Environmental Science

Victorian Certificate of Education **Study Design**

Victorian Curriculum and Assessment Authority
2004

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Latoya BARTON
The sunset (detail)
from a series of twenty-four
9.0 x 9.0 cm each, oil on board

Liana RASCHILLA
Teapot from the *Crazy Alice* set
19.0 x 22.0 x 22.0 cm
earthenware, clear glaze. lustres

Kate WOOLLEY
Sarah (detail)
76.0 x 101.5 cm, oil on canvas

Christian HART
Within without (detail)
digital film, 6 minutes

Merryn ALLEN
Japanese illusions (detail)
centre back: 74.0 cm, waist (flat): 42.0 cm
polyester cotton

James ATKINS
Light cascades (detail)
three works, 32.0 x 32.0 x 5.0 cm each
glass, flourescent light, metal

Lucy McNAMARA
Precariously (detail)
156.0 x 61.0 x 61.0 cm
painted wood, oil paint, egg shells, glue, stainless steel wire

Tarkan ERTURK
Visage (detail)
201.0 x 170.0 cm
synthetic polymer paint, on cotton duck

Nigel BROWN
Untitled physics (detail)
90.0 x 440.0 x 70.0 cm
composition board, steel, loudspeakers,
CD player, amplifier, glass

Chris ELLIS
Tranquility (detail)
35.0 x 22.5 cm
gelatin silver photograph

Kristian LUCAS
Me, myself, I and you (detail)
56.0 x 102.0 cm
oil on canvas

Ping (Irene VINCENT)
Boxes (detail)
colour photograph

Tim JOINER
14 seconds (detail)
digital film, 1.30 minutes

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Environmental Science

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Contents

IMPORTANT INFORMATION

Accreditation period

Units 1–4: 2005–2011

The accreditation period commences on 1 January 2005.

Other sources of information

The *VCAA Bulletin* is the only official source of changes to regulations and accredited studies. The *VCAA Bulletin*, including supplements, also regularly includes advice on VCE studies. It is the responsibility of each VCE teacher to refer to each issue of the *VCAA Bulletin*. The *VCAA Bulletin* is sent in hard copy to all VCE providers. It is available on the Victorian Curriculum and Assessment Authority's website at www.vcaa.vic.edu.au

To assist teachers in assessing school-assessed coursework in Units 3 and 4, the Victorian Curriculum and Assessment Authority publishes an assessment handbook that includes advice on the assessment tasks and performance descriptors for assessment.

The current year's *VCE and VCAL Administrative Handbook* contains essential information on assessment and other procedures.

VCE providers

Throughout this study design the term 'school' is intended to include both schools and other VCE providers.

Photocopying

VCE schools only may photocopy parts of this study design for use by teachers.

Introduction

RATIONALE

Environmental Science provides the opportunity for students to understand the structure, function and diversity of natural ecosystems on this planet and evaluate the impacts of human activities on them. Students examine strategies to maintain and protect the ecological health of the environment while meeting the needs and desires of human populations.

Environmental Science investigates the interactions between natural and human systems. This study examines the application of environmental science to ecologically sustainable development and environmental management. Students should understand the values and attitudes that underpin environmental decisions and reflect on effective ways for modifying behaviour of individuals and groups for positive environmental outcomes.

While undertaking this study, students will develop skills in practical scientific investigations, environmental fieldwork techniques, report writing, research and analysis.

AIMS

This study is designed to enable students to:

- understand the structure, function and diversity of ecosystems;
- investigate the impact on the environment of societal values and decisions;
- develop practical laboratory and field skills for describing and monitoring the environment and its state of ecological health;
- examine human impacts on ecosystems and investigate ways to minimise them;
- understand the concepts and principles of environmental science;
- investigate the role of science in the management of the environment;
- develop a critical perspective on environmental science;
- undertake activities that contribute positively to the sustainability of the environment.

STRUCTURE

The study is made up of four units. Each unit deals with specific content and is designed to enable students to achieve a set of outcomes. Each outcome is described in terms of key knowledge and skills.

ENTRY

There are no prerequisites for entry to Units 1, 2 and 3. Students must undertake Unit 3 prior to undertaking Unit 4. Units 1 to 4 are designed to a standard equivalent to the final two years of secondary education. All VCE studies are benchmarked against comparable national and international curriculum.

DURATION

Each unit involves at least 50 hours of scheduled classroom instruction.

CHANGES TO THE STUDY DESIGN

During its period of accreditation minor changes to the study will be notified in the *VCAA Bulletin*. The *VCAA Bulletin* is the only source of changes to regulations and accredited studies and it is the responsibility of each VCE teacher to monitor changes or advice about VCE studies published in the *VCAA Bulletin*.

MONITORING FOR QUALITY

As part of ongoing monitoring and quality assurance, the Victorian Curriculum and Assessment Authority will periodically undertake an audit of Environmental Science to ensure the study is being taught and assessed as accredited. The details of the audit procedures and requirements are published annually in the *VCE and VCAL Administrative Handbook*. Schools will be notified during the teaching year of schools and studies to be audited and the required material for submission.

SAFETY

This study may involve the handling of potentially hazardous substances and/or the use of potentially hazardous equipment. It is the responsibility of the school to ensure that duty of care is exercised in relation to the health and safety of all students undertaking the study.

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

In designing courses for this study teachers should incorporate information and communications technology where appropriate and applicable to the teaching and learning activities. The Advice for Teachers section provides specific examples of how information and communications technology can be used in this study.

KEY COMPETENCIES AND EMPLOYABILITY SKILLS

This study offers a number of opportunities for students to develop key competencies and employability skills. The Advice for Teachers section provides specific examples of how students can demonstrate key competencies during learning activities and assessment tasks.

LEGISLATIVE COMPLIANCE

When collecting and using information, the provisions of privacy and copyright legislation, such as the Victorian *Information Privacy Act 2000* and *Health Records Act 2001*, and the federal *Privacy Act 1988* and *Copyright Act 1968* must be met.

Assessment and reporting

SATISFACTORY COMPLETION

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated achievement of the set of outcomes specified for the unit. This decision will be based on the teacher's assessment of the student's performance on assessment tasks designated for the unit. Designated assessment tasks are provided in the details for each unit. The Victorian Curriculum and Assessment Authority publishes an assessment handbook that includes advice on the assessment tasks and performance descriptors for assessment for Units 3 and 4.

Teachers must develop courses that provide opportunities for students to demonstrate achievement of outcomes. Examples of learning activities are provided in the Advice for Teachers section.

Schools will report a result for each unit to the Victorian Curriculum and Assessment Authority as S (Satisfactory) or N (Not Satisfactory).

Completion of a unit will be reported on the Statement of Results issued by the Victorian Curriculum and Assessment Authority as S (Satisfactory) or N (Not Satisfactory). Schools may report additional information on levels of achievement.

AUTHENTICATION

Work related to the outcomes will be accepted only if the teacher can attest that, to the best of their knowledge, all unacknowledged work is the student's own. Teachers need to refer to the current year's *VCE and VCAL Administrative Handbook* for authentication procedures.

LEVELS OF ACHIEVEMENT

Units 1 and 2

Procedures for the assessment of levels of achievement in Units 1 and 2 are a matter for school decision. Assessment of levels of achievement for these units will not be reported to the Victorian Curriculum and Assessment Authority. Schools may choose to report levels of achievement using grades, descriptive statements or other indicators.

Units 3 and 4

The Victorian Curriculum and Assessment Authority will supervise the assessment of all students undertaking Units 3 and 4.

In the study of Environmental Science the student's level of achievement will be determined by school-assessed coursework, a mid-year examination and an end-of-year examination. The Victorian Curriculum and Assessment Authority will report the student's level of performance on each assessment component as a grade from A+ to E or UG (ungraded). To receive a study score, students must achieve two or more graded assessments and receive S for both Units 3 and 4. The study score is reported on a scale of 0–50. It is a measure of how well the student performed in relation to all others who took the study. Teachers should refer to the current year's *VCE and VCAL Administrative Handbook* for details on graded assessment and calculation of the study score. Percentage contributions to the study score in Environmental Science are as follows:

- Unit 3 school-assessed coursework: 17 per cent
- Unit 4 school-assessed coursework: 17 per cent
- Mid-year examination: 33 per cent
- End-of-year examination: 33 per cent

Details of the assessment program are described in the sections on Units 3 and 4 in this study design.

Unit 1: The environment

This unit focuses on the environment and its components. The function of ecosystems and the interactions in and between the ecological components will be investigated. The unit presents opportunities to consider the effects of natural and human-induced changes in ecosystems.

AREA OF STUDY 1

Ecological components and interaction

The Earth's structure may be classified into four major categories: hydrosphere, lithosphere, atmosphere and biosphere. This area of study examines the processes occurring within the spheres of the Earth and the interactions that occur in and between the ecological components of each major category.

Outcome 1

On completion of this unit the student should be able to identify and describe the components and natural processes within the environment.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 1.

Key knowledge

This knowledge includes

- concepts of environment, ecosystem, components and processes;
- the Sun as the source of energy for life, including nuclear fusion reaction on the Sun, spectrum of light, and flow of energy to and from the Earth;
- components and structures of the hydrosphere, lithosphere, atmosphere and biosphere;
- recycling of critical nutrients through biogeochemical cycles, including the carbon cycle, which support life on Earth.

Key skills

These skills include the ability to

- compare and contrast definitions of environment and ecosystem, and illustrate the interrelationships between components and processes;
- conduct practical investigations on the nature and characteristics of solar energy;
- classify the components and structure of the Earth's spheres;
- collect and analyse data from fieldwork and/or practical work to demonstrate interactions in and between the Earth's spheres;
- describe and compare the nutrient cycles of water, nitrogen, carbon and phosphorous in the different spheres of the Earth.

AREA OF STUDY 2

Environmental change

The environment is not static but undergoes continual change. It can be changed by natural or human-induced factors. Students use scientific data and processes to examine environmental change.

Outcome 2

On completion of this unit the student should be able to analyse one human-induced environmental change and options for remediation.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 2.

Key knowledge

This knowledge includes

- the characteristics and distribution, causes and effects of human-induced environmental changes; for example, salinity, soil erosion, fire regimes, desertification, eutrophication, water pollution, introduced species, ozone depletion, enhanced greenhouse effect, urban air pollution;
- human-induced changes that contribute to the conservation and remediation of the environment; for example, revegetation, development and management of wildlife corridors, conservation and management of parks, soil remediation, waste minimisation, environmental stream flows, use of wetland systems for filtering wastewater, treatment of sewage, banning of Chlorofluro carbons (CFCs), use of catalytic converters in cars.

Key skills

These skills include the ability to

- collect and record data from fieldwork and/or practical work to describe the characteristics and distribution of human-induced environmental change;
- analyse fieldwork and/or practical work data to describe the effects of human-induced environmental change;
- describe and compare conservation and/or remediation projects;
- investigate the effects of conservation and/or remediation projects on the environment;
- predict and justify the consequences of introducing a conservation and/or remediation project to an ecosystem which has been influenced by human-induced environmental change;
- collaborate with one or more sectors of the local community in the development or implementation of an environmental project.

AREA OF STUDY 3

Ecosystems

The characteristics of ecosystems are varied and subject to change. The changes within ecosystems can be short or long term, cyclic or random occurrences and caused by natural- or human-induced factors.

Outcome 3

On completion of this unit the student should be able explain the flow of energy, nutrient exchange and environmental changes in ecosystems.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 3.

Key knowledge

This knowledge includes

- interactions between organisms, including competition, predation, mutualism, parasitism, commensalism, and their effects on the ecosystem;
- distinguishing characteristics of a variety of ecosystems in Victoria; for example, wetlands, urban, desert, coastal, rainforest, mallee, grassland, marine, and rural;
- natural short-term cyclic environmental changes and their effects in ecosystems; for example, daily, diurnal, nocturnal, seasonal, tidal;
- natural long-term environmental changes and their effects in ecosystems; for example, ecological succession, plate tectonics, drying of the Australian continent, extinction of species, evolutionary mechanisms, climate change;
- natural random environmental changes; for example, erosion, flood, drought, fire, earthquake, volcanic activity.

Key skills

These skills include the ability to

- identify components and processes within ecosystems that illustrate flow of energy, nutrient exchange and environmental changes;
- construct food chains and food webs for ecosystems;
- organise and classify organisms into trophic and energy flow pyramids;
- assemble a biomass pyramid for an ecosystem;
- model interactions between organisms and their effects on ecosystems;
- collect data to describe distinguishing characteristics of a variety of ecosystems and analyse how they function;
- observe and record natural short-term cyclic environmental changes in ecosystems and explain their effects;
- model natural long-term environmental changes in ecosystems and describe their effects;
- observe, record and analyse the effects of natural random environmental changes using primary and/or secondary data.

ASSESSMENT

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated achievement of the set of outcomes specified for the unit. This decision will be based on the teacher's assessment of the student's overall performance on assessment tasks designated for the unit.

The key knowledge and skills listed for each outcome should be used as a guide to course design and the development of learning activities. The key knowledge and skills do not constitute a checklist and such an approach is not necessary or desirable for determining the achievement of outcomes. The elements of key knowledge and skills should not be assessed separately.

Assessment tasks must be a part of the regular teaching and learning program and must not unduly add to the workload associated with that program. They must be completed mainly in class and within a limited timeframe. Teachers should select a variety of assessment tasks for their assessment program to reflect the key knowledge and skills being assessed and to provide for different learning styles.

For this unit students are required to demonstrate achievement of three outcomes. As a set these outcomes encompass all areas of study.

Demonstration of achievement of Outcomes 1, 2 and 3 must be based on the student's performance on a selection of assessment tasks. Where teachers allow students to choose between tasks they must ensure that the tasks they set are of comparable scope and demand. Assessment tasks for this unit are:

- fieldwork and reports;
- oral presentations;
- practical activities;
- practical reports;
- reports in multimedia and/or poster format;
- tests.

Unit 2: Monitoring the environment

This unit focuses on the characteristics of environmental indicators and their use in monitoring programs. Environmental indicator data will be defined, collected and interpreted.

AREA OF STUDY 1

Environmental indicators

Environmental indicators are physical, chemical, biological or socioeconomic measures that best represent the key elements of a complex ecosystem or environmental issue. Environmental indicators for an ecosystem are investigated and the data interpreted.

Outcome 1

On completion of this unit the student should be able to explain the nature of environmental indicators for pollution and ecological health of ecosystems.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 1.

Key knowledge

This knowledge includes

- the types of environmental indicators for pollution and ecological health of ecosystems;
- the concept of ecological niche of organisms and its application for establishing environmental indicators, including thresholds, range of tolerance and limiting factors of species;
- appropriate physical, chemical, biological environmental indicators for an ecosystem or environmental issue; for example, turbidity in streams, pH, light intensity, biological oxygen demand in streams; salinity level in soils or water; presence /absence of pollution intolerant species in streams; presence/absence of introduced species; public urban green space per capita.

Key skills

These skills include the ability to

- identify and classify the types of environmental indicators;
- examine the capacity to use organisms for establishing environmental indicators;
- use a variety of practical techniques to collect environmental indicator data in the field;
- suggest and justify appropriate environmental data for an ecosystem.

AREA OF STUDY 2

Using environmental indicators

Environmental indicators are critical for analysing and reporting on the quality of the environment and in managing the maintenance of ecological functioning of systems. A local environmental issue is investigated and monitored using environmental indicators. The use of environmental indicators by a variety of government agencies or corporate organisations is also investigated.

Outcome 2

On completion of this unit the student should be able to investigate and report on a local example of environmental degradation or environmental issue, using an appropriate monitoring program.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 2.

Key knowledge

This knowledge includes

- characteristics, distribution, causes and effects of a selected local example of environmental degradation or environmental issue;
- suitable environmental indicators to monitor the state of the local environment related to the selected example of environmental degradation or environmental issue;
- role of the monitoring program on the selected local example of environmental degradation or environmental issue;
- role of government policies and regulatory bodies including State Environment Protection Policies (SEPPs) and the Environment Protection Authority in pollution control.

Key skills

These skills include the ability to

- collect data from fieldwork, practical work and/or research to describe the characteristics, distribution, causes and effects of a selected local example of environmental degradation or environmental issue;
- identify suitable environmental indicators to monitor the state of the local environment;
- analyse the role of the recommended monitoring program;
- describe the influence of government SEPPs on monitoring and reporting the state of the local environment;
- work in a team to develop and implement an appropriate monitoring program and prepare a report of findings.

Outcome 3

On completion of this unit the student should be able to analyse the scientific basis and use of standards for environmental indicators for pollution control and ecological health of ecosystems.

In achieving this outcome the student will draw on knowledge and related skills outlined in area of study 2.

Key knowledge

This knowledge includes

- the role of government policies and regulatory bodies including SEPPs and the Environment Protection Authority and their use in pollution control;
- the use of environmental indicators by Victorian Government agencies or corporate organisations to control pollution and/or measure the ecological health of ecosystems;
- the use of environmental indicators in national State of the Environment reporting;
- the Condition–Pressure–Response model used in the national State of the Environment reporting.

Key skills

These skills include the ability to

- analyse government SEPPs and define their role in pollution control;
- identify responsibilities of government agencies or corporate organisations for monitoring and reporting on the state of the environment at local, state and national levels;
- demonstrate the application of the Condition–Pressure–Response model;
- analyse the use of environmental indicators in decision-making processes.

ASSESSMENT

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated achievement of the set of outcomes specified for the unit. This decision will be based on the teacher's assessment of the student's overall performance on assessment tasks designated for the unit.

The key knowledge and skills listed for each outcome should be used as a guide to course design and the development of learning activities. The key knowledge and skills do not constitute a checklist and such an approach is not necessary or desirable for determining the achievement of outcomes. The elements of key knowledge and skills should not be assessed separately.

Assessment tasks must be a part of the regular teaching and learning program and must not unduly add to the workload associated with that program. They must be completed mainly in class and within a limited timeframe. Teachers should select a variety of assessment tasks for their assessment program to reflect the key knowledge and skills being assessed and to provide for different learning styles.

For this unit students are required to demonstrate achievement of three outcomes. As a set these outcomes encompass all areas of study.

Demonstration of achievement of Outcomes 1, 2 and 3 must be based on the student's performance on a selection of assessment tasks. Where teachers allow students to choose between tasks they must ensure that the tasks they set are of comparable scope and demand. Assessment tasks for this unit are:

- fieldwork and reports;
- oral presentations;
- practical activities;
- practical reports;
- reports in multimedia and/or poster format;
- tests.

Unit 3: Ecological issues: energy and biodiversity

This unit focuses on two major ecological issues which provide challenges for the present and the future. The consequences on the atmosphere of natural and enhanced greenhouse effects, and issues of biodiversity and its significance in sustaining ecological integrity, will be examined.

AREA OF STUDY 1

Energy and global warming

This area of study examines the concepts associated with energy and its use by human societies. It begins to explore the idea of energy efficiency. It also investigates the relationship between energy use and the enhanced greenhouse effect.

Outcome 1

On completion of this unit the student should be able to describe the principles of energy, and relate them to the contribution of one fossil and one non-fossil energy source to the enhanced greenhouse effect.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 1.

Key knowledge

This knowledge includes

- definition of scientific concepts and principles of energy, including conservation of energy, energy efficiency of conversions, ways of increasing energy efficiency, mechanical energy, potential and kinetic energy, heat, combustion, exothermic and endothermic reactions;
- one fossil fuel energy resource and one non-fossil energy resource with regard to
  - accessibility
  - energy conversions required
  - efficiency of energy conversions
  - environmental impact of extraction, conversion, distribution and use on the environment and society;

- characteristics of renewable and non-renewable energy sources, including biomass, solar, hydro-electric, wind, coal, natural gas, nuclear;
- greenhouse effect: natural and enhanced;
- the interaction of energy with greenhouse gases: energy absorption, re-emission, radiation and dissipation by greenhouse gases;
- major human intervention in the biosphere contributing to the enhanced greenhouse effect, including fossil fuel use and land use changes;
- impacts of the enhanced greenhouse effect;
- options for reducing the enhanced greenhouse effect, including National Greenhouse Strategy, Kyoto protocol, increasing energy efficiency, emission trading and vegetation sinks.

Key skills

These skills include the ability to

- use practical work to investigate scientific concepts and principles of energy;
- describe and distinguish between energy sources;
- research, analyse and compare one fossil fuel with one non-fossil fuel energy source;
- summarise the environmental impact of developing and using a fossil fuel compared with a non-fossil fuel energy source;
- investigate and report on ways of increasing energy efficiency;
- distinguish between natural and enhanced greenhouse effects;
- describe how the use of different energy sources affects the enhanced greenhouse effect;
- describe how major human intervention in the biosphere contributes to the enhanced greenhouse effect.

AREA OF STUDY 2

Diversity in the biosphere

This area of study examines the concept of biodiversity and its role in sustaining ecological integrity and the survival of populations. Students investigate processes that threaten biodiversity and examine scientific principles applied in managing biodiversity.

Outcome 2

On completion of this unit the student should be able to describe the characteristics of biodiversity, and evaluate strategies to reduce the effects of threatening processes on one selected endangered animal.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 2.

Key knowledge

This knowledge includes

- types of biodiversity, including genetic, species and ecosystem diversity;
- significance and value of biodiversity to ecosystem function and human survival, including ecosystem services, biological resources, and social benefits;
- conservation categories including genetic diversity, populations and species, and their use in conservation planning;

- assessment of biodiversity, including number of species, endemism, species diversity, including the application of simple indices;
- threats to biodiversity, including
  - habitat modification and destruction
  - competition from exotic species
  - loss of pollinators, dispersal agents, host species or symbionts
  - genetic drift, genetic swamping, inbreeding, demographic variation or other consequences of small population size
  - overexploitation and over collection;
- assessment of threat in determining conservation categories, including critical, endangered and vulnerable;
- methods of protecting environments and managing populations, including wildlife corridors, urban environments, national parks, captive breeding programs, and remnant vegetation;
- use of scientific data to establish biodiversity treaties, agreements and regulatory frameworks, including Convention on International Trade of Endangered Species (of wild flora and fauna) (CITES), Ramsar Convention, and the sections of the *Flora and Fauna Guarantee Act 1988* that apply to the protection of an endangered animal.

Key skills

These skills include the ability to

- identify and describe the types of biodiversity;
- analyse the value of biodiversity to determine its significance;
- collect fieldwork and/or practical work data to assess the biodiversity of an area;
- identify and examine the threats to biodiversity;
- collect primary and/or secondary data and assess the threat to biodiversity in determining conservation status of specific organisms within an area;
- describe and evaluate methods for protecting environments and managing populations;
- explain the importance of scientific data used in protection measures of biodiversity treaties, agreements and regulatory frameworks.

Outcome 3

On completion of this unit the student should be able to explain how scientific data is applied to the assessment of environmental risk in ensuring biodiversity.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 2.

Key knowledge

This knowledge includes

- assessment of biodiversity, including number of species, endemism, species diversity, genetic diversity including the application of simple indices;
- assessment of threat in determining conservation categories, including critical, endangered and vulnerable;
- environmental impact assessment;
- precautionary principle and statistical techniques to estimate and manage biodiversity;
- assessment of risk, including estimating the risk of extinction.

Key skills

These skills include the ability to

- relate environmental impact assessment, precautionary principle and statistical power calculations;
- estimate qualitative significance in statistical data and the implications for conservation;
- use scientific data in risk assessment;
- use qualitative methods to estimate the risk of extinction;
- explain the factors identified as contributing to extinction;
- apply simple indices to the measurement of impacts for wildlife management and conservation in terms of the risks.

ASSESSMENT

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated achievement of the set of outcomes specified for the unit. This decision will be based on the teacher's assessment of the student's overall performance on assessment tasks designated for the unit. The Victorian Curriculum and Assessment Authority publishes an assessment handbook that includes advice on the assessment tasks and performance descriptors for assessment.

The key knowledge and skills listed for each outcome should be used as a guide to course design and the development of learning activities. The key knowledge and skills do not constitute a checklist and such an approach is not necessary or desirable for determining the achievement of outcomes. The elements of key knowledge and skills should not be assessed separately.

Assessment of levels of achievement

The student's level of achievement in Unit 3 will be determined by school-assessed coursework and a mid-year examination.

Contribution to final assessment

School-assessed coursework for Unit 3 will contribute 17 per cent to the study score.

The level of achievement for Unit 3 is also assessed by a mid-year examination, which will contribute 33 per cent to the study score.

School-assessed coursework

Teachers will provide to the Victorian Curriculum and Assessment Authority a score representing an assessment of the student's level of achievement.

The score must be based on the teacher's rating of performance of each student on the tasks set out in the following table and in accordance with an assessment handbook published by the Victorian Curriculum and Assessment Authority. The assessment handbook also includes advice on the assessment tasks and performance descriptors for assessment.

Assessment tasks must be a part of the regular teaching and learning program and must not unduly add to the workload associated with that program. They must be completed mainly in class and within a limited timeframe. Where optional assessment tasks are used, teachers must ensure that they are comparable in scope and demand. Teachers should select a variety of assessment tasks for their program to reflect the key knowledge and skills being assessed and to provide for different learning styles.

Outcomes	Marks allocated*	Assessment tasks
Outcome 1 Describe the principles of energy, and relate them to the contribution of one fossil and one non-fossil energy source to the enhanced greenhouse effect.	20 20	A written report of a practical activity **and** A report in annotated poster or multimedia format.
Outcome 2 Describe the characteristics of biodiversity, and evaluate strategies to reduce the effects of threatening processes on one selected endangered animal.	30	A report on one selected endangered animal presented in any one or combination of the following: • a written report • an oral report • a multimedia presentation.
Outcome 3 Explain how scientific data is applied to the assessment of environmental risk in ensuring biodiversity.	30	Any one or a combination of the following: • a written report • an oral report • a multimedia presentation • a written response to set questions • a report on data collected from fieldwork or other sources.
Total marks	**100**	

*School-assessed coursework for Unit 3 contributes 17 per cent to the study score.

Mid-year examination

Description

All outcomes for Unit 3 will be examined.

The examination will assess a representative sample of key knowledge and skills that underpin Outcomes 1, 2 and 3 of the unit.

Format

The examination will be divided into two sections; a multiple-choice section and a short-answer response section.

All questions are compulsory.

Students will complete the examination using a structured answer booklet.

The examination will be set by a panel appointed by the Victorian Curriculum and Assessment Authority.

Conditions

The examination will be completed under the following conditions:

- Duration: one and a half hours.
- Date: mid-year, on a date to be published annually by the Victorian Curriculum and Assessment Authority.
- Victorian Curriculum and Assessment Authority examination rules will apply. Details of these rules are published annually in the *VCE and VCAL Administrative Handbook*.
- The examination will be marked by a panel appointed by the Victorian Curriculum and Assessment Authority.

Contribution to final assessment

The examination will contribute 33 per cent to the study score.

Unit 4: Ecological sustainability

This unit focuses on pollution and its relationship to the health of humans and the environment. It advances further understanding of managing the environment to ensure development meets human needs while maintaining ecological integrity of the environment.

AREA OF STUDY 1

Pollution and health

This area of study examines the concept of pollution, the source of pollutants and the effects of pollution on the health of humans and the environment. The significance of technology, government initiatives, communities and individuals in redressing the impact of pollutants is analysed.

One pollutant (of local significance where possible) is to be studied in depth. The general characteristics of mercury and sulfur dioxide as pollutants are to be studied in less depth than the selected pollutant.

Outcome 1

On completion of this unit the student should be able to describe the characteristics of pollutants, and evaluate management options for reducing the risk of a pollutant affecting the health of the environment and humans.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 1.

Key knowledge

This knowledge includes

- general characteristics of mercury and sulfur dioxide as pollutants
  - environmental human health, health of the environment, environmental hazards
  - point and diffuse sources of pollution and pollutant sinks
  - transport mechanisms, including persistence, mobility, bioaccumulation
  - exposure, dosage, chronic and acute toxicity, allergies, specificity and synergistic action;
- characteristic of one pollutant (excluding mercury and sulfur dioxide), including
  - strategies that reduce the risk of pollutants affecting human health and the environment, with reference to the one selected pollutant (of local significance where possible)
  - direct and indirect effects on the health of humans and the environment of the one selected pollutant (of local significance where possible).

Key skills

These skills include the ability to

- discuss the characteristics of mercury and sulfur dioxide as pollutants;
- collect appropriate data safely from fieldwork and/or practical work to describe the physical and chemical properties of the pollutant;
- establish appropriate techniques to measure the pollutant under health and safety guidelines;
- measure and analyse the presence of the pollutant in the selected environment and report the findings of the collected data;
- assess the credibility of the collected primary data of the pollutant;
- compare the collected primary data of the pollutant with relevant standards or guidelines;
- examine the physiological effects of the pollutant;
- predict the probable environmental effects of the measured pollutant;
- identify the transport mechanisms and sources of the pollutant;
- develop and evaluate a protocol to overcome the problems caused by the pollutant;
- research and report on a pollutant associated with an emerging health problem.

AREA OF STUDY 2

Applied environmental science

This area of study examines the application of environmental science to ecologically sustainable development and environmental management.

The area of study should be related to one selected environmental science project studied in depth. Suitable projects could include:

- geotechnical and transport engineering; for example, construction of roads, freeways, railways, airports, mines;
- environmental engineering; for example, coastal erosion protection, mine revegetation, municipal recycling system, freeway revegetation;
- water conservation and water engineering; for example, studies of pollution in bays and oceans, sewage treatment plants, river diversion tunnels, stormwater drainage systems;
- energy and pollution minimisation strategies; for example, waste heat use in bread industry, air quality monitoring, electrostatic precipitation in smoke stacks, waste minimisation plan, cleaner production plan, energy efficient housing and commercial buildings;
- soil remediation and soil erosion; for example, bioremediation of soils, studies of dryland salinity, total catchment management to reduce soil erosion;
- intensive and alternative agricultural practices; for example, feedlots, irrigation, organic farming, biological controls in farming.

Outcome 2

On completion of this unit the student should be able to use the principles of ecologically sustainable development and environmental management to evaluate a selected environmental science project.

To achieve this outcome the student will draw on knowledge and related skills outlined in area of study 2.

Key knowledge

This knowledge includes

- assessment of the environmental impacts and risks associated with one selected environmental science project, preferably with local application;
- ecologically sustainable development;
- environmental management: tools and strategies, including Environmental Management Systems, waste minimisation, Life Cycle Analysis, environmental impact assessment, Environmental Risk Assessment;
- influence and consequences of regulatory frameworks related to the activities of the environmental science project;
- assessment of the impact of ecotourism on the environment and the strategies required to manage ecotourism;
- role of the community, media, environmental interest groups, non-government and/or government agencies in encouraging responsible environmental practices.

Key skills

These skills include the ability to

- assess the environmental impacts and risks associated with an environmental science project;
- examine the elements of environmental management and its relationship to ecologically sustainable development;
- use scientific data to construct a management plan for an ecologically sustainable development;
- determine the stakeholders involved, including community, business, industry or government agency where relevant;
- evaluate the effectiveness of the environmental management plan implemented by the organisation;
- develop a management plan in response to scientific data to ensure that ecologically sustainable development can be obtained;
- analyse the impact of ecotourism.

ASSESSMENT

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated achievement of the set of outcomes specified for the unit. This decision will be based on the teacher's assessment of the student's overall performance on assessment tasks designated for the unit. The Victorian Curriculum and Assessment Authority publishes an assessment handbook that includes advice on the assessment tasks and performance descriptors for assessment.

The key knowledge and skills listed for each outcome should be used as a guide to course design and the development of learning activities. The key knowledge and skills do not constitute a checklist and such an approach is not necessary or desirable for determining the achievement of outcomes. The elements of key knowledge and skills should not be assessed separately.

Assessment of levels of achievement

The student's level of achievement for Unit 4 will be determined by school-assessed coursework and an end-of-year examination.

Contribution to final assessment

School-assessed coursework for Unit 4 will contribute 17 per cent to the study score.

The level of achievement for Unit 4 is also assessed by an end-of-year examination, which will contribute 33 per cent to the study score.

School-assessed coursework

Teachers will provide to the Victorian Curriculum and Assessment Authority a score representing an assessment of the student's level of achievement.

The score must be based on the teacher's rating of performance of each student on the tasks set out in the following table and in accordance with an assessment handbook published by the Victorian Curriculum and Assessment Authority. The assessment handbook also includes advice on the assessment tasks and performance descriptors for assessment.

Assessment tasks must be a part of the regular teaching and learning program and must not unduly add to the workload associated with that program. They must be completed mainly in class and within a limited timeframe. Where optional assessment tasks are used, teachers must ensure that they are comparable in scope and demand. Teachers should select a variety of assessment tasks for their program to reflect the key knowledge and skills being assessed and to provide for different learning styles.

Outcomes	Marks allocated*	Assessment tasks
Outcome 1 Describe the characteristics of pollutants, and evaluate management options for reducing the risk of a pollutant affecting the health of the environment and humans.	25 25	A report on the findings of selected fieldwork and/or practical activities relating to pollutant(s) **and** An evaluation of management strategies based on primary and/or secondary data.
Outcome 2 Use the principles of ecologically sustainable development and environmental management to evaluate a selected environmental science project.	25 25	A report **or** A test **and** A report **or** An environmental management plan.
Total marks	**100**	

*School-assessed coursework for Unit 4 contributes 17 per cent to the study score.

End-of-year examination

Description

All outcomes for Unit 4 will be examined.

The examination will assess a representative sample of key knowledge and skills that underpin Outcomes 1 and 2 of the unit.

Format

The examination will be divided into two sections; a multiple-choice section and a short-answer section.

All questions are compulsory.

Students will complete the examination using a structured answer booklet.

The examination will be set by a panel appointed by the Victorian Curriculum and Assessment Authority.

Conditions

The examination will be completed under the following conditions:

- Duration: one and a half hours.
- Date: end-of-year, on a date to be published annually by the Victorian Curriculum and Assessment Authority.
- Victorian Curriculum and Assessment Authority examination rules will apply. Details of these rules are published annually in the *VCE and VCAL Administrative Handbook*.
- The examination will be marked by a panel appointed by the Victorian Curriculum and Assessment Authority.

Contribution to final assessment

The examination will contribute 33 per cent to the study score.

Advice for teachers

DEVELOPING A COURSE

A course outlines the nature and sequence of teaching and learning necessary for students to demonstrate achievement of the set of outcomes for a unit. The areas of study broadly describe the learning context and the knowledge required for the demonstration of each outcome. Outcomes are introduced by summary statements and are followed by the key knowledge and skills which relate to the outcomes.

Teachers must develop courses that include appropriate learning activities to enable students to develop the knowledge and skills identified in the outcome statements in each unit.

For Units 1 and 2, teachers must select assessment tasks from the list provided. Tasks should provide a variety and the mix of tasks should reflect the fact that different types of tasks suit different knowledge and skills and different learning styles. Tasks do not have to be lengthy to make a decision about student demonstration of achievement of an outcome.

In Units 3 and 4, assessment is more structured. For some outcomes, or aspects of an outcome, the assessment tasks are prescribed. The contribution that each outcome makes to the total score for school-assessed coursework is also stipulated.

The sequence in which the course content could be covered

The content in the areas of study is an indication of the breadth and depth with which topics should be treated. The sequence of teaching is not necessarily prescribed by the sequence of content. There are a number of equally appropriate ways of presenting the required content and practical work in a coherent and comprehensive course. The outcomes, however, must be central to course planning.

Areas of study in Unit 1 can be used to illustrate the flexibility of the sequence of teaching. For example, teachers and students may decide to focus on the key knowledge and skills dealing with natural changes to environments in Outcome 3, before studying those relating to a human induced environmental change in Outcome 2.

Field and practical work

Field and practical work, experimentation, observation and measurement as well as the design of environmental responses are essential to developing student understanding in environmental science. Both practical work and fieldwork provide opportunities to explore and evaluate the application of theoretical scientific concepts. Students should experience a variety of practical and fieldwork activities. A logbook can be a useful means of recording practical and fieldwork activities.

Practical work and fieldwork also provide students with opportunities to work effectively in teams to gather and analyse data in order to determine appropriate responses to environmental issues.

Use of a log book

The log book can be used to record ideas, queries, observations and measurements while participating in the range of practical and fieldwork activities. Its purpose is to provide a basis for further learning, such as contributing to class discussion about a demonstration or fieldwork exercise, reporting back to the class on an experiment, responding to questions in a practical worksheet or problem-solving exercise, or writing up a formal report of an experiment.

The log book need not be a single volume. It could take the form of an exercise book, a bound workbook of practical and fieldwork activities with space for comments, spreadsheet printout, loose sheets or other suitable format.

Outline of a sample course for Unit 1

This outline suggests how content could be structured to cover the outcomes for Unit 1. The main areas of content and possible learning activities are included. This outline is not meant to be prescriptive or exhaustive.

Fieldwork in Unit 1

The ideas of fieldwork and field ecosystems are used in a broad sense. Schools with limited access to natural ecosystems could use sections of gardens, particularly soil and leaf litter or artificial aquatic ecosystems in aquaria. However, wherever possible, investigations of such ecosystems should be supported by fieldwork in local natural ecosystems such as the local stream, remnant vegetation or parklands. If using local or state parks, regulations regarding activities and the collection of organisms need to be checked and followed. Activities should be planned to create minimal impact on the environment under investigation.

Relevant outcomes	Key knowledge	Learning and practical activities
Outcome 1 Identify and describe the components and natural processes within the environment.	**Weeks 1–2** Definition of environment and ecosystem. The Sun as the source of energy for all life on Earth. Nuclear fusion reaction on the Sun. Solar radiation and how it travels to Earth. The spectrum. Reflection of light. Refraction of light. Absorption of light. The atmosphere. The hydrosphere.	Demonstrate through practical work the nature and properties of light, including: • visible light • spectrum • refraction • reflection • scattering • evaporation rates. Annotate a diagram to highlight how solar radiation affects the water cycle. Conduct practical exercises to determine the factors that influence evaporation and condensation (the water cycle).

Relevant outcomes	Key knowledge	Learning and practical activities
Outcome 1 Identify and describe the components and natural processes within the environment.	**Weeks 3–6** The biosphere Abiotic factors limiting range of flora and fauna. The lithosphere. Biogeochemical cycles – nitrogen, phosphorous and carbon.	Identify the characteristic flora and fauna that distinguish different Victorian ecosystems. Demonstrate through practical work the nature and properties of rocks, minerals and soils, including: • colour • formation • hardness • porosity. Examine different substances that contain carbon, phosphorus and nitrogen, e.g. coal, fertilisers, matches, and identify their location in the appropriate biogeochemical cycle.
Outcome 2 Analyse one human-induced environmental change and options for remediation.	**Weeks 7–11** Local ecosystems that illustrate human-induced environmental changes. Factors that contribute to a local environmental change and strategies used by people to remedy negative changes.	Investigate and report upon a local environmental problem that has been addressed by a local council, business or interest group and focus on the manner in which remediation has progressed.
Outcome 3 Explain the flow of energy, nutrient exchange and environmental changes in ecosystems.	**Weeks 12–15** Characteristics of different ecosystems in Victoria. Natural short-term cyclic environmental changes. Natural long-term changes and their effects. Natural random events such as erosion, flood, drought, fire, earthquake and volcanic activity. Flow of energy, nutrient exchange and environmental change in an ecosystem.	In pairs, research and report on the characteristics of a Victorian Ecosystem. Undertake an excursion to a rock platform or local lake area to investigate the zonation of plants. Develop a time line for a local area that dates the occurrence of major events such as flood, drought and bushfire. Model interactions between organisms and their effects on ecosystems. Observe and record natural short-term cyclic environmental changes. Model natural long-term environmental changes and describe their effects.

Relevant outcomes	Key knowledge	Learning and practical activities
Outcome 3	**Weeks 16–18**	
Explain the flow of energy, nutrient exchange and environmental changes in ecosystems.	Food chains and food webs. Classify organisms into trophic and energy flow pyramids. Construction of a pyramid of numbers. Assemble a biomass pyramid. Interactions between organisms, including competition, mutualism, predation, parasitism and commensalism. Competition in ecosystems. Predation, commensalism, mutualism and parasitism.	Investigate a local pond or river to identify as many animals as possible and use them in an appropriate food web. Use the Internet to investigate the roles in nature of: • Mistletoe plant • Remona • Tick bird.

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

In designing courses and developing learning activities for Environmental Science, teachers are encouraged to make use of applications of information technology and new learning technologies, such as computer-based learning, multimedia and the World Wide Web.

Datalogging is used to monitor environmental or physiological parameters over short or long periods. The requirements include sensors, computer, interface and software. Examples of the use of datalogging technology include investigating the relationship between light intensity and dissolved oxygen levels in a stream over a few days; monitoring salinity levels in soils or stream; measuring the growth rate of seedlings under different light intensities or temperatures.

Spreadsheets can be used to investigate patterns in experimentally obtained data. They can also be useful to simulate experimental situations, where experiments are not possible or the equipment is not available.

Computer software packages that model and simulate environmental scenarios are important tools that allow students to examine realistic situations within time lines that are observable and managed within the classroom. Furthermore, databases presenting biological keys and field guides of Australian flora and fauna are useful in assisting students to identify species in the field.

The use of the Internet is a powerful tool for research and provides the opportunity to gain updated information about environmental management policies and strategies. It also provides a medium to monitor and research environmental issues from perspectives of the various stakeholders involved in the issue.

KEY COMPETENCIES AND EMPLOYABILITY SKILLS

Students undertaking the following types of assessment, in addition to demonstrating their understanding and mastery of the content of the study, typically demonstrate the following key competencies and employability skills.

Assessment task	Key competencies and employability skills
Report on data collected from fieldwork	Planning and organisation, communication (written and/or oral)
Written report of a practical activity	Teamwork, self-management, problem-solving, initiative/innovation, written communication
Test	Summarising and interpreting information
Evaluation of management strategies based on primary and/or secondary data	Interpreting data, communication of information in an organised way
Multimedia presentation	Collecting, summarising and interpreting data, use of information and communications technology

LEARNING ACTIVITIES

Examples of learning activities for each unit are provided in the following sections. Examples highlighted by a shaded box are explained in detail in accompanying boxes. The examples that make use of information and communications technology are identified by this icon ICT.

Unit 1: The environment

AREA OF STUDY 1: Ecological components and interaction

Outcome 1

Identify and describe the components and natural processes within the environment.

Examples of learning activities


use the Internet to investigate a variety of Victorian ecosystems; identify their characteristic components and processes

identify the difference between environment and ecosystems


prepare a model of the Earth or use a software package to simulate a model and show the components and structure of the atmosphere, biosphere and lithosphere

describe and classify abiotic and biotic components of ecosystems and describe the function of six described components


use a word-processing program to develop a flow-diagram that demonstrates the pathways of solar energy through the atmosphere and biosphere


undertake experiments using datalogging methods to show the properties of sunlight

examine and compare the cycling of critical nutrients/matter on Earth such as carbon, phosphorous, nitrogen, water and oxygen

use practical work to investigate photosynthesis which transforms solar energy to an energy source accessible to organisms

use practical work to investigate soil types and their properties

compare plant communities on different soil types

investigate the relationship between carbon dioxide and plant growth

undertake fieldwork that provides evidence of interactions between the Earth's spheres, e.g. impact of soil erosion on terrestrial or aquatic ecosystems, geological processes, introduction of feral animal or plant to an ecosystem

investigate processes of sedimentation, weathering and fossil formation through practical work

visit sites and document the effects of erosion of soil by water such as sheet erosion, gully erosion, tunnelling, stream bank erosion or wind

Detailed example

CYCLING OF CRITICAL NUTRIENTS OR MATTER

The cycling of carbon is presented as an example to study other cycles. Small groups elect to investigate a critical nutrient/matter and how it is cycled within the Earth's spheres.

Each group:

- designs or carries out experiment/s to demonstrate the structure/properties of the most common/accessible form of the nutrient/matter;
- researches the cycle of the critical nutrient/matter (students could use the Internet);
- describes the chemical/physical/biological interactions that occur as the critical nutrient/matter completes it cycle;
- prepares a diagram to illustrate the pathway of the critical nutrient/matter in its cycle;
- explains why the nutrient/matter is critical;
- identifies and briefly describes if there is an environmental issue associated with the critical nutrient/matter.

After researching the critical nutrient/matter, each group prepares and presents a summary of their findings. The group must also prepare a handout for their colleagues which summarises the key characteristics of their critical nutrient/matter. Students can utilise a software package to prepare their presentations.

After presentations are delivered, students use their logbook notes to respond to a series of questions, describing and comparing the similarities and differences between three nutrients/matter and their cycles.

AREA OF STUDY 2: Environmental change

Outcome 2

Analyse one human-induced environmental change and options for remediation.

Examples of learning activities

undertake fieldwork at a local site where human-induced change has occurred, e.g. back burning, erosion, farm dams, breakwater, river improvement

prepare a report of the fieldwork, describing the characteristics of the human-induced change; use collected data to support findings

undertake fieldwork to compare the effects of a badly eroded site with a stable site; describe and compare the soil profiles/types and other characteristics that contribute to the site's soil erosion

visit a local business or industry that is undertaking conservation and/or remediation strategies and summarise the strategies and their effects


investigate using the Internet and other resources appropriate strategies to contribute to conservation and remediation of the local environment

assess the effectiveness of similar conservation and remediation strategies, and predict the effectiveness if applied to the local environment site investigated

make suggestions to conserve and/or remediate the site in the local environment and present these as recommendations to the local council

undertake conservation and/or remediation measures to improve the quality of the local environment site

investigate the effect of ballast water releases in Port Phillip Bay and discuss possible methods to minimise the environmental impacts


use datalogging techniques to observe changes to the ground water table in the local area and study its effects

investigate the recycling program for beverage containers in a local shopping complex

investigate change to bushfire frequency in the local environment and the consequences of this change

describe the impact of erosion in the local environment and how it could be remedied


use CD-ROMs, the Internet and print resources to investigate ozone depletion in the stratosphere

AREA OF STUDY 3: Ecosystems

Outcome 3

Explain the flow of energy, nutrient exchange and environmental changes in ecosystems.

Examples of learning activities

use datalogging and spreadsheets to observe, measure and record changes within an ecosystem, such as the school ground over a short period, e.g. over one day or two weeks

use secondary data to identify the major effects of random environmental changes within the local area, e.g. changes in flood levels, frequency of bushfires or droughts

prepare a poster or a report in multimedia format that describes the evidence for, and effects of, one natural long-term environmental change on Australian environments, such as ecological succession, plate tectonics or drying of the Australian continent

compare the availability of soil nutrients in Australian ecosystems with European ecosystems; discuss the limitations of Australian soils in relation to the introduction into Australia of European agricultural practices from 1788 to 1850

classify producers by undertaking practical work using appropriate microscopic techniques

investigate an ecosystem by constructing a food chain and food web; depict how the chemical energy available from foods is transferred through various trophic levels

investigate the processes of photosynthesis and respiration through practical work, including datalogging

classify organisms of an ecosystem; identify the differences between producer organisms and organisms at other trophic levels

prepare an annotated poster or multimedia presentation that reflects an energy-flow pyramid for a Victorian ecosystem

use data collected in the field through such techniques as quadrats, transects or water sample sweeps, to construct a foodweb for an ecosystem

examine a biomass pyramid and describe the characteristics of the ecosystem

describe the interactions (e.g. competition, predation, mutalism, etc.) between eight organisms within an ecosystem; examine their effect on the functioning of that ecosystem

Unit 2: Monitoring the environment

AREA OF STUDY 1: Environmental indicators

Outcome 1

Explain the nature of environmental indicators for pollution and ecological health of ecosystems.

Examples of learning activities

examine the definition and purpose of environmental indicators

describe and classify a list of environmental indicators by type and purpose

examine the way biological indicators are used to define concepts such as ecological niche of organisms, threshold, range of tolerance, and limiting factors of species

investigate the use of organisms as biological environmental indicators

visit a zoo or local ecosystem to observe an organism living in its habitat; identify the organism and through observation and research identify the ecological niche of that organism; look for evidence of pressures on the organism in its environment, and identify the effects of those pressures on the individual and the population of the species


use datalogging and spreadsheets to design experiments to observe and measure the range of tolerance for a specific plant species, e.g. tolerance of salt by bean plants


visit CSIRO's website and those of other large scientific organisations to investigate a variety of techniques to monitor environmental indicator data, the correct use of these data collection techniques, and their suitability for gaining useful data within a specific ecosystem


use a range of equipment to measure and record environmental indicator data, e.g. light intensity meter, pH meter, salinity meter, soil testing kits, sampling nets, field guides, turbidity discs, dissolved oxygen measuring equipment, dB meter, conductivity meter

AREA OF STUDY 2: Using environmental indicators

Outcome 2

Investigate and report on a local example of environmental degradation or environmental issue, using an appropriate monitoring program.

Examples of learning activities

identify an example of a local site of environmental degradation or a local environmental issue


use datalogging in the field to collect data which describes the characteristics of the local site and its environmental degradation; include the distribution of the environmental degradation and collect data that provides evidence to illustrate the cause and effect of the environmental degradation at the local site

undertake fieldwork to collect data which describes the characteristics of the local environmental issue; collect data that demonstrates the cause and effect of the environmental issue within the local environment


use datalogging in the field to determine the environmental quality of an ecosystem using qualitative and/or quantitative chemical analysis, for example the presence of oxides of nitrogen in air, titrimetric analysis to show the level of chloride ions in water, colorimetric analysis to determine phosphate ions in water

identify appropriate environmental indicators to monitor the state of the environment at a local site, looking at environmental degradation or a local environmental issue


use the Internet to investigate and compare two different State Environment Protection Policies (SEPPs) and the indicators used in pollution control

develop an appropriate monitoring program for the local site, looking at environmental degradation or a local environmental issue, using at least two environmental indicators and explain their significance; discuss the role of the monitoring program

use a water quality monitoring program to determine the health of a local stream

collect data on bird species and numbers to monitor the role of remnant vegetation in supporting species biodiversity

collect saltwatch or frogwatch data and describe its use by local community and/or authorities

use air quality monitoring data to determine the pollution levels in a local area

investigate the influence of water-related SEPPs in determining water quality monitoring programs

AREA OF STUDY 2: Using environmental indicators

Outcome 3

Analyse the scientific basis and use of standards for environmental indicators for pollution control and ecological health of ecosystems.

Examples of learning activities

examine one SEPP, e.g. SEPP – Waters of Western Port Bay and Catchment, SEPP – Waters of Victoria, SEPP – Gr oundwaters of Victoria, SEPP – The Air Environment, SEPP – Control of noise from commerce, industry and trade, SEPP – Control of music noise from public premises, SEPP – Siting and management of landfills receiving municipal waste, SEPP – Industrial Waste Management Policy (Waste Minimisation), SEPP – Industrial Waste Management Policy (Control of ozone-depleting substances); identify the major structure of the SEPP; evaluate how the scientific data is used to determine standards (e.g. why are there different levels of standards for different situations within a SEPP) and establish appropriate environmental monitoring programs (e.g. how can standards be used to develop environmental monitoring programs)

research SEPPs through the Internet and discuss their application in pollution control

examine the Pressure–State–Response model and how scientific data is used in this model

propose a set of environmental indicators to measure the state of the school environment and include at least one each of chemical, physical, and biological indicators

examine the use of environmental indicator data by corporate organisations, e.g. Annual Environmental Reports

investigate the use of environmental indicator data and reporting on environmental monitoring programs by government agencies such as the Department of Natural Resources and Environment, e.g. refer to management plans or action plans, or industry organisations such as annual environmental reporting or annual reports, and discuss how they use the scientific data in their reporting

explore a local environmental issue and invite a related policy maker, policy implementers and a member of a local community group to discuss the significance of environmental indicators in decision making

investigate protection standards for beneficial uses, e.g. water, air, etc.

use environmental indicator data to investigate air pollution patterns in Victoria

use environmental indicator data to investigate indoor air pollution and human health

investigate the determination of standards (objectives) in a (selected) SEPP

investigate the effects on humans or the environment if a SEPP standard is exceeded in the short and long term

use the Internet to research the role of the Environment Protection Authority in pollution control

analyse scientific techniques to regulate or monitor environmental standards

analyse the use and types of environmental indicators and monitoring program/s used by a corporation and a Victorian Government agency such as the Department of Natural Resources and Environment or its equivalent

identify and compare the purpose of Victorian State of Environment reports with the Australian State of Environment reporting

classify types of environmental indicators used in State of Environment reporting and identify how they could be used in decision-making processes

compare the OECD Pressure–State–Response model with the Condition–Pressure–Response model adopted by Australia in its State of Environment reporting

Detailed example

DEVELOPING INDICATORS OF PRESSURE-RESPONSE

Discuss the Pressure–State–Response model presented in the OECD report (OECD, 1991, *The State of the Environment*, Paris), which has been adopted and used by nations, including Australia, to describe human–environment interaction and present State of the Environment reports.

Examine the school and identify the diversity of environments within the school, and the environmental issues of concern. Examples of school environmental issues include use of energy resources, use of water resources, areas for recreational activities, area for maintaining local biodiversity, use of paper, use of trees for shade, destination and effects of school litter, waste to landfill.

The class is divided into teams. Each team is to prepare a set of indicators for their specific issue of environmental concern using the Pressure–State–Response model. The team should:

- determine the indicator/s that will identify and measure the pressure that the issue presents on and beyond the school environment
- determine the indicator/s that will identify and measure the state or condition of the school environment related to the issue
- identify what actions could minimise the impact of the environmental issue on the school environment and beyond
- determine the indicator/s that will identify and measure the response to the environmental issue.

Each team presents and justifies their set of proposed indicators to the class.

Unit 3: Ecological issues: energy and biodiversity

AREA OF STUDY 1: Energy and global warming

Outcome 1

Describe the principles of energy, and relate them to the contribution of one fossil and one non-fossil energy source to the enhanced greenhouse effect.

Examples of learning activities

use practical investigations to explore concepts of potential, kinetic and mechanical energy, work and heat

use the conservation of energy and laws of thermodynamics to explain the efficiency of energy conversions

use practical work to develop concepts of endothermic and exothermic reactions and investigate combustion as an important reaction to transform one energy resource such as coal to another such as electricity


visit CSIRO and ABC websites to begin an investigation into a variety of different energy sources that are used in Australia; compare these with energy sources used internationally

identify and compare two types of energy sources, one fossil and the other a non-fossil energy source, and their effects on the environment during the development and use of the energy


use the Internet to research and summarise the characteristics of renewable and non-renewable energy sources, including biomass, solar, hydroelectric, wind, coal, natural gas and nuclear, and their relative contributions to the enhanced greenhouse effect

investigate the fractional distillation process of an oil refinery and identify how the diversity of products is obtained from crude oil; carry out a fractional distillation in the laboratory

investigate the use of alternative fuels such as energy sources, e.g. ethanol; make ethanol from the fermentation of glucose and identify the gaseous by-product of this process; prepare a poster to present arguments about ethanol as a sustainable energy source and its contribution to the enhanced greenhouse effect


use the Internet to research ways in which different organisations such as industrial, business, schools, hospitals, households use energy more efficiently and prepare a poster to summarise successful efficient energy use

design an experiment/model that represents the greenhouse effect; analyse greenhouse effect mechanisms

construct a flow diagram that compares efficiencies in a solar heater or a wind generator

use practical investigations to release or use energy efficiently


use a computer simulation model to predict the effects of the greenhouse effect in a variety of situations, and describe appropriate responses to minimise the impact

project a spectrum onto a screen; place a solution of chlorophyll dissolved in methylated spirits between the light source and the screen to show the absorption of visible light by a substance

create a concept map that demonstrates the interrelationships between energy use, human activities, greenhouse gases and the enhanced greenhouse effect

examine changing concentration of atmospheric carbon dioxide over the last 1000 years using data from scientific literature and Antarctic core samples

identify the greenhouse gases and their capacity to retain heat; make comparative calculations to demonstrate the ability of greenhouses gases to retain heat


use the Internet and print sources to collect four recent articles presented by the media (including two from scientific journals) about the enhanced greenhouse effect; summarise the major points and compare and examine how scientific data is used to justify the information presented in the articles

collect and analyse data about methane levels at a local tip and suggest an appropriate response to reduce the methane emission


use various sources including the Internet, journals and CD-ROMs to investigate government initiatives in the reduction of greenhouse gases in the atmosphere, such as the Greenhouse and its key measures; including key initiatives such as the National Greenhouse Strategy, National Greenhouse Gas Inventory, National Greenhouse Research Program, Greenhouse Challenge Program, Household Greenhouse Action, Greenfleet, AUSTENERGY, National Bicycle Strategy, Plantations of vegetation sinks for Australia: The 2020 Vision, Bushcare: the National Vegetation Initiative, Regional Forest Agreements, National Strategy for Cleaner Production, emission trading

debate the effectiveness of the following options for reducing the enhanced greenhouse effect: National Greenhouse Strategy, Kyoto Protocol, increasing energy efficiency, emission trading and vegetation sinks

identify a vegetation sink and explain at least three factors that affect the effectiveness of vegetation sinks

prepare a presentation that outlines the following characteristics of one named fossil and one non-fossil fuel energy resource in Victoria: location, accessibility, energy conversions required, environmental impacts of extraction, conversion, distribution and use on the environment and society; use your knowledge of the principles of energy to explain the relative contribution of each of the energy sources to the enhanced greenhouse effect

Detailed example

ANALYSING GREENHOUSE EFFECT MECHANISMS

Students undertake a series of experiments to gain understanding of energy absorption, re-emission, radiation and dissipation which operate in the greenhouse effect. In each experiment, students should discuss how the principle of energy demonstrated relates to the enhanced greenhouse effect. Experiments and activities could include:

- use of light box equipment and charts of electromagnetic radiation to show the composition of white light, the energy associated with different colours, and that the associated wavelength associated with a particular colour is inversely proportional to the energy
- comparing data which illustrates the wavelengths of solar energy and the effects of short and long wavelengths on absorption and re-emission
- identifying energies and associated wavelengths of the emission spectral lines when metal salts are heated or in a mercury-cadmium or sodium lamp
- comparing and contrasting absorption and emission of heat energy by different materials and surfaces of the same material
- comparing the rise in temperature of the water inside metal cans painted different colours and subjected to heating by a 1000 W globe
- measuring the rise in temperature of samples of gases placed in direct sunlight or a halogen lamp
- designing an experiment to measure the rate of dissipation of heat energy from a system.

AREA OF STUDY 2: Diversity in the biosphere

Outcome 2

Describe the characteristics of biodiversity, and evaluate strategies to reduce the effects of threatening processes on one selected endangered animal.

Examples of learning activities

discuss the types and levels of biodiversity and their significance to ecosystem functioning and human survival

use practical work to investigate the role of moulds in ecosystem functioning and their importance in medicine

visit websites such as Ecology Links, Environment Australia and World Wildlife Fund, to research a program that is used to manage or conserve a species and identify what level or unit of conservation is being addressed by the program (e.g. is it conserving genetic diversity, population/s or the entire species?); suggest why the conservation efforts are being concentrated at this unit of conservation

use a number of techniques to assess biodiversity in the school or at a site in the local environment, e.g. quadrants, transects, sampling; assess the biodiversity of that environment in a variety of measures such as number of species, species richness, species evenness, species diversity and endemism; use simple diversity indices like Simpson's Index and Shannon Weiner Index to analyse the data collected

identify a number of threatened species or communities and examine the threats to the survival of the species or communities

give examples of how the following act as threats to biodiversity: habitat modification and destruction; competition from exotic species; loss of pollinators, dispersal agents, host species or symbionts; genetic drift, genetic swamping, inbreeding; exploitation and over-collecting

analyse data collected for a marine species and explain the threats to its survival, e.g. orange roughy, scallops, abalone, dugong

discuss the differences between the following conservation categories: critical, endangered, vulnerable

visit an organisation that is conserving biodiversity at a site and arrange a tour and presentation of their conservation strategy; summarise the strategy and examine its problems and level of effectiveness

visit a site of remnant vegetation and collect data to analyse the significance of remnant vegetation and wildlife corridors in protecting biodiversity

collect primary and secondary data specific to a site to identify and assess the biodiversity of the environment: identify the threats to biodiversity at the site and suggest a strategy to reduce the threatening process

research the impact of the human population on biodiversity and predict the effect on global biodiversity of a human population of 6 billion

research how scientific data is used in the following biodiversity protection measures: CITES, Ramsar Convention and the *Victorian Flora and Fauna Guarantee Act 1988*; comment on the scientific principles underlying each treaty, agreement and regulatory framework

debate the effectives of the following methods of protecting environments and managing populations: urban environments, national parks and captive breeding programs

use the Internet to identify a locally endangered animal. Use primary and secondary data to evaluate the effectiveness of strategies to reduce the threats

Detailed example

A LOCALLY ENDANGERED ANIMAL

Students research the threats to a locally endangered animal using the Internet. They evaluate strategies to reduce the effects of threatening processes using primary and secondary data. Research should include:

- using Internet to identify a locally endangered animal that is listed in the *Victorian Flora and Fauna Guarantee Act 1998* and has an Action Statement prepared for it
- conducting fieldwork to gather primary data about this animal
- describing the animal and its habitat
- describing the threatening processes that contribute to the animals conservation status
- describing the strategies that have been used and/or recommended to reduce these threats
- evaluating the effectiveness of these strategies using primary and secondary data to justify the evaluation.

AREA OF STUDY 2: Diversity in the biosphere

Outcome 3

Explain how scientific data is applied to the assessment of environmental risk in ensuring biodiversity.

Examples of learning activities

discuss and define the concept of environmental risk assessment


use a word-processing package to construct a concept map that illustrates the relationships between assessment of biodiversity, threatening processes and environmental risk assessment

define the concept of the precautionary principle and use it in a variety of contexts

identify the factors involved in estimating extinction rates

summarise the role that environmental impact assessment plays in considering biodiversity issues relating to a named development proposal

explain the factors identified as contributing to the extinction risk of a local species or community

comment qualitatively on the adequacy of statistical data and consider the role of Type I and Type II errors and their effects in conserving biodiversity

identify the type/s of uncertainty in managing a population at risk

investigate the use of a simple index like Population Viability Analysis models for managing populations and respond to its effectiveness in a particular example


use the Internet to collect two articles on managing for biodiversity and examine the use of risk assessment in the program


in conserving a species listed in the bioinformatics section of the Melbourne Museum website; investigate the role of environmental impact assessment, precautionary principle and statistical power calculations in analysing the application of scientific data to environmental risk assessment; present the analysis in the form of a structured report

examine the use of a population model, such as Population Viability Analysis, in predicting a simple extinction risk index for a threatened population (examples of populations under threat include the eastern barred bandicoot, southern brown bandicoot, leadbeater's possum, greater bilby, powerful owl, helmeted honeyeater, matchstick banksia)

Unit 4: Ecological sustainability

AREA OF STUDY 1: Pollution and health

Outcome 1

Describe the characteristics of pollutants, and evaluate management options for reducing the risk of a pollutant affecting the health of the environment and humans.

Examples of learning activities

- *introduction of key terms, processes*

– discuss the definition of pollutant and distinguish between environmental human health, health of the environment and environmental hazards

– compare the characteristics of a point and diffuse source of pollution, e.g. ingesting a carcinogen (point pollutant source) and exposure to smoke (diffuse pollutant source)

– describe the characteristics of mercury and sulfur dioxide as pollutants

– discuss the role and variety of pollutant sinks and the issue of diluting the effect of pollutants; carry out experiment/s to simulate the dilution effect with non-toxic substances

– use practical work to simulate a stream and the effect on the dissolved oxygen content while increasing nitrogenous nutrients into the stream

- *selected pollutant*

– design practical investigations to assess the effectiveness of cleaning up oil spills in an aquatic environment (e.g. cleaning of feathers using different cleaning agents or absorbing oil on the surface of water)

– use the Internet or printed scientific journals to collect and report on two scientific articles that discuss emerging health problems; examples include issues associated with endocrine disrupters which affect hormonal actions, pollutants that impair body and brain development in developing organisms or pollutants associated with increased incidence of asthma

– assess the role of the Environmental Protection Authority, Victoria in managing risk to health of environment or communities

– investigate the impact of litter in a local catchment; classify the categories of litter and its potential sources, and suggest methods to reduce the litter

– read and analyse an organisation's environmental risk/management assessment plan; construct a diagram of the waste/pollutants that are produced and evaluate the effectiveness of the organisation's strategies to reduce the effects

– use data to evaluate the impact on the quality of air in urban areas of relevant Australian Design Rules for motor vehicles

– research how mercury and sulfur dioxide are introduced into the environment; present flow diagrams to show the pathway of mercury and sulfur dioxide pollutants as they move through the environment from various sources to sinks

- discuss the relative significance of the following characteristics in the health effects of sulfur dioxide and mercury as pollutants: persistence, mobility, exposure, and bioaccumulation
- list strategies that are used to reduce the effects of mercury and sulfur dioxide pollution
- identify a pollutant in the local area and collect appropriate data safely from fieldwork to describe and analyse its physical and chemical properties; record all data in a logbook
- determine the sources of the selected pollutant
- describe the transport mechanisms of the selected pollutant and relate them to its physical and chemical characteristics
- use datalogging in the field to investigate the effects of a selected pollutant, e.g. exposure, dosage, chronic and acute toxicity, allergies, specificity and synergistic action
- collect field data to investigate the effect on surrounding water, air or soil quality as a result of the selected pollutant
- assess the credibility of primary data collected about the selected pollutant
- analyse data to discuss the human and environmental health effects of the selected pollutant
- develop and evaluate a protocol to overcome the problems caused by the pollutant
- outline other protocols or strategies that are or could be used to reduce the effects of the selected pollutant

Detailed example

CHARACTERISTICS OF MERCURY AND SULFUR DIOXIDE

The class divides into two pairs or two teams to complete the four items of the research task with each focusing on either sulfur dioxide or mercury.

They then report their findings back to the class, perhaps using PowerPoint, web pages, a poster or other aids.

All students develop a summary table of the general characteristics of each pollutant.

The research includes:

1. Describing how mercury and sulfur dioxide are introduced into the environment.
2. Presenting flow diagrams to show the pathway of mercury and sulfur dioxide pollutants as they move through the environment from their various sources to sinks.
3. Discussing the relative significance of the following characteristics in the health effects of mercury and sulfur dioxide
   - persistence
   - mobility
   - exposure
   - bioaccumilation.
4. Listing strategies that are used to reduce the effects of mercury and sulfur dioxide pollution.

Extension: List the similarities and differences in characteristics of each pollutant and discuss how these characteristics influence the success of strategies used to reduce the effects of each pollutant.

AREA OF STUDY 2: Applied environmental science

Outcome 2

Use the principles of ecologically sustainable development and environmental management to evaluate a selected environmental science project.

Examples of learning activities

discuss the principles and goals of Ecologically Sustainable Development (ESD) and environmental management


visit the International Standards Organisation's website to gain information on environmental management systems (EMS) and identify the major components of an EMS

identify how Life Cycle Analysis can help organisations develop strategies for the minimisation of waste

examine the waste of a bin in the school/house (ensure gloves and tongs are used); classify and analyse the categories of waste and recommend the major headings of a waste minimisation plan to reduce the waste at school/home

investigate an Environmental Impact Assessment statement for a specific project and describe the processes involved in identifying and assessing the impact of the human activity on the environment

debate the significance of ecologically sustainable development and environmental management practices


research an example of an activity classed as ecotourism and assess its impacts on the environment; discuss the strategies used to manage these impacts and assess them using the goals of Ecologically Sustainable Development (ESD)

select an environmental project undertaken by a business, industry or government agency and use it to study its environmental risks and impacts, how to reduce these risks and impacts, then evaluate the effectiveness of the strategies implemented

collect scientific data which provides evidence of the organisation's environmental management strategies and examine the validity of the data

identify how environmental regulation affects the operation of the activities undertaken by the selected organisation

discuss the influence of local communities, media, government agencies and lobby groups on the operation of the activities undertaken by the selected organisation and in encouraging responsible environmental practices

use scientific data and the goals of ESD to develop or evaluate a management plan for the selected environment science project

evaluate the development and use of environmental impact assessment for major infrastructure projects, e.g. roads, shipping channels, airports or for revegetation plans of a mining company

Detailed example

ECOTOURISM AND ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD)

As a class research decide upon a definition of ecotourism. Compare your definition with that given on the Ecotourism Australia website.

Brainstorm a list of ecotourism activities that members of your class have participated in over the past 12 months.

Select and research an example of an activity classed as ecotourism and assess its impact on the environment. You may wish to use 'determine the applicability of cradle to grave' or 'life cycle analysis techniques' in this assessment.

Discuss the strategies used to manage these impacts and assess their effectiveness using the concept of ESD. An Australian Government definition of ESD was given in the 1992 *National Strategy for Ecologically Sustainable Development*:

'Using, conserving and enhancing the community's resources so the ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'.

To achieve this, development activity like ecotourism should also try to minimise the consumption of raw materials and the generation of wastes.

SCHOOL-ASSESSED COURSEWORK

In Units 3 and 4 teachers must select appropriate tasks from the assessment table provided for each unit. Advice on the assessment tasks and performance descriptors to assist teachers in designing and marking assessment tasks will be published by the Victorian Curriculum and Assessment Authority in an assessment handbook. The following is an example of a teacher's assessment program using a selection of the tasks from the Units 3 and 4 assessment tables.

Outcomes	Marks allocated	Assessment tasks
Unit 3 **Outcome 1** Describe the principles of energy, and relate them to the contribution of one fossil and one non-fossil energy source to the enhanced greenhouse effect.	20	A written report that analyses the findings from practical work conducted on energy radiation, dissipation, re-absorption, re-emission and their relationship to the enhanced greenhouse effect.
	20	A report in a poster format that summarises the contribution of the development of one fossil and one non-fossil energy source to the enhanced greenhouse effect.
Outcome 2 Describe the characteristics of biodiversity, and evaluate strategies to reduce the effects of threatening processes on one selected endangered animal.	30	A report on the Spot-tailed Quoll presented in a combination of: • an oral report • a multimedia presentation.
Outcome 3 Explain how scientific data is applied to the assessment of environmental risk in ensuring biodiversity.	30	A written report which analyses the use of scientific data available in the bioinformatics section of the Melbourne Museum website to develop a proposed management plan for a population.
Total marks for Unit 3	**100**	
Unit 4 **Outcome 1** Describe the characteristics of pollutants, and evaluate management options for reducing the risk of a pollutant affecting the health of the environment and humans.	25	A summary report on the findings of the characteristics of the selected pollutant in the local area using data from the student's log book.
	25	An evaluation of management strategies to reduce the risks of the selected pollutant on humans and the environment, using primary and/or secondary data.
Outcome 2 Use the principles of ecologically sustainable development and environmental management to evaluate a selected environmental science project.	25	A test focusing on ESD principles and how they apply to a selected environmental science project.
	25	A report using scientific data to evaluate an environmental management plan relating to a selected environmental science project.
Total marks for Unit 4	**100**	

SUITABLE RESOURCES

Courses must be developed within the framework of the study design: the areas of study, outcome statements, and key knowledge and skills.

Some of the print resources listed in this section may be out of print. They have been included because they may still be available from libraries, bookshops and private collections.

At the time of publication the URLs (website addresses) cited were checked for accuracy and appropriateness of content. However, due to the transient nature of material placed on the web, their continuing accuracy cannot be verified. Teachers are strongly advised to prepare their own indexes of sites that are suitable and applicable to the courses they teach, and to check these addresses prior to allowing student access.

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www.deh.gov.au/education/

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www.environment.vic.gov.au

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World Wildlife Fund
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http://tolweb.org/tree/phylogeny.html

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www.seav.vic.gov.au/

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http://avel.edu.au/

UNSW School of Environmental Engineering
www.civeng.unsw.edu.au/

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www.abc.net.au/science/news/stories/s668373.htm

Wind Energy
www.pacifichydro.com.au/

Zoos Victoria
www.zoo.org.au/

ORGANISATIONS

Australian Conservation Foundation
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Email: acfenv@peg.apc.org
Website: www.acfonline.org.au/

Bureau of Meteorology
150 Lonsdale Street
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Website: www.epa.vic.gov.au/

Environment Victoria Inc.
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Email: envict@peg.apc.org

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Website: www.gould.edu.au/

Healesville Sanctuary
Badger Creek Road
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Website: www.zoo.org.au/

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Website: www.mdbc.gov.au/

The Royal Melbourne Zoological Gardens
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Scienceworks
2 Booker Street
Spotswood 3015
Tel: (03) 9392 4800
Website: http://scienceworks.museum.vic.gov.au/

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150 Palmerston Street
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Email: vaee@vaee.vic.edu.au
Website: www.vaee.vic.edu.au/

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Website: www.conservationvolunteers.com.au/

City West Water
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Website: www.citywestwater.com.au

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Cooperative Research Centre for the Sustainable Development of Tropical Savannas
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Website: http://savanna.ntu.edu.au

Cooperative Research Centre for Water Quality and Treatment
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Fax: (08) 8259 0228
Email: don.bursill@sawater.sa.gov.au
Website: www.med.monash.edu.au/epidemiology/crc

Cooperative Research Centre for Vertebrate Biocontrol
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Fax: (02) 6242 9242
Email: crc.office@dwe.csiro.au
Website: www.cse.csiro.au/index.htm

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Website: www.ecorecycle.vic.gov.au

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Website: www.sofweb.vic.edu.au/een/fresh.htm

Greening Australia (Victoria) Inc.
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Fax: (03) 9457 3687
Email: general@gavic.org.au
Website: www.greeningaustralia.org.au/GA/VIC/

Marine Discovery Centre
Victorian Institute for Marine Science
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Queenscliff 3225
Tel: (03) 5258 3344
Fax: (03) 5258 1435
Email: seastuff@mafri.com.au
Website: www.sofweb.vic.edu.au/een/marine.htm

Melbourne Water Corporation
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Website: www.melbournewater.com.au/
Threatened Species Network (Victoria)
Tel: 1800 032 551
Email: tsnviv@ozemail.com.au
Website: www.wwf.org.au/About_WWF_Australia/How_we_work/In_the_field/TSN/vic.php

Victorian Association of Forest Industries (VAFI)
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