Tangle Orchid
Pollia	*crispata*	*Commelinaceae*	
Polygola	*apathifolium*	*Polygonaceae*	
Polyosma	*cunninghamii*	*Escalloniaceae*	Featherwood
Polyscias	*murrayi*	*Araliaceae*	Pencil Cedar
Prunella	*vulgaris*	*Labiateae*	
Psychotria	*loniceroides*	*Rubiaceae*	
Ranunculus	*inundatus*	*Ranunculaceae*	River Buttercup
Ranunculus	*plebeius*	*Ranunculaceae*	Hairy Buttercup
Rapanea	*variabilis*	*Myrsinaceae*	Muttonwood
Ripogonum	*fawcettianum*	*Smilacaeae*	Small Supplejack
Rubus	*aff. moorei*	*Rosaceae*	
Sarcomelicope	*simplicifolia*	*Rutaceae*	Yellowwood
Sarcopetalum	*harveyanum*	*Menispermaceae*	Pearl Vine
Scolopia	*braunii*	*Flacourtiaceae*	Flintwood
Sloanea	*australis*	*Eleaocarpaceae*	Maidens Blush
Solanum	*aviculare*	*Solanaceae*	Kangaroo Apple
Solanum	*vescum*	*Solanaceae*	Kangaroo Apple
Stenocarpus	*salignus*	*Proteaceae*	Beefwood
Symplocos	*thwaitesii*	*Symplocaceae*	

TABLE 3-2: PLANT SPECIES EXPECTED ON CAMPUS GROUNDS 2007 (cont …)

GENUS	SPECIES	FAMILY	COMMON NAME
Tasmannia	*insipida*	*Winteraceae*	
Toona	*australis*	*Meliaceae*	Red Cedar
Trema	*aspera*	*Ulmaceae*	Poison Peach
Tristania	*neriifolia*	*Myrtaceae*	Water Gum
Tristaniopsis	*laurina*	*Myrtaceae*	Water Gum
Typha	*domingensis*	*Typhaceae*	Cumbungi
Tylophora	*barbata*	*Asclepiadaceae*	

TABLE 3-3: ENDANGERED AND VULNERABLE VERTEBRATES UNDER TSC ACT 1995 FOUND NEAR OURIMBAH (from NPWS database)

Mammals

Bent-wing Bat	*Miniopteris schreibersii*
Koala	*Phascolarctus cinereus*
Large-footed Mouse	*Myotis adversus*
Little Bent-wing Bat	*Miniopteris australis*
Long-nosed Potoroo	*Potorous tridactylus*
Parma Wallaby	*Macropus parma*
Red legged Pademelon	*Thylogale stigmatica*
Squirrel Glider	*Petaurus norfolcensis*
Tiger Quoll	*Dasyurus maculatus*
Yellow-bellied Glider	*Petaurus australis*
Yellow-bellied Sheathtail Bat	*Saccolaimus flavientris*
Eastern Little Mastiff Bat	*Mormopterus norfolkensis*

Birds

Barking Owl	*Ninox connivens*
Glossy black Cockatoo	*Calyptorhynchus lathami*
Masked Owl	*Tyto novaehollandiae*
Powerful Owl	Ninox stenua
Sooty Owl	*Tyto tenebricosa*
Superb Fruit-dove	*Ptilinopus superbus*

Reptiles and Amphibians

Giant Burrowing Frog	*Heleioporus australiacus*
Green-thighed Frog	*Litoria brevipalmata*
Pale-headed Snake	*Hoplocephalus bitorquatus*
Red-crowned Toad	*Pseudophryne australis*
Stephens Banded Snake	*Hoplocephalus stephensii*
Stuttering Frog	*Mixophyes balbus*

6 WATER USE AND CONSERVATION

6.1 Introduction

Water inputs to the Campus are from:

- the Gosford-Wyong supply system,
- rainfall on the Campus
- surface runoff and subsurface drainage to the Campus from other parts of the catchment

Water outputs from the Campus occur through:

- the Gosford-Wyong sewerage system,
- surface and subsurface drainage from the Campus, most of which flows into Bangalow Creek,
- evapotranspiration from vegetation, soil and other surfaces within the Campus.

Quantitative estimates of the above inputs and outputs have been made below. These are useful for assessing the sustainability of water supplies, and how they may be used more efficiently.

6.2 Input from supply system

Estimates of inputs from the Gosford-Wyong supply system were made from water consumption data provided by the University of Newcastle for September 2003 to August 2004.

The corresponding estimates for 2006-7 were made by increasing the 2004 data by 10% to allow for the increase in Campus population since that date. Fig. 2 shows the resulting cumulative consumption plotted graphically and smoothed to reduce irregularities peculiar to 2004. The slope of the smoothed curve at any time of the year gives an estimate of the generalised input supply rate and, in the absence of actual data, this provides estimates of present consumption rates (2006-7).

The present input/consumption, as obtained from Fig. 2, ranges from about 24 kilolitres/day in the

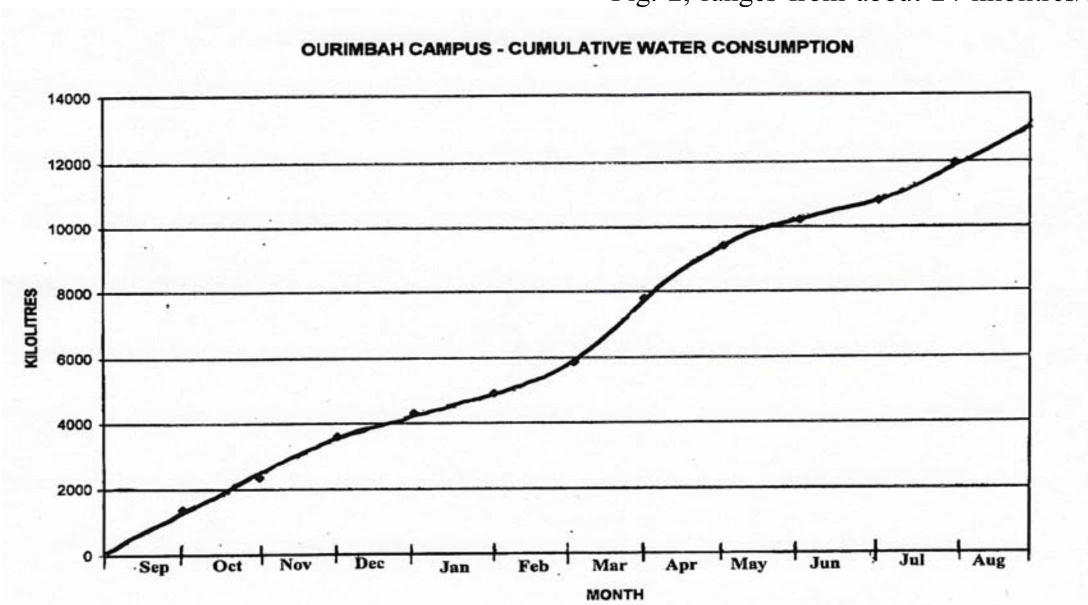

Fig. 2 Estimated cumulative water consumption Sep 2006- Aug 2007 (adjusted 2003-4 data)

vacation periods up to about 65 kilolitres/day in February-March during Semester. Averaged over a year it is about 36 kilolitres/day.

The total annual consumption of water by the Campus in 2007 is therefore about 13 megalitres (ML). Most of this is used by students and staff for toilets, washing, drinking and other domestic purposes. About 10% (1.3 ML) would be consumed for miscellaneous purposes such as gardening and ground maintenance, leakage loss and evaporation loss (based on Bell, 1972, 1988 and discussions with University staff).

6.3 Input from rainfall

The closest official rainfall station with long records is Ourimbah (Bureau of Meteorology Station No.61093), located 2 km west of the Campus. Regional isohyet maps show that the rainfall characteristics here would be essentially the same as those of the Campus. Accordingly, the station's records for the 27-year period 1976-2002 give the following:

> Average annual rainfall: 1350 mm
>
> Lowest decile of annual rainfall: 880 mm (representing a very dry year)
>
> Highest decile of annual rainfall: 1950 mm (representing a very wet year).

In common with water supply systems throughout Australia, the Gosford-Wyong supply system has been severely affected by drought in recent years, and more frequent drought conditions have been predicted as a result of global climate change.

Rainfall on building roof areas has therefore been recognised as a potential supplementary water source, and many supply authorities are now promoting the installation of roof tanks for storing and using this water.

The total roof area of Campus buildings is estimated to be 2.8ha and the potential water yield from rainfall on this has been calculated as follows:

> Average year (1350 mm rainfall): 26 ML (assuming 30% overflow)
>
> Dry year (880 mm rainfall): 22 ML (assuming 10% overflow)
>
> Wet year (1950 mm rainfall) 28 ML (assuming 50% overflow).

These amounts are considerably larger than the present annual water consumption of about 13 ML

The water requirements of the Campus could therefore be met in most years from the rainfall on about half the total roof area, with appropriate facilities for storage, treatment and distribution.

6.4 Surface runoff to Campus

Most of the surface runoff to the Campus is concentrated in Campus Creek which has a catchment area of 89 ha above the Loop Road and 150 ha at the western University boundary near the car parks (see Fig 1).

In analyses by Bell (2001) of the 24-year Ourimbah Creek streamflow record and corresponding catchment rainfall, the following rainfall-runoff relationships were found:

> 31 percent of the rainfall becomes runoff in an average year,
>
> 6 percent of the rainfall becomes runoff in a very dry (lowest decile) year,
>
> 46 percent of the rainfall becomes runoff in a very wet (highest decile) year.

	Average Year	**Very Dry Year** (lowest decile)	**Very Wet Year** (highest Decile)
Catchment Rainfall (mm)	1350	880	1950
Runoff percentage (%)	31	6	46
Catchment Runoff u/s Loop Road (ML)	330	40	820
Catchment Runoff d/s Loop Road (ML)	370	120	780
Total Catchment Runoff at outlet (ML)	700	160	1600

TABLE 4-1 ESTIMATES OF RUNOFF TO CAMPUS CREEK

As the natural Campus vegetation and terrain are reasonably similar to those of the Ourimbah Creek catchment it is appropriate to assume the same percentages for the 'natural' or 'pervious' areas of the Campus catchments. It is also appropriate to assume 100% of the rainfall on impervious areas (roads, carparks, roofs etc) becomes runoff, enabling estimates of runoff to Campus Creek as shown in Table 4-1.

The confluence of Campus Creek and Bangalow Creek is regarded as the runoff outlet for the estimates of Table 4-1. At this point the annual runoff ranges from about 160 ML in a very dry year to 1600 ML in a very wet year.

At particular times the flows at the outlet are extremely variable. Periods of virtually no flow may prevail for many months under drought conditions while instantaneous flows exceeding 3000 Ml/day may occur in extreme floods (as may be estimated from data in Institution of Engineers, Australia, 1987).

Table 4-1 also shows the estimated runoff at the Loop Road culvert is about 330 ML in an average year, and ranges from 40 ML to 880 ML in very dry and very wet years respectively. The instantaneous flow here averages 0.9 ML/day and ranges from zero to more than 2000 ML/day.

6.5 Subsurface flow and groundwater

Very reliable estimates of the proportion of the rainfall that recharges groundwater and/or becomes subsurface flow are not possible with the available data, but in an average year it is probably of the order of 10% (Bell, 2006). This would be equivalent to about 240 ML/year over the 150 ha catchment of Campus Creek. As explained below, there is good evidence that this groundwater could be another satisfactory source of water supply within the Campus, if required.

Because of the continuing drought conditions in recent years, Wyong and Gosford Councils have commenced exploring the potential of groundwater in various parts of the Central Coast for supplementing the public supply. Test bores for this purpose have been sunk in Sohier Park adjoining the Campus and according to Wyong Council (pers com) have given steady yields of about 1.0 to 1.5 ML/day of good quality water at relatively shallow depths. Similar yields would be expected from bores at appropriate points on the Campus. If such yields were sustainable, the current Campus water demand of 13 ML per year could be readily met by two bores operating for less than 20 hours per month.

6.6 Water outputs from Campus

After consumption, most of the water supplied to the Campus each year is discharged into the Gosford-Wyong sewerage system. This does not include water used for miscellaneous purposes such as lawns and gardens, losses through leakage, evaporation etc, and some of the water used for cooking, drinking and washing. Making allowances for such items it is estimated that the water output from the Campus through the sewerage system is about 11 ML per year.

The calculated flows at the catchment outlet in Table 4-1 may be regarded as water outputs if they are not used. Under flood conditions these flows should be as unrestricted as possible, and particular attention was apparently given to this in the hydraulic design of the waterway. Before the Campus was established, it was known that several past floods (notably 1988 and 1992) had inundated much of the site and to avoid this happening again, the original channel was substantially enlarged.

Additional flood mitigation measures have been incorporated in the waterway design with four retention ponds. These are in the form of an ornamental lake, a 'farm dam', and two additional ponds adjoining the car parks (see Fig. 1).

Estimates of the water losses from an area through evapotranspiration over a reasonably long periods may be made with a simple water balance equation, namely:

Evapo transpiration = rainfall - runoff – groundwater recharge.

If this equation is applied to the data in Table 2, assuming 10% of the rainfall becomes groundwater recharge, the estimated annual evaporation losses from the main Campus area and total topographic basin are 675 ML and 1332 ML respectively.

6.7 Water quality

As no significant air pollution has been reported in the Ourimbah district, rainwater on the Campus should generally be safe to drink. When diverted from roofs into tanks it may take up small quantities of contaminants such as bird droppings, plant matter and dust. However, thousands of residents of the Central Coast have been drinking this water for many years with no treatment, and its quality is probably as good as tap water from the public supply.

Nevertheless, if there are likely to be concerns about possible contamination of roof tank water, inexpensive systems are available to prevent entry of the contaminants and also to chemically sterilise the water.

The water quality in the ornamental lake has been checked occasionally with standard 'waterwatch' measurements of dissolved oxygen, pH, nitrates, phosphates, turbidity, dissolved solids and *E. coli.* Although these suggest that the water quality in Campus Creek is generally good, more frequent measurements are desirable because of the large variability of flow conditions.

A permanent water quality monitoring site should be established on the lake with observations at regular fortnightly intervals and at additional times, if possible, during and after significant rainfall events.

The original landscape design provided for the recirculation of water between the lake and farm dam to assist in maintaining water quality through aeration, and to facilitate its use for irrigating lawns and gardens. We were informed that this system has not been used for many years as the lawns and native gardens require little watering.

Appropriate aquatic and riparian vegetation have been established in and around the lake and dam, and these would assist in aerating the water and maintaining its quality. Nevertheless, we consider that the relatively undisturbed forest/woodland cover of the catchment area is the most important factor in maintaining the water quality.

As mentioned in 2.4, removal or disturbance of the forest/woodland cover of the catchment could have very detrimental effects on the waterway system through the Campus. Increased soil erosion and deposition through disturbance of the catchment vegetation would cause an increase in water turbidity. If such disturbance is associated with land development resulting in more people living in or using the catchment, other types of water pollution may also be expected. This would be from waste disposal, fertilizers, pesticides, grazing animals etc.

The need to prevent the above adverse impacts provides strong support for our important Recommendation 3 in Section 2.4.

6.8 Other recommendations

From this analysis it is clear that the available natural supplies of water from rainfall, groundwater and catchment runoff are quite substantial. Even under conditions of continuing drought with feasible climate change it would be possible for the Campus to become completely self-sufficient in this resource if required.

The following recommendations are made to maintain this potential and to reduce the present use of water from the public supply system:

RECOMMENDATION 10:

Install tanks and infrastructure of appropriate size to catch, store and distribute roof water from as many Campus buildings as possible.

RECOMMENDATION 11:

Establish a permanent monitoring system on the ornamental lake to monitor the 'standard' water quality parameters adopted in the NSW Government's 'waterwatch' system for schools and conservation groups. The observations and measurements should be made regularly at least once per fortnight, and also during and after significant rainfall events.

RECOMMENDATION 12:

Maintain contacts with the groundwater investigation program of Gosford and Wyong Councils. If the program continues, the Councils should be requested to establish test bores within the main Campus area and also at higher elevations in the Campus Creek valley.

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7 STATIONARY ENERGY USE AND EMISSIONS

7.1 Existing energy saving features

The original Campus design by architects Cox Richardson incorporated a number of energy-saving and environmentally desirable features. These included:

- Stands of indigenous trees and shrubs, vegetated screen plantings and large ponds of water amongst buildings to assist the microclimatic moderation of extreme high and low temperatures.
- Buildings elongated east and west with generous roof overhangs to the north to minimise exposure to the hot summer sun.
- Skylights and other natural lighting, and high windows located to provide natural cross-ventilation in many buildings.
- Cars concentrated near Campus entrances well away from most buildings.
- Electrically operated cars for rapid, quiet and pollution-free transport of security and maintenance staff around the Campus.
- Provision for an off-road bicycle way through the middle of the Campus from east to west with extensions to the playing fields and Ourimbah railway station.

Most of the above features are reasonably effective, although the natural cross-ventilation window system, is not used much because most buildings are kept cool through air conditioning. Also, the potential for off-road bicycle use through the Campus, has not yet been developed.

There is little doubt, however, that the concentrating of cars away from buildings and the use of electric cars by security staff contribute to the absence of air pollution and noise that are often detrimental in other educational institutions. There is also little doubt that some of the other features assist in keeping the energy requirements and costs for the Campus reasonably low. Nevertheless, there is still the potential for further reducing the use of electrical power and the corresponding greenhouse gas emissions. Such reductions would also be economically beneficial.

A significant deficiency in the environmental design features of the Campus, as acknowledged by Cox Richardson (2003), is that no renewable energy initiatives were specified. Such features could have included the provision of hot water from solar heating or from the incineration of combustible wastes.

7.2 Current electricity consumption

The current (2007) electricity consumption is estimated to be about 4.4 GWh/year, based on the adjusted 2004 data. This power is all from the supply network and at least 90% of it may be assumed to be generated in coal based power stations.

According to various references (e.g. Australian Bureau of Statistics, 2006; Australian Greenhouse Office, 2005), each KWh of electrical power used in NSW results in the emission of about 0.90 tonnes of CO_2 e (greenhouse gas equivalent carbon dioxide), and the annual Campus consumption therefore results in emissions of about 4,000 tonnes of CO_2 e per year.

7.3 Reducing current consumption

Large, and possibly excessive, components of the present Campus electricity consumption would be due to (a) the air conditioning systems, (b) heating of hot water, and (c) computers, printers and photocopiers. The following recommendations are therefore made:

RECOMMENDATION 13:

Commission a professional energy audit to advise in detail on energy use and the minimisation of carbon emissions throughout the Campus. This could indicate the need for replacing some present equipment with more energy-efficient equipment, using gas instead of electrical power for some applications, better energy management practices, and modifications to buildings to improve lighting, insulation, ventilation etc.

RECOMMENDATION 14:

In addition to any audit advice, give particular attention to energy usage by Campus computers. Appropriate models should be selected and operated with energy saving settings and efficient practices.

RECOMMENDATION 15:

In buildings where water heating is a major item, consider the installation of solar water heating systems.

RECOMMENDATION 16:

Create a non-academic professional position with a title such as 'sustainability officer' or 'environmental officer' whose duties would include (a) ensuring resource- efficient and environmentally desirable measures and practices are followed in all parts of the Campus, (b) monitoring and reporting on the effectiveness of these measures and practices, and (c) making recommendations at appropriate times to advance the sustainability of the Campus.

7.4 Need for a professional energy audit

Our inquiries have suggested that professional energy audits typically reveal energy wastages of 30% in institutions such as universities. The costs of modifications to eliminate such wastages are often recovered quickly, as shown by standard treasury evaluation criteria for capital works. For example, a recent audit at the Australian National University found Computer operating practices were a significant source of energy wastage and cost.

The recommended more efficient operating practices for a typical desktop PC (such as turning the screen off at night and setting the sleep mode to operate during periods of inactivity) reduced the power consumption from 860 KWh/year to 130 KWh/year, with corresponding reductions in annual energy costs and CO_2e emissions (ANU nvironmental Management Office, 2004).

7.5 Water heating as a major source of consumption

In other residential and institutional buildings, water heating is a major consumer of energy, and often accounts for 30% or more of the total consumption. Efficient systems for the solar heating of water are now available and the conversion of other water heating systems to solar heating is usually regarded as the most cost-effective measure for significantly reducing greenhouse gas (GHG) emissions.

This applies particularly to domestic and institutional activities. Expert advice on the most appropriate and cost-effective solar heating system for the Campus would be an important outcome of the suggested professional energy audit, and could result in substantial economic savings.

7.6 Power from photovoltaic panels

It should be possible to greatly reduce the dependence of the Campus on the public power supply system, and perhaps eventually make it completely independent, with an ambitious program to directly generate power on the Campus from photovoltaic roof panels.

This could be done on a relatively large scale because of the general east-west alignment of the Campus buildings, and more than 10,000 square metres of unobstructed, north-sloping roof area. Data from Apricus (2007) indicate that total solar energy receipts by this area are about 17.5 GWh per year, i.e. four times the total Campus consumption.

Nevertheless, with present commercially available photovoltaic panels, little more than 2 GWh per year could be generated from the above area and the net cost could be as high as $8 million (even allowing for Government rebates and the value of renewable energy certificates).

It therefore appears that the installation of large areas of photovoltaic panels on Campus buildings would not be justified at the present time. However, rapid advances are currently being made in solar energy technology and considerably cheaper, more efficient photovoltaic panels are certain to be available in the near future. We believe this potential should be thoroughly reviewed in 5 or 6 years time and the large-scale use of solar electrical energy on the Campus be planned as a desirable, longer-term objective (see Recommendation 19).

In the meantime, it would be appropriate for some experimental testing of recent developments in solar energy generation to be carried out on the Campus, as in Recommendation 17.

RECOMMENDATION 17:

Set up experimental tests on one of the newly proposed systems for generating solar energy, and use it to assist in recharging the batteries of the electric cars used by security staff. If the energy source for these cars could be made directly renewable in this way they would deserve and gain greater recognition as an innovative, environmentally sustainable feature of the Campus.

7.7 Potential for wind energy

We understand the University of Newcastle has an active Wind Energy Group, and in many parts of Australia wind seems a more practical and economic source of renewable energy than solar power.

At first glance, Ourimbah Campus does not appear to be very promising in this regard as the main building complex is in a well sheltered valley. Nevertheless, there may be some wind energy potential at the highest point on the topographic divide just outside the northern boundary of the Campus, as shown in Fig. 1.

This highest point is an isolated knoll 80 to 90 metres above the general level of the Campus, and with good exposure to the wind in every direction (above a 5 metre high tree canopy). The site should therefore be brought to the attention of the University's Wind Energy Group.

RECOMMENDATION 18:

Request the University of Newcastle Wind Energy Group to examine the highest point on the topographic divide just outside the northern boundary of the Campus (as shown in Fig. 1) and advise on its potential for the generation of wind energy for the Campus.

7.8 Other energy sources for the Campus

With the growing concern about global warming and the distinct possibility of an energy revolution in the near future, no forms of renewable energy should be dismissed as insignificant without careful investigation.

This applies particularly in a university context where innovation and the questioning of convention should flourish. Accordingly, some unlikely but nevertheless conceivable Campus energy sources should be mentioned. One of these is the small, but potentially useful, source of hydro-electricity in Campus Creek.

In recent years, very efficient micro hydroelectric generators have been developed to supply power to small settlements from streams with intermittent flows of similar magnitude to those of Campus Creek. (Commonwealth of Australia, 2005).

A number of these have reversible turbine/generator assemblies capable of delivering power supplies from 300 Watts up to 20 KW (depending on the fall and prevailing flows). In 2005 their cost ranged from about $3000 to $50,000. The reversibility feature enables them to also pump water back to the source with energy inputs only about 30 % larger than their supply capabilities.

For effective operation a micro hydroelectric generator usually requires a small weir and storage on the selected stream, and a fall of at least 8 metres to the delivery point. We consider several sites meeting these requirements are available on upper reaches of Campus Creek.

Although a micro hydroelectric generator system could be a useful supplementary source of electrical energy when Campus Creek is flowing it could possibly be of greater value for storing surplus energy from solar and/or wind generating systems when it is not otherwise required (for example at weekends or during holidays).

At these times the surplus energy is used to pump water up into the weir where it remains available for hydroelectric energy generation when required. Pumped storages such as this are more efficient storages of surplus energy than the batteries normally used with solar and wind generation.

We therefore suggest that, if consideration is given to the installation of substantial Campus solar and/or wind generating systems in the future, detailed consideration should also then be given to a complementary micro hydroelectric and pumped storage system on Campus Creek.

Another possible, but perhaps currently unattractive source of renewable energy for the Campus, is from the incineration and/or biotechnological treatment of organic waste such as paper, food scraps, leaves, sticks, plant and grass clippings. Heat from either direct combustion of the waste or from combustion of fuels produced by its biotechnological treatment may possibly be used as a supplementary source of hot water or to generate electrical power.

Although incinerators developed in the past for power generation have been unpopular because of unwanted emissions and residues, these problems have apparently now been eliminated. A number of systems claimed to have no adverse environmental impacts have recently become commercially available.

We understand this technology, as for solar energy technology, is progressing rapidly at present and should be significantly improved in the near future. The following recommendation is therefore made:

RECOMMENDATION 19:

Commission a thorough review in about 2013 or 2014 of new technology in solar energy generation, microhydroelectric energy generation and storage, and energy-generating incineration. Consider the potential of these processes, either singly or in combination, as supplementary energy sources for the Campus.

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8 TRANSPORT ENERGY USE AND EMISSIONS

8.1 Significance of fuel depletion

Stationary energy use by the Campus is almost entirely dependent on coal, while transport energy use is almost entirely dependent on petroleum fuels. Unlike coal, world reserves of petroleum fuels are reported to be declining rapidly. This has contributed to a general rise in the cost of petroleum during recent years and larger rises are likely in the near future, threatening much of our present economic activity.

If fuel supplies are depleted to the levels predicted by many authorities (e.g.Diesendorf, 2007) our main forms of transportation will be seriously disrupted. The manufacture and distribution of most items now essential to our lifestyles, particularly from the plastics and chemical industries that directly depend on petroleum, will also be seriously disrupted. In our analyses of the Campus transport energy we have therefore drawn attention to the quantities of fuel used, as well as to the resulting CO_2e emissions.

8.2 Campus transport data

A detailed travel modes survey for Ourimbah campus was carried out by Transit Planners Pty Ltd during Semester 1, 2004. According to information obtained from staff of the University of Newcastle, the 2007 Campus population is about 10% higher than the 2004 population so we have increased the survey data by 10% to provide the following estimates for 2007:

- The average number of people arriving at and leaving the Campus each day during semesters is about 4,800 by car, 400 by train, 60 by bus, 26 by walking and 7 by bicycle.
- The average number of people per car arriving at and leaving the campus is 1.27.
- The average number of trains arriving at Ourimbah each day with students is 47.
- The average number of bus trips through the Campus each day is 28.

Although the Transit Planners' survey data included the numbers of people travelling to the Campus from the northern and southern parts of the Central Coast, it did not indicate the distances travelled by the cars. We therefore obtained this information from the drivers of 30 cars arriving at the Campus during a day of Semester 1, 2005, and found that the average distance travelled per car from this sample was about 11 km.

8.3 Fuel use by Campus transport

Estimates of fuel use by transport to and from the Campus are based on the following assumptions:

a) the data in 6.2 apply for 240 days each year,

b) an average car uses 11.5 litres of fuel per 100 km,

c) an average bus uses 24.6 litres per 100 km

d) Campus bus users travel, on average, the same distance as car users,

e) Campus bus users account for 20% of the passengers on the relevant buses.

Assumptions (b) and (c) are based on information from Australian Bureau of Statistics, (2006). Assumptions (d) and (e) are based on personal communications with bus travellers.

The estimates show that Campus car transport consumes about 2.2 million litres of fuel per year and bus transport for Campus travel consumes about 12,000 litres of fuel per year.

The latter estimate is fairly gross because assumptions (d) and (e) are of uncertain validity, but it is clear that the total bus fuel consumption is very small compared with the total car fuel consumption.

Nevertheless, the fuel consumption per person for cars and buses does not differ as much as expected, being 460 litres per year for car users and of the order of 200 litres per year for bus users. This relatively small difference can be attributed to the small number of bus users.

8.4 CO_2 emissions by Campus transport

Our estimates of carbon emissions corresponding to the above fuel uses depend on the following assumptions, based on data from Australian Greenhouse Office (2005):

(a) 1.0 litre of car fuel produces 2.4 kg CO_2e, and

(b) 1.0 litre of bus fuel produces 2.7 kg CO_2 e.

The estimates show that transport to and from the Campus each year produces about 5,300 tonnes CO_2e from cars and 32 tonnes CO_2e from buses. Again, the calculated amounts per person per year are less favourable to bus transport than expected, being about 0.54 tonnes CO_2e for buses, while the corresponding amount for cars is about 1.10 tonnes per person per year.

There are no directly relevant data to enable estimates of the CO_2e emissions from the coal-dependent electricity used in train transport of people to and from the Campus.

However, data for comparable circumstances in the United Kingdom suggests that the emission per person per km on an electric train is about 25% of the emission per person per km in a car (National Energy Foundation, 2006).

If this is assumed for the Campus it may be estimated that the total equivalent emission per year for train travellers is about 110 tonnes CO_2e. The amount per person per year is about 275 kg CO_2e.

8.5 Fuel use and emissions due to air travel

As international air transport is not usually counted in national greenhouse gas inventories it tends to be ignored, but a number of recent studies have identified it as a significant source of carbon emissions on a global scale (IPCC, 2007).

Estimates made by researchers in the United Kingdom suggest that the amount of fuel consumption and CO_2e emission per person per km on a typical international air flight are about 80% of the amounts per person per km in an average car (National Energy Foundation, 2006). Because of the large distances covered, a single air flight may therefore give calculated fuel consumption and emission per person of the same order of magnitude as the amounts per year for an average car (National Energy Foundation, 2006).

As overseas travel and study are important professional activities of about 100 academic and teaching staff on the Campus, estimates have been made of their approximate fuel use and emissions, assuming each takes the equivalent of one return flight to U.S.A. or Europe every fourth year. Based on these assumptions the calculated total fuel consumption and emissions for the Campus are about 140,000 litres per year, and 300 tonnes CO_2e per year respectively.

Therefore, if our assumptions are reasonable, staff air travel would increase the total fuel use attributable to the work and activities of the Campus by about 6 % and the total carbon emissions by about 3%.

8.6 Need to increase train and bus travel

The above estimates suggest that Campus fuel use and carbon emissions could be significantly reduced if more students and staff used train and bus transport and fewer used car transport. With regard to bus transport it seems clear that the Campus bus services are grossly underused.

As only 60 people are reported to use the services it seems necessary to take measures to at least double that number, which would make the fuel consumption and emissions per person much lower than those for car transport.

We understand an evening shuttle bus service around the Loop Road commenced recently on the Campus (Campus Central Newsletter, 2007). It runs from 5pm to 10pm, stops at a number of places around the Loop Road and takes passengers to Ourimbah railway station.

The major objective of the service is apparently to enhance the safety of students and staff moving around the Campus after dark. Three or four similar trips during daylight hours with timing to correspond with the train service could possibly become popular because of the convenience it would provide. Such a bus service may be a good way of encouraging greater use of train transport and should be given some attention in the investigation proposed in Recommendation 20.

RECOMMENDATION 20:

Carry out a thorough investigation of the Campus bus services and why they are underused. The routes, distributions of potential users, time tables, bus sizes and other aspects of service efficiency should all be examined with a view to making suggestions to the bus companies for substantial improvements.

The unreliability of train and bus services was regarded as an important contributing factor to the overwhelming preference for car travel in the 2004 Transit Planners' study. In their investigation of this factor they found that a difference of 4 minutes or more occurred between scheduled and actual times of arrival for 60% of trains and 30% of buses.

Nevertheless, we consider this reason for not using public transport is less important than the fact that private cars are usually faster, cheaper and more convenient for getting busy students and staff to and from the Campus.

The above circumstances may change in the near future if the cost of fuel greatly increases, but other measures are also required to reduce the excessive car dependence of students and staff. Recommendations 21 to 24 are all made for this purpose.

RECOMMENDATION 21:

Through leaflets, advertisements and other media, make students and staff more aware of public transport options (times, places etc) and the benefits of public transport (usable time for reading, less stress etc), as well as the social responsibility to reduce fuel use and greenhouse emissions

RECOMMENDATION 22:

Schedule lecture times to suit students arriving by train and bus, with appropriate allowances for service unreliability and the time to walk from transport to lectures.

RECOMMENDATION 23:

Request City Rail to have more trains stop at Ourimbah from 8am to 10 am and 4pm to 6pm. At present there is only one train stopping there in each of these time slots but several others pass through without stopping.

RECOMMENDATION 24:

Form a small committee to obtain details of the origins, routes and times of cars travelling to and from the campus and use this information to organise an effective system of car pooling.

8.7 Need to encourage walking and cycling

A Sustainable Transport Committee established by the Community Environmental Network has given particular attention to the planning of cycleways to and around Ourimbah. It has proposed a bicycle co-operative for the Campus (perhaps with second-hand bicycles) and high quality facilities for securing and borrowing bicycles at convenient locations throughout the Campus and near the railway station.

Some other suggested measures to encourage cycling and walking to and from the Campus are in our Recommendations 25 and 26.

RECOMMENDATION 25:

Develop the cycleway originally planned by Architects Cox Richardson to pass from the eastern extremity of the Loop Road through the middle of the Campus to the car park, with extensions to Ourimbah railway Station and the playing fields.

RECOMMENDATION 26:

Make representations to Wyong and Gosford Councils, City Rail and RTA to co-operate in an integrated effort to establish cycleways to benefit the Central Coast Community and the Campus. Schemes that should be considered include (a) good facilities for securing and borrowing bicycles at all railway stations, (b) the establishing of safe bicycle routes through networks of streets (for example from The Entrance to Tuggerah) by blocking selected streets to through motor traffic but allowing the passage of bicycles, and (c) the construction of a major, relatively level cycleway from Wyee to Woy Woy, mainly along the edge of the railway reserve.

8.8 Other measures

Environmentalists and economists have argued that, in contributing to global warming and its future impacts, motor vehicle users of today are not paying the full costs of their vehicle use (see Stern, 2007). It follows that cost penalties on these users would be well justified, especially if such penalties could contribute to relieving the future impacts.

A 'greenhouse parking fee' for each car parking on or near the Campus would be consistent with this idea if a low-cost system of collecting the fee could be introduced (e.g. machines that dispense tickets to be displayed through windscreens). The proceeds from such a system could contribute to emission-reducing measures such as:

- Establishing the bicycle co-operative suggested above in 6.7.
- Subsidising students' bus and train fares.
- Subsidising students' accommodation on or near the Campus.
- Establishing a special 'Campus Greenhouse Fund' for carrying out recommendations in this report. Community members and local business people could also be invited to contribute to this fund.

RECOMMENDATION 27:

Charge a fee for each car parking on or near the Campus. Receipts exceeding the cost of collection should contribute towards making the Campus more sustainable.

A greenhouse parking fee could further contribute to Campus sustainability by discouraging some students and staff from taking their cars to the Campus. Our recommendation 27 is therefore well justified.

As mentioned earlier, one of the original plans by Architects Cox Richardson envisaged future student accommodation on the Campus, and this has prompted our Recommendation 5 in 2.5. A major justification for Recommendation 5 is that a large proportion of students living on or near the Campus would considerably reduce the fuel use and CO_2 e emissions resulting from their present transport to and from the Campus.

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9 WASTE DISPOSAL AND RECYCLING

9.1 Towards a no-waste community

As suggested earlier there would be virtually no waste or adverse by-products in an ideal sustainable community. Technological methods have already been developed for converting most materials we now regard as waste to potentially valuable resources. This applies to most metal, plastic, paper, wood, agricultural and garden wastes, as well as food scraps and other organic matter.

Some conversion methods are still unsatisfactory because they are costly, have excessive energy needs and still produce adverse by-products, but further advances, particularly in biotechnology, should solve most of these problems in the foreseeable future. Some of the currently unfavourable economic aspects of waste conversion methods will also be reduced by the increasing scarcity and value of end-products, and the increasing costs of disposal by landfill.

In general terms, the Campus could move towards a no-waste community with

a) effective measures for separating recyclable and non-recyclable waste,

b) recycling of as much of the waste as possible, and

c) avoiding as much as possible the production of non-recyclable waste.

To achieve these objectives we suggest a professional waste audit be commissioned and, based on the findings of this audit, a waste management plan for the Campus be prepared.

RECOMMENDATION 28:

Commission a professional waste audit and prepare a detailed waste management plan for the Campus based on the findings of this audit.

9.2 Benefits of a Campus waste audit

A professional waste audit should include the following:

- A detailed account of the composition and quantities of waste generated.
- An assessment of the effectiveness of existing waste management systems.
- Identification of opportunities for improving waste management systems and strategies.
- The collection of baseline data for measuring the effectiveness of waste minimisation strategies.
- Estimated costs and outcomes of alternative draft management plans.

The cost of such an audit is likely to be quickly recovered by the economic savings that would result from the recommended strategies. Information on how to arrange a professional audit may be obtained from NSW Dept Environment and Conservation (2006) and also from waste management consultants listed in the telephone directory.

A limited waste audit of the Callaghan Campus was made in 1998 with an EPA grant (details on *www.epa.nsw,gov,au/waste/97/46*). This resulted in 17 recommended waste reduction strategies that were claimed to have reduced the Campus waste stream by over 60 %. Even better results than these could be expected with a full professional audit of the Ourimbah Campus.

9.3 Waste generated by Ourimbah Campus

In the absence of specific data, approximate estimates of the amounts of waste generated by Ourimbah campus may be made with information from the following:

- the limited 1998 audit carried out for the Callaghan Campus, as mentioned above,
- a study of compostable organic wastes from Ourimbah Campus by Stanger *et al* (2000),
- brief information on internet outlining the results of waste audits at several other Australian universities, namely the University of Sydney, Monash University and La Trobe University.

Different sets of waste categories were adopted in each of the above information sources, and it is not completely clear what items are included in some of the categories.

Nevertheless, there is a reasonable degree of consistency in the amounts of paper, plastic and food waste per person recorded at each university. These are all about 10 kg of paper, 0.5 to 1.0 kg of plastic and 1 to 2 kg of food waste per person (on campus) each year.

If the above values per person are adopted for Ourimbah Campus, and assuming a population of 4,000 (see 2.2), the corresponding total waste production is estimated at about 40 tonnes of paper, 3 tonnes of plastic and 6 tonnes of food waste per year.

We understand that a substantial proportion of the paper and some of the plastic, glass and metal waste is recycled through the Wyong Council recycling services but the actual amounts in each category could not be estimated.

In common with other tertiary institutions, Ourimbah Campus has large numbers of computers, printers and associated items to be disposed of each year ('e-waste'). Some of these are collected and recycled directly by commercial operators. Wyong Council collects the remainder, many of which end up in landfill.

The study by Stanger *et al* (2000) indicates that the Campus generates large (but highly variable) amounts of organic waste from garden and lawn maintenance, building activities and laboratories. Some of this is recycled on Campus in the form of mulch and compost and the remainder is collected for processing by Wyong Council.

As estimated in 4.5, about 11 ML of waste water is discharged each year from the Campus through the Wyong sewerage system. This is a valuable resource currently contributing to Wyong Council's water recycling scheme.

Wyong Council's water recycling system is planned for extensive expansion in the future and this will be an important contribution to the sustainability of the Shire. In the present treatment of waste water by the Council the solids are separated and the water used to irrigate golf courses, ovals, bowling greens, and for toilet flushing in public amenity blocks, caravan parks etc. Future treatment will result in most of the currently unused waste water being made available for industry and agriculture.

The solids removed from the water are also a valuable resource. Some are currently used as soil conditioners and fertilizers in the Council's landscaping works. Although the remainder are now buried in landfill sites they have the potential for conversion to carbon-neutral biogas for energy generation in the future.

9.4 Significance of cellulosic waste

Cellulosic waste includes paper, timber, sawdust and vegetative waste such as lawn and plant clippings. Particularly large amounts of such waste, probably exceeding 65 tonnes per year, are generated from Ourimbah Campus, and this seems typical of other Australian tertiary institutions, including Callaghan Campus. Some apparently important advances in biotechnology have been made recently that may assign special significance to cellulosic waste.

It is claimed that carbon-neutral, low energy methods for converting most types of cellulose to ethanol are now economically feasible (see

Kalscheuer *et al*, 2006; Hansen, 2007; EESI, 2007; Weekend Australian, 2007). Cellulose is found in all plant matter and is abundant in every country of the world. It is also the main component of cellulosic waste.

Only small engine modifications are needed to operate contemporary motor vehicles with ethanol instead of petrol, and some countries (e.g. Brazil) already have large numbers of ethanol-powered vehicles. Traditionally, the methods of producing this fuel have been mainly from grains such as wheat and corn, or from other food crops such as sugar. The production of ethanol to date has therefore been at the expense of food production, making it an environmentally undesirable replacement for petrol (see Montbeit, 2006). However, if it can be produced economically from cellulose, as reported above, this dramatically changes its desirability as a petrol replacement.

As cellulose is formed in the growth of plants it is renewable and sustainable. Because the amount of carbon released in the combustion of ethanol from cellulose is no greater than the amount taken up in its original growth, there is no net increase in greenhouse gases.

Ethanol from cellulosic waste therefore promises to be an ideal transport fuel as one of the sustainable petrol replacements. Furthermore, in addition to helping solve the oil depletion and greenhouse problems, its production from cellulosic waste solves a disposal problem.

A Priority Research Centre for Energy (PRC/E) was recently established by the University of Newcastle. A current program of the Centre's research on transport fuels focuses on 'transport carriers' and does not appear to give any attention to the production of ethanol from waste. In view of the particularly large amounts of cellulosic waste produced by the University's campuses, and the likely importance of the above recent developments we suggest this topic be reviewed for possible inclusion in the Centre's program.

Adequate appraisal of the new developments in this area would require specialised expertise in fermentation biotechnology**.** If such expertise is not already available to the Centre it is suggested that measures be taken to obtain it.

RECOMMENDATION 29:

In view of the large amounts of cellulosic waste produced by the University's campuses, and the apparent implications of recent advances in producing ethanol from cellulosic waste, an expert appraisal of this topic is recommended for possible inclusion in the program of the University's Priority Research Centre for Energy.

9.5 Growth of wast management industry

Before about 1980, waste disposal in Australia was almost entirely the responsibility of local government, and recycling or reuse of waste was mainly confined to bottles and some metals. After about 1985, however, business entrepreneurs started to become interested in the commercial opportunities in waste treatment and recycling. This was prompted by signs of future shortages of some basic resources, wider recognition of the environmental problems caused by traditional waste disposal, and advances in the technology of waste treatment.

The recent growth of interest in waste has resulted in the development of a multi-billion dollar industry involving all levels of government, and commercial companies ranging from very large to very small. In Wyong Shire, typical of many local government areas, the council still largely manages most of the collection and local transport of waste but most of the recycling, treatment and distribution of end-products is profitably managed by private enterprise.

The extent to which this has happened may be assessed by perusal of the local 2006-7 Yellow Pages telephone directory. Under the headings 'waste management', 'waste disposal' and 'recycling' over 150 companies are listed.

It should be noted that there is some controversy and concern within the conservation movement and general community about the growing dominance of waste management by private enterprise. There is now wide recognition that private enterprise (with its simple aims, limited constraints, operational flexibility, rewards-for-performance and related motivational elements) can achieve many objectives faster and with greater economic efficiency than government enterprise.

The private sector could therefore be credited for the present relatively advanced level of waste management in Australian urban areas. It may also be argued that the private sector is not motivated to reduce or minimise waste production as this would reduce their business. Furthermore, although the private sector may rapidly develop and introduce new technology, the aim of each business is to find the most profitable technology for its particular area of operation. This will not necessarily correspond with the most effective technology for meeting the broader and longer-term needs of the general community.

Many people therefore believe that governments have continuing strong responsibilities in waste management, especially in such matters as:

- Regulating the industry to prevent the development of practices counterproductive to the public interest.
- Promoting and supporting outcome-oriented, independent research, and unbiased monitoring of advances in waste management.
- Planning the development of the industry to meet broader and longer-term needs of the general community.
- Providing incentives and disincentives to guide the industry in the required directions.

As suggested elsewhere, the present prevailing economic and political ideology does not seem to favour public enterprise, and government responsibilities such as the above tend to be overlooked or avoided by our political decision-makers. Influential university personnel and bodies could help minimise this by reminding politicians, when appropriate, of the limitations of private enterprise in this particular area.

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10 SUSTAINABILITY SUMMARY 2007

10.1 Sustainability parameters

In our investigation of the sustainability of the Campus we have attempted, where appropriate and possible, to use relevant quantitative parameters to express the findings. Although such parameters should not be expected to completely define or describe the degree of sustainability of the Campus they assist in maintaining perspective and relativity. For example, changes in the parameters over a period of time may serve as 'performance indices' to show the success or otherwise of measures to improve sustainability during that time. Parameters values may also express the goals we are aiming for and provide some indication of how much needs to do be done to achieve these goals at any particular time.

The table below provides an indication of the degree of sustainability of the Campus in 2007 as summarised by the estimated values of the parameters we have selected, as detailed in Sections 3 to 7. The goals are consistent with the ideal sustainable Campus described in 1.7.

SUSTAINABILITY PARAMETER	ESTIMATED 2007 VALUE	GOAL FOR 2030	COMMENTS
Biodiversity Number of plant species Number of animal species	 258 ?	 258+ ? +	Number of plant species as in Tables 3-1 and 3-2 Fauna survey still to be done (Recommendation 7)
Water Consumption from public supply (ML)	13	0	Campus supply could come from roof tanks and/or groundwater
Stationary energy Power consumption from coal (GWHr) Equivalent CO_2e emission (tonnes)	4 4,000	0 0	Assumes Campus supply in 2030 could all come from renewable sources either on or off Campus
Transport energy Petroleum use by cars (litres) buses air travel Equivalent CO_2e by cars (tonnes) buses air travel trains	 2,200,000 12,000 140,000 5,300 32 300 110	 0 0 ? 0 0 ? negligible	Assumes petroleum dependent vehicles will be largely replaced by forms of transport using renewable energy
Total petroleum use (litres)	2,350,000	negligible	
Total CO_2e emission (tonnes) (stationary + transport energy)	9,700	negligible	

11 THE RECOMMENDATIONS: SUMMARY AND PRIORITIES

11.1 Prioritising the recommendations

The recommendations have been prioritised according to our (subjective) assessment of the importance of their contributions to (a) the ultimate sustainability of the Campus as envisaged in 1.7, and (b) the value of the Campus as an example to the broader community.

The following categories have been adopted:

priority A:	regarded as essential for both (a) and (b)
priority B:	regarded as essential for either (a) or (b)
priority C:	regarded as desirable for either (a) or (b), but less important than priority

11.2 When should the recommendations be implemented ?

To answer this question the following have been taken into account:

- the likely cost of their implementation
- possible adverse consequences of their delay, and
- possible advantages of their delay due to expected improvements in technology.

Accordingly, the recommendations have been placed into three categories:

Short term:	should be fully implemented within the next 5 years
Medium term:	should be planned for implementation in 5 to10 years, or earlier if circumstances favourable
Long term:	should be planned for implementation in 10 to 20 years, or earlier if circumstances favourable.

Short term priority A

RECOMMENDATION 13: Commission a professional energy audit to advise in detail on energy use and the minimisation of carbon emissions throughout the Campus. This could indicate the need for replacing some present equipment with more energy-efficient equipment, using gas instead of electrical power for some applications, better energy management practices, and modifications to buildings to improve lighting, insulation, ventilation etc**.**

RECOMMENDATION 14: In addition to any audit advice, give particular attention to energy usage by Campus computers. Appropriate models should be selected and operated with energy saving settings and efficient practices.

RECOMMENDATION 20: Carry out a thorough investigation of the Campus bus services and why they are underused. The routes, distributions of potential users, time tables, bus sizes and other aspects of service efficiency should all be examined with a view to making suggestions to the bus companies for substantial improvements.

RECOMMENDATION 28: Commission a professional waste audit and prepare a detailed waste management plan for the Campus based on the findings of this audit.

Short term priority B

RECOMMENDATION 2: Consideration be given to the endorsement of the Talloires Declaration by The University of Newcastle. Alternatively, consideration be given to endorsement of the Declaration by The Ourimbah Campus, as a separate collaborative tertiary institution.

RECOMMENDATION 3: Recognise the need to protect and maintain the present forest cover on the topographic basin upslope of the main Campus area and request Wyong Council to effectively limit further development in the entire Campus Creek basin and adjoining forested areas.

RECOMMENDATION 15: In buildings where water heating is a major item, consider the installation of solar water heating systems

RECOMMENDATION 16: Create a non-academic professional position with a title such as 'sustainability officer' or 'environmental officer' whose duties would include (a) ensuring resource- efficient and environmentally desirable measures and practices are followed in all parts of the Campus, (b) monitoring and reporting on, the effectiveness of these measures and practices, and (c) making recommendations at appropriate times to advance the sustainability of the Campus.

Short term priority C

RECOMMENDATION 7: Arrange a systematic fauna survey as soon as possible and repeat this every 5 years to monitor changes in faunal diversity.

RECOMMENDATION 11: Establish a permanent monitoring system on the ornamental lake to monitor the 'standard' water quality parameters adopted in the NSW Government's 'waterwatch' system for schools and conservation groups. The observations and measurements should be made regularly at least once per fortnight, and also during and after significant rainfall events

RECOMMENDATION 12: Maintain contacts with the groundwater investigation program of Gosford and Wyong Councils. If the program continues, the Councils should be requested to establish test bores within the main Campus area and also at higher elevations in the Campus Creek valley.

RECOMMENDATION 17: Set up experimental tests on one of the newly propsed systems for generating solar energy, and use it to assist in recharging the batteries of the electric cars used by security staff. If the energy source for these cars could be made directly renewable in this way they would deserve and gain greater recognition as an innovative, environmentally sustainable feature of the Campus.

RECOMMENDATION 21: Through leaflets, advertisements and other media, make students and staff more aware of public transport options (times, places etc) and the benefits of public transport (usable time for reading, less stress etc), as well as the social responsibility to reduce fuel use and greenhouse emissions.

RECOMMENDATION 23: Request City Rail to have more trains stop at Ourimbah from 8am to 10 am and 4pm to 6pm. At present there is only one train stopping there in each of these time slots but several others pass through without stopping.

RECOMMENDATION 29: In view of the large amounts of cellulosic waste produced by the University's campuses, and the implications of recent advances in producing ethanol from cellulosic waste, an expert appraisal of this topic is recom mended for possible inclusion in the program of the University's Priority Research Centre for Energy.

Medium term priority A

RECOMMENDATION 4: In the Campus planning, consider acquisition of the adjoining properties in the topographic basin to ensure that land use on the properties remains completely compatible with the sustainability objectives of the Campus

RECOMMENDATION 10: Install tanks and infrastructure of appropriate size to catch, store and distribute roof water from as many Campus buildings as possible.

RECOMMENDATION 19: Commission a thorough review in about 2013 or 2014 of new technology in solar energy generation, microhydroelectric energy generation and storage, and energy-generating incineration. Consider the potential of these processes, either singly or in combination, as supplementary energy sources for the Campus.

Medium term priority B

RECOMMENDATION 1: Form a small committee to monitor and publicize, over the next three years, the University of Newcastle courses that deal in detail with the major problems of sustainability. A thorough review of these courses should then be made, with input invited from all interested staff, students and community members. The review should investigate whether the major problems of sustainability are adequately treated in each relevant discipline (especially in economics, business, management and the social sciences). It should also examine the possible rationalization of courses and the case for a professional multidisciplinary degree course directed particularly towards finding effective solutions to sustainability problems as suggested in 1.5

RECOMMENDATION 18: Request the University of Newcastle Wind Energy Group to examine the highest point on the topographic divide just outside the northern boundary of the Campus (as shown in Fig. 1) and advise on its potential for the generation of wind energy for the Campus.

RECOMMENDATION 22: Schedule lecture times to suit students arriving by train and bus, with appropriate allowances for service unreliability and the time to walk from transport to lectures.

RECOMMENDATION 24: Form a small committee to obtain details of the origins, routes and times of cars travelling to and from the campus, and use this information to organise an effective system of car pooling.

RECOMMENDATION 25: Develop the cycleway originally planned by Architects Cox Richardson to pass from the eastern extremity of the Loop Road through the middle of the Campus to the car park, with extensions to Ourimbah railway Station and the playing fields.

Medium term priority C

RECOMMENDATION 6: Monitor changes in vegetation biodiversity by repeating the native plant species survey about every 5 years.

RECOMMENDATION 8: Establish a small number of nesting boxes and large pipes or similar items in selected areas of the forested part of the Campus for a trial period. If these are found to provide effective nests or shelter for native fauna consider placing many others throughout the area.

RECOMMENDATION 27: Charge a fee for each car parking on or near the Campus. Receipts exceeding the cost of collection should contribute towards making the Campus more sustainable.

Long term priority A

RECOMMENDATION 5: Stabilize Campus population at about 7,500 students and staff, with at least half of the students residing on or near the Campus. This may require the construction of high-rise student accommodation on Campus, and schemes to assist or encourage students to find other accommodation near the Campus.

RECOMMENDATION 26: Make representations to Wyong and Gosford Councils, City Rail and RTA to co-operate in an integrated effort to establish cycleways to benefit the Central Coast Community and the Campus. Schemes that should be considered include (a) good facilities for securing and borrowing bicycles at all railway stations, (b) the establishing of safe bicycle routes through networks of streets (for example from The Entrance to Tuggerah) by blocking selected streets to through motor traffic but allowing the passage of bicycles, and (c) the construction of a major, relatively level cycleway from Wyee to Woy Woy, mainly along the edge of the railway reserve

Long term priority B

RECOMMENDATION 9: If considered feasible, re-establish lost and endangered plant and animal species in appropriate locations on the Campus.