Environmental Science

LEVEL 3	**15** **TCE CREDIT POINTS**
COURSE CODE	ESS315118
COURSE SPAN	2018 — 2025
READING AND WRITING STANDARD	NO
MATHEMATICS STANDARD	NO
COMPUTERS AND INTERNET STANDARD	NO

This course was delivered in 2023. Use A-Z Courses to find the current version (if available).

In studying Environmental Science, learners develop their investigative, analytical and communication skills

Learners apply these skills to their understanding of ecology and environmental issues in order to engage in public debate, solve problems and make evidence-based decisions about contemporary environmental issues in society.

Learner Requirement

Learners enrolled in this course are required to work responsibly and safely in practical situations.

Course Description

Environmental Science prepares learners for tertiary studies that include ecology and ecologically sustainable management.

Learners will:

- engage with research, experimental work, field trips and analysing data to explore:
  o the nature of ecological systems
  o how ecosystems change naturally and due to human activity
  o how we depend on and impact on ecosystems
  o what strategies we use to sustainably manage ecosystems
- experience how all these are interrelated using locally available ecosystems
- use their case study to investigate in detail and apply their knowledge to an ecosystem or issue of their choice.

Rationale

Knowledge and understanding of science, scientific literacy and scientific method are necessary for learners to develop the skills to resolve questions about their natural and constructed world.

The wider benefits of this 'scientific literacy' are well established, including giving learners the capability to investigate the natural world and changes made to it through human activity. The ability to think and act in scientific ways helps build the broader suite of capabilities in learners as confident, self-motivated and active members of our society. It helps them to:

- be interested in, and understand, the world around them
- engage in discourse about science
- understand the testable and contestable nature of science, and question the claims made by others about scientific matters
- be able to identify questions and draw evidence-based conclusions
- make informed decisions about the environment, about their own health and well-being, and about the role and impact of science on society

In studying Environmental Science, learners develop their investigative, analytical and communication skills. Learners apply these skills to their understanding of ecology and environmental issues in order to engage in public debate, solve problems and make evidence-based decisions about contemporary environmental issues in society.

Aims

Environmental Science aims to develop learners':
- interest in ecology and environmental science and their perspective on the interrelationship between the natural world and human society
- ability to make informed, evidence-based personal responses to contemporary and future environmental issue
- understanding that ecological and environmental science knowledge is used in a variety of contexts, and how its use influences, and is influenced by: ethical, political, cultural, social, economic aesthetic, educational, and scientific considerations
- ability to conduct a variety of research, field and laboratory investigations involving collection and analysis of qualitative and quantitative data, and to interpret evidence
- ability to critically evaluate environmental science concepts, interpretations, claims and conclusions with reference to evidence
- ability to communicate environmental understanding, findings, arguments and conclusions using appropriate representations, modes and genres.

Learning Outcomes

On successful completion of this course, learners will be able to:

1. plan activities, monitor and evaluate progress, use organisational strategies to complete activities and meet deadlines, and contribute to completion of group activities in the context of environmental science and ecology (C1)
2. safely and competently use practical scientific techniques and equipment to collect data related to environmental science and ecology (C2)
3. use scientific inquiry to develop, conduct, interpret and evaluate experiments related to environmental science and ecology (C2)
4. apply discriminating research skills and the principles of academic integrity (C3)
5. communicate, predict and explain phenomena using qualitative and quantitative representations in appropriate modes and genres, and following accepted conventions and terminology (C3)
6. explain and discuss the personal, local and global interdependence of issues and responsibilities concerning social equity and environmental values (C4)
7. apply ecological concepts to describe and discuss processes, explaining how and why ecosystems change over time (C5 and C6)
8. utilise environmental science and ecological concepts, describing humans as an integral part of the biosphere, locally and globally; including their impact (C7)
9. identify and discuss personal and community values that humans attach to natural resources, alternative uses for natural resources, and the implications of decision making (C7)
10. analyse, interpret and critically assess environmental issues, utilising legislative and policy tools, to draw socially responsible conclusions (C8)
11. create positive socially, economically and environmentally sustainable management solutions to issues (C8)
12. In addition, learners may: relate learning to their personal futures, including further learning and employment.

Pathways

Environmental Science is designed for learners on a pathway related to ecology and the environment, science and its applications to sustainable environmental management. Study of this course provides preparation for career areas such as: environmental management; national parks; fisheries; forestry; mining; agriculture; tourism; teaching; journalism; media; ecology; geography; demography; business; economics; politics and law.

The study of Environmental Science may provide a pathway to the study of Biology Level 3, Geography Level 3, and Agricultural Systems Level 3.

Resource Requirements

Providers offering this course need access to equipment, materials and a suitable space to carry out the practical component of the course effectively and safely. In addition, they will need the ability and materials required to allow learners to conduct research in the field.

Course Size And Complexity

This course has a complexity level of 3.

At Level 3, the learner is expected to acquire a combination of theoretical and/or technical and factual knowledge and skills and use judgment when varying procedures to deal with unusual or unexpected aspects that may arise. Some skills in organising self and others are expected. Level 3 is a standard suitable to prepare learners for further study at tertiary level. VET competencies at this level are often those characteristic of an AQF Certificate III.

This course has a size value of 15.

Relationship To Other TASC Accredited And Recognised Senior Secondary Course

Environmental Science complements some other TASC accredited senior secondary courses including: Agricultural Systems, Biology, Geography and Housing and Design.

The focus on natural ecosystems, how they change, and the ways humans impact on and manage them provides a rich context for learners concurrently or subsequently studying these other courses. For example, Environmental Science provides:

- some implications for natural ecological systems of environmentally sustainable techniques within Agricultural Systems and an insight into non-production ecology
- understanding of the complexity of the ecology that emerges when the organisms considered within Biology interact in nature
- the mechanisms for the changes to land cover and an understanding of the application of management strategies studied within Geography
- some of the motivations and management strategies for environmentally sustainable practices that are key to Housing and Design.

Course Delivery

Providers may utilise any ecosystems available to the learners to enrich their understanding. The order of delivery is determined by the nature of available ecosystems and current ecological issues.

Course Requirements

All content within this course is compulsory and will be studied within context of field and experimental work to provide a depth of understanding about the nature and application of ecology and how ecological systems are managed. Learners will create and utilise data and information wherever possible.

There is a mandatory extended Case Study that requires learners to apply the knowledge gained within the course to data they have collected and information they have researched.

Course Content

In Environmental Science learners will develop a perspective on the interrelationship between ecosystems (criteria 5 and 6) and human society (criteria 7 and 8); a view that will allow them to develop an informed personal response to the environmental issues of today and tomorrow.

Learners will be drawn to their own relationship with the environment and the significance of the choices and decisions they make in their own lives.

Much of the course can be studied within the context of current environmental issues and topics highlighted in the media.

OVERVIEW

For the content areas of Environmental Science, the three (3) interrelated strands are:

- **Science Inquiry Skills** (criterion 2)
- **Science as a Human Endeavour** (criterion 4)
- **Science Understanding** (criteria 5 to 8)

building on learning in F-10 Australian Curriculum: Science.

In the practice of science, the three strands are closely integrated: the work of scientists reflects the nature and development of science; is built around scientific inquiry; and seeks to respond to and influence society.

Science Inquiry Skills and **Science as a Human Endeavour** strands (respectively):

- develop, interpret and analyse experiments and investigations (criterion 2)
- discuss the application and impact of environmental science in society (criterion 4

must be integrated into the four interwoven threads of **Science Understanding** strand:

- ecological processes (criterion 5
- ecosystem change (criterion 6)
- human dependence and impact on ecosystems (criterion 7)
- ecologically sustainable management of the environment (criterion 8).

Each thread is compulsory; however the order of delivery is not prescribed.

Analysis, interpretation and drawing conclusions from data

Analysing and interpreting data is essential to every part of the course. Learners will be given practice in analysing, interpreting and drawing conclusions from environmental data presented in a variety of forms (for example, tables, graphs, models, illustrations and photographs). Familiarity with data will be integrated into the entire course and relate to all criteria aside from criteria 1 and 3. The data may be secondary or primary data generated from the learner's own investigations. The case study provides an opportunity for the learners to present and analyse data. The ability to relate and critically evaluate data is fundamental to this course.

SCIENCE INQUIRY SKILLS

DEVELOP, INTERPRET AND ANALYSE EXPERIMENTS AND INVESTIGATIONS (CRITERION 2)

Key Knowledge and skills:

Experimental Design:

Learners will independently engage with the key stages of experimental design – measuring both biotic and abiotic variables.

The key stages for experimental design within Environmental Science are:

- propose a testable hypothesis that identifies clearly the independent and dependent variable
- design a controlled experiment, and:
  - explain the requirements for only one independent variable and the importance of controlling all other variables (fixed variables)
  - explain the need for a control for comparison
  - explain the need for a large sample size and replications, and the limitations where this is not possible
  - explain the practical, economic, ethical and environmental constraints on the design.
- analyse and interpret data, and:
  - describe patterns / trends in results
  - provide a reasonable interpretation / explanation of the results
  - provide a summary conclusion as to whether results support or negate the hypothesis.

- evaluate the method and suggest improvements to experiments, and:
  - identify the strengths and weaknesses of an experimental design
  - identify the limitations and sources of possible errors in the study
  - suggest possible improvements to the method
  - suggest further / alternative experiments.

Biotic and Abiotic Surveys:

- Understand the role of abiotic and biotic factors as independent variables which can be studied in ecosystems. Such studies include:
- baseline studies and continuous monitoring of environmental factors
- use of indicator (index) species as indicators of environmental health o techniques such as capture/recapture, line transects, quadrats, remote sensing
- chemical analysis of water, air and soil.

SCIENCE AS A HUMAN ENDEAVOUR

The strand of **Science as a Human Endeavour** is underpinned by two broad concepts:

- the acceptance of scientific knowledge can be influenced by the context in which it is considered
- science can be limited in its ability to provide definitive answers to public debate; a need for additional data to better understand the science, or interpretation of the data may be open to question.

ANALYSE THE APPLICATION AND IMPACT OF ENVIRONMENTAL SCIENCE ON SOCIETY (CRITERION 4)

Key Knowledge and Skills:

Key concepts to be considered are:

- people's values (ethical, political, cultural, social, economic, aesthetic, educational, scientific) are important in decision making
- Environmental Science knowledge can enable scientists to offer valid explanations and make reliable predictions. This knowledge, and understanding by society, is relevant to environmental issues and informs decision making
- the understanding of environmental issues and science changes over time
- ICT and other technologies have dramatically increased the size, accuracy, and geographic and temporal scope of data sets with which scientists work
- the application of scientific knowledge may have beneficial and/or harmful and/or unintended consequences
- pressure groups / a range of stakeholders influence decision making about scientific research and environmental issues
- current issues demonstrate the complexity and tensions (ethical, political, cultural, social, economic, ethical, aesthetic, social, educational, scientific) surrounding decision making on environmental issues.

SCIENCE UNDERSTANDING

ECOLOGICAL PROCESSES (CRITERION 5)

This thread relates to the biological concepts and how ecosystems operate and function.

Key Concepts and Skills: Inputs and outputs of ecosystems

- role of producers in photosynthesis and factors affecting productivity
- role of producers, consumers and decomposers in ecosystems
- food chains and food webs
  - energy flow through ecosystems.

Matter and energy

- nutrient cycles: carbon, nitrogen (including role of legumes), phosphorus, water:
  - sources and sinks of all cycles.
- concept of trophic levels:
  - loss of biomass and energy at each trophic level (10% concept)
  - reasons for so few trophic levels in some ecosystems.
- pyramids of numbers, biomass and energy.

Relationships between species

- niche concept – broad and narrow
- intraspecific and interspecific competition, predation, parasitism, commensalism, and mutualism
- generalists and specialists.

Populations

- characteristics of populations
- basic demographic change, birth, death and migration rates
- factors that limit population size, carrying capacity, and importance of competition
- graphical representation of population growth: predator/prey relationships, environmental resistance, S curves and J curves.

Key Knowledge and Skills:

The systems approach

- levels of organisation within the biosphere
- the energy laws (First & Second Laws of Thermodynamics)
- positive and negative feedback. Ecosystems
- Influence of abiotic factors on biotic components:
    - range of tolerance
    - zone of physiological stress
    - optimal zone.
- Australia/Tasmania has varied terrestrial and aquatic ecosystems that can be used as context for the concepts and processes described above.
    - characteristics of dry sclerophyll, wet sclerophyll, rainforest, mixed forest, grassland, alpine ecosystems, considered in relation to fire, climate, geology, soils, light, slope/aspect
    - characteristics of freshwater, estuarine, marine aquatic ecosystems, considered in relation to salinity, nutrient inputs (upwelling and from land/runoff), climate, tides, altitude, disturbance.

ECOSYSTEM CHANGE (CRITERION 6)

This thread encompasses how ecosystems are changing due to natural events and/or human impacts on the systems.

Key Knowledge and Skills:

How natural cycles influence ecosystems:

- diurnal and seasonal – how daily and annual changes in sunlight availability, temperature and rainfall influence ecosystems
- tidal – changes in water availability, temperature, salinity, dissolved oxygen and sunlight availability within the intertidal zone
- ENSO (El Nino Southern Oscillation – general features only) as a major climatic driver influencing Australia's weather. El Nino brings an increased risk of bushfires, decreased rainfall, increased temperature and greater risk of heatwaves. La Nina leads to increased rainfall
- fire cycle and regeneration of forest types.

Changes in climate

- how greenhouse gas (GHG) composition has changed in the Earth's atmosphere over time
- sources of evidence for changes, such as ice cores from Antarctica/Greenland, monitoring atmospheric gases at Cape Grim and Mauna Loa, seasonal layers of calcium carbonate deposition in coral, sediment cores, tree rings, raised beaches revealing past sea levels, landforms due to ice age glaciation in the past.

Consequences of changes in atmospheric gas composition

- ozone depletion
- ocean acidification
- coral bleaching (due to changes in temperature, pH and water salinity)
- global warming (enhanced greenhouse effect) leading to climate change
    - sea level rise, coastal erosion and flooding
    - ice melt
    - changing sea currents
    - increase in frequency and intensity of extreme weather events
    - changes to species distribution and timing of biological events (for example, long term associations of chicks being fed newly hatch grubs likely to be disrupted)
    - changes to timing of biological events and loss of synchrony, for example, migration, hatching and food sources
    - decreased reliability of agricultural food production.

Introduced species

- introduced species leading to ecosystem imbalances and impacts on natural populations:
    - why introduced species thrive
    - impacts of introduced species, for example, spread of disease, competition with or predation on native species, habitat degradation
    - control methods, include trapping, shooting, poisoning, manual removal, biological control.

Biodiversity and its importance

- types of biodiversity (genetic, species, ecosystem)
- the importance of each type of biodiversity
- processes that threaten biodiversity, for example, habitat destruction and degradation, competition/predation and disease from introduced species, pollution, and climate change.

HUMAN DEPENDENCE AND IMPACT ON ECOSYSTEMS (CRITERION 7)

Learners will consider how humans depend on the ecosystems and what impacts we have as a result of those dependencies. They will do this by

Key Knowledge and Skills:

Importance of ecosystem services

- the role of ecosystems in providing humans with:
    - food, oxygen, clean water, clean air
    - resources - renewable and non-renewable
    - climate regulation
    - protection.

Ecological footprint

- the factors that are considered in the footprint (energy, food, housing, transport, and waste production)
- comparison of ecological footprints of different human populations.

Concepts relating to pollution

- definition of a pollutant versus contaminant
- characteristics of pollutants (biodegradability, persistence in environment, point and diffuse sources)
- bioaccumulation and biomagnification, eutrophication and Biological Oxygen Demand (BOD)
    - it is suggested these be delivered using the impacts listed below.

Impact of resource use
* population growth is placing increased demands on the environment. The matrix below expands on these resources requirements and provides a summary of environmental impacts - including those pollution concepts listed above - that will be covered within this criterion.

Resource	Activity	Environmental impact
Food	Agriculture	* repeated chemical use can lead to resistance: for example: - insecticide - herbicide. * poor fertiliser practices: - leaching contaminates groundwater - runoff leading to eutrophication. * production of greenhouse gases: - nitrous oxide from incorrect timing of fertiliser application (e.g. waterlogged soil promotes anaerobic denitrification.) - methane from enteric bacteria. * salinity due to poor irrigation practices and land clearance.
	Aquaculture	* impact on benthic organisms underneath fish farm pens * decline in water quality * reliance on native baitfish to feed farmed fish.
	Fisheries	* reliance on individual species and technology change has led to overfishing.
Water	Sewage spills	* nutrient load can lead to eutrophication * pathogens causing disease * BOD from organic matter.
	Industrial spills	* BOD from organic matter (e.g. dairy effluent) * biomagnification of heavy metals.
	Increase in demand	* threat to environmental flow and ecosystem integrity * virtual water.
Energy Production	Burning of fossil fuels and other emission production	* reliance on fossil fuels * production of greenhouse gases * acid rain * air pollution (e.g. photochemical smog)

		* ozone production in the troposphere causes environmental and human health problems.

ECOLOGICALLY SUSTAINABLE MANAGEMENT OF THE ENVIRONMENT (CRITERION 8)

This thread provides experience with strategies for the sustainable use of resources within a development cycle and management strategies for environmental protection.

Key Knowledge and Skills:
Concept of commons

- tragedy of the commons.

Ecologically sustainable development

- definition of ecological sustainability
- important principles
  o intergenerational equity
  o intragenerational (social) equity
  o conservation of and preventing loss of biodiversity and ecological integrity
  o precautionary and anticipatory principle
  o pricing environmental values and natural resources (user pays principle)
  o efficiency of resource use
- United Nations Sustainable Development Goals (general awareness only)
- consideration of a Social Licence to Operate (SLO)
  o an informal acceptance or approval by a community of a development.

Environmental management
Tools to manage the environment include:

- Environmental Impact Assessment (EIA)/Environmental Impact Statement (EIS)
- Environmental Management Plan (EMP) development
  o resources to be managed and impacted
  o offsetting loss
  o environmental buffering
  o ongoing monitoring and management
  o legislative requirements
  o stakeholder consultation.
  o learners should be able to make appropriate, specific and relevant suggestions in relation to EIA and EMP scenarios.

Other strategies for management as well as the required management process (above) there are five other broad strategies that can be used:

- education
- science and technology
- economics
  o green economics compared to traditional economics
  o examples: real cost pricing principle – externalities / environmental cost (user pays principle), taxes (polluter pays principle); incentives; rebates.
- law
  o general principles behind key legislation protecting biodiversity and the environment
  o Australian Government Environment Protection and Biodiversity Conservation Act (EPBCA) and Tasmanian Government Threatened Species Protection Act (TSPA).
  o focus upon at least two topical international conventions and instruments, for example: United Nations Framework Convention on Climate Change (UNFCCC); Convention on International Trade in Endangered Species (CITES); the Montreal Protocol; International Whaling Commission (IWC); Law of the Sea; World Heritage List; Ramsar Convention, Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); and Migratory Bird Agreements.
- conservation of ecosystems and biodiversity
  o comprehensiveness, adequacy and representativeness (CAR) system of reserves for Australia's bioregions, including Marine Protected Areas (MPAs)
  o World Heritage Areas (WHAs).

Management of challenges to sustainability

- Human population growth is placing increasing demands on resources. Careful management is required to ensure resource use is sustainable for current and future generations. Students are required to identify examples of strategies - education, economics, legislation, science and technology – that can be used to manage the following resource demands:
- agricultural food production in Tasmania (examples could include the dairy industry, aquaculture or cropping)
- energy (consider local strategies to minimise the global impact of carbon emissions and climate change)
- water in Tasmania.

Work Requirements

PRACTICAL WORK

At least 30 hours will be spent on practical activities, including field trips, which are an integral part of the course, and are to be used as a means of teaching and consolidating the course content as well as a vehicle for assessment. The purpose of practicals throughout the year varies and includes:

learning and practising scientific techniques

- practices to avoid health and safety issues are to be used independently throughout the year
- illustration of concepts
- exploring components of experimental design
- meeting the requirements of experimental design while addressing Criterion 2.

On at least three occasions (excluding the case study) learners will be given the opportunity to address criterion 2 by following an experimental design process as outlined in the course content. On each of these occasions the learner will document:

a hypothesis (identifying independent and dependent variables)

- a method (including apparatus and diagrams where appropriate)
- clearly presented data
- a discussion of:

o how data were used to draw a conclusion relative to the hypothesis
o sources of error and limitations of design
o possible improvements in design.

Examples of suitable practical activities to apply experimental design are:

replication of environmental conditions in the laboratory
- abiotic and biotic sampling in the field
- observations of the behaviour of organisms in the field
- observations of the abundance and type of organisms in the field.

CASE STUDY

Each learner must complete a case study that will represent more than 20 hours of design time. The case study will be assessed against a number of criteria with particular emphasis on the criteria not included in the external assessment (Criteria 1, 3 and 4). The study will contain some primary information and not be based solely on secondary knowledge.

Examples of primary information include:

data from field observations

- data from sampling in the field
- experimental data
- ecological surveys
- data recorded to indicate:

    o resource use
    o impacts of resource use
    o pollution produced
    o impacts of pollution.

- opinion based surveys
- surveys of environmental management practices
- expert interviews.

The study can be individual or a small group investigation. The topic will be chosen in consultation with the teacher, allowing flexibility in the choice of topic, the method of investigation and the format in which it is presented.

The case study presented must communicate the:

subject of the study
- purpose of the study
- relevant background information
- methodology for collection of primary data
- rationale for methodology chosen
- materials used
- data collected (quantitative and qualitative)
- analysis and discussion of data
- conclusions drawn
- references to secondary data and information

- acknowledgement of others involved and their roles.

Assessment

Criterion-based assessment is a form of outcomes assessment that identifies the extent of learner achievement at an appropriate end-point of study. Although assessment – as part of the learning program – is continuous, much of it is formative, and is done to help learners identify what they need to do to attain the maximum benefit from their study of the course. Therefore, assessment for summative reporting to TASC will focus on what both teacher and learner understand to reflect end-point achievement.

The standard of achievement each learner attains on each criterion is recorded as a rating 'A', 'B', or 'C', according to the outcomes specified in the standards section of the course.

A 't' notation must be used where a learner demonstrates any achievement against a criterion less than the standard specified for the 'C' rating.

A 'z' notation is to be used where a learner provides no evidence of achievement at all. Providers offering this course must participate in quality assurance processes specified by TASC to ensure provider validity and comparability of standards across all awards. Further information on quality assurance processes, as well as on assessment, is on the TASC website: http://www.tasc.tas.gov.au

Internal assessment of all criteria will be made by the provider. Providers will report the learner's rating for each criterion to TASC.

TASC will supervise the external assessment of designated criteria which will be indicated by an asterisk (*). The ratings obtained from the external assessments will be used in addition to internal ratings from the provider to determine the final award.

Quality Assurance Process

The following processes will be facilitated by TASC to ensure there is:

- a match between the standards of achievement specified in the course and the skills and knowledge demonstrated by learners
- community confidence in the integrity and meaning of the qualification.

TASC gives course providers feedback about any systematic differences in the relationship of their internal and external assessments and, where appropriate, seeks further evidence through audit and requires corrective action in the future.

External Assessment Requirements

The external assessment for this course will comprise:

- a written examination assessing criteria: 2, 5, 6, 7 and 8

For further information see the current external assessment specifications and guidelines for this course available on the TASC website.

Criteria

The assessment for *Environmental Science* Level 3 will be based on the degree to which a learner can:

1. apply personal skills to plan, undertake and complete activities
2. develop, interpret and analyse experiments and investigations*
3. collect, record, process and communicate information
4. analyse the application and impact of environmental science in society
5. apply ecological concepts and processes*
6. apply concepts and processes of ecosystem change*
7. apply concepts relating to human dependence and impact on ecosystems*
8. apply principles and processes related to ecologically sustainable management of the environment.*

[* = denotes criteria that are both internally and externally assessed]

Standards

Criterion 1: apply personal skills to plan, undertake and complete activities

The learner:

Rating A	Rating B	Rating C
selects and uses techniques and equipment safely, competently and methodically, applying them in unfamiliar contexts	selects and uses techniques and equipment safely, competently and methodically	uses familiar techniques and equipment safely and competently
follows instructions accurately and methodically, adapting to new circumstances	follows instructions accurately and methodically to complete activities	follows instructions accurately to complete activities
monitors and critically evaluates progress towards meeting goals and timelines, and plans realistic future actions	monitors and evaluates progress towards meeting goals and timelines, and plans/negotiates realistic future actions	monitors progress towards meeting goals and timelines and plans/negotiates future actions
effectively utilises a wide range of strategies to meet planned timelines and address all requirements of the activity	utilises a wide range of strategies to meet planned timelines and address all requirements of the activity	utilises a range of strategies to meet planned timelines and address most requirements of the activity
monitors and evaluates own contribution, and guides others, to successfully complete group activities.	monitors and analyses their contribution to the successful completion of group activities.	monitors and can explain their contribution to the successful completion of group activities.

Criterion 2: develop, interpret and analyse experiments and investigations

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
expresses a hypothesis to explain observations, as a precise and testable statement that can be supported or refuted by an experiment	expresses a hypothesis to explain observations, as a precise and testable statement	expresses a testable hypothesis to explain observations
designs a controlled, safe and ethical experiment, identifying all variables and including all accepted elements of experimental design, to efficiently collect valid, reliable data	designs a controlled, safe and ethical experiment, identifying main variables, to collect valid and reliable data	designs a controlled experiment, identifying main variables and addressing safety and ethics, to collect valid data
critically analyses and interprets data to draw a valid conclusion that relates to a hypothesis	analyses and interprets data to draw a valid conclusion that relates to a hypothesis	draws valid conclusions from data that relate to a hypothesis
critically analyses limitations and sources of error in experimental design, with reference to evidence	analyses limitations and sources of error in experimental design	explains limitations and sources of error in experimental design
critically analyses and evaluates experimental designs and provides evidence-based critiques and discussions on valid improvements and alternatives.	analyses and assesses experimental designs and describes possible valid improvements.	explains valid improvements in experimental designs.

Criterion 3: collect, record, process and communicate information

The learner:

Rating A	Rating B	Rating C
evaluates the reliability and appropriateness of information sources used	analyses the reliability and appropriateness of information sources used	explains the validity of information sources used
collects a wide range of appropriate experimental data, and records it methodically for analysis	systematically collects and logically records relevant experimental data	collects and logically records relevant experimental data

critically analyses concepts, communicating data and information using appropriate scientific formats and language	analyses concepts, clearly communicating data and information using appropriate scientific formats and language	explains concepts, clearly communicating data and information using correct scientific formats and language
clearly differentiates the information, images, ideas and words of others from the learner's own	clearly differentiates the information, images, ideas and words of others from the learner's own	differentiates the information, images, ideas and words of others from the learner's own
referencing conventions and methodologies are followed with a high degree of accuracy	referencing conventions and methodologies are followed correctly	referencing conventions and methodologies are generally followed correctly
creates appropriate, well structured reference lists/bibliographies.	creates appropriate, structured reference lists/bibliographies.	creates appropriate reference lists/bibliographies.

Criterion 4: analyse the application and impact of environmental science in society

The learner:

Rating A	Rating B	Rating C
evaluates relevance of identified science background to an issue	analyses relevant science background to an issue	explains the relevant science background to an issue
evaluates significant components of an issue to present a detailed and balanced discussion, with reference to evidence	analyses and describes components of an issue to present a balanced discussion	identifies and explains key components of an issue
clearly describes and critically evaluates tensions and connections between an issue and all significant relevant influences	clearly analyses the tensions and connections between an issue and key relevant influences	explains connections between an issue and relevant influences
analyses and evaluates the benefits of the use of scientific knowledge, and any harmful or unintended consequences arising from this use	analyses benefits of the use of scientific knowledge, and any harmful or unintended consequences arising from this use	explains the benefits of the use of scientific knowledge, and any harmful or unintended consequences arising from this use
evaluates relevant evidence and decision making processes to reach reasoned conclusions.	analyses relevant evidence to reach reasoned conclusions.	explains relevant evidence to reach reasoned conclusions.

Criterion 5: apply ecological concepts and processes

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
critically analyses complex interrelationships utilised in ecology	analyses interrelationships utilised in ecology	explains simple interrelationships utilised in ecology
applies concepts to critically analyse complex ecological processes	applies concepts to analyse ecological processes	applies concepts to explain ecological processes
identifies and evaluates complex problems and issues related to the study of ecological processes	identifies and analyses problems and issues related ecology	identifies and explains problems and issues related ecology
makes evidence-based ecological predictions in complex familiar and unfamiliar contexts	makes evidence-based ecological predictions in familiar and simple, unfamiliar contexts	makes plausible, evidence-based ecological predictions
selects, critically analyses interprets data with reference to ecological concepts, identifying any limitations, to reach evidence-based conclusions.	selects, analyses and interprets data with reference to ecological concepts to reach evidence-based conclusions.	explains data and ecological concepts to support valid conclusions.

Criterion 6: apply concepts and processes of ecosystem change

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
critically analyses complex changes to interrelationships when ecosystems are altered	analyses changes to interrelationships when ecosystems are altered	explains changes to interrelationships when ecosystems are altered
critically analyses local and global changes to ecosystems	analyses local and global changes to ecosystems	explains local and global changes to ecosystems
applies concepts to evaluate complex local and global ecosystem change	applies concepts to analyse local and global ecosystem change	applies concepts to explain local and global ecosystem change
identifies and evaluates complex problems and issues related to ecosystem change	identifies and analyses problems and issues related to ecosystem change	identifies and explains problems and issues related to ecosystem change
makes evidence-based predictions related to ecosystem change in complex familiar and unfamiliar contexts	makes evidence-based predictions related to ecosystem change in familiar and simple unfamiliar contexts	makes plausible predictions using evidence in familiar contexts related to ecosystem change
selects, critically analyses and interprets data - identifying any limitations - to reach evidence-based conclusions related to ecosystem change.	selects, analyses and interprets data to reach evidence-based conclusions related to ecosystem change.	selects and explains data and concepts to reach valid conclusions related to ecosystem change.

Criterion 7: apply concepts relating to human dependence and impact on ecosystems

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
evaluates how humans depend on ecosystems	analyses how human depend on ecosystems	explains how humans depend on ecosystems
evaluates how humans impact on ecosystems	analyses how humans impact on ecosystems	explains how humans impact on ecosystems
applies concepts to evaluate complex local and global human dependence and impacts on ecosystems	applies concepts to analyse local and global human dependence and impacts on ecosystems	applies concepts to explain local and global human dependence and impacts on ecosystems
identifies and evaluates complex problems related to how humans depend and impact on ecosystems	identifies and analyses problems and issues related to how humans depend and impact on ecosystems	identifies and explains problems and issues related to how humans depend and impact on ecosystems
makes evidence-based predictions related to how humans depend and impact on ecosystems in complex familiar and unfamiliar contexts	makes evidence-based predictions related to how humans depend and impact on ecosystems in familiar and simple unfamiliar contexts	makes plausible predictions using evidence in familiar contexts related to how humans depend and impact on ecosystems
selects, critically analyses and interprets data, identifying any limitations, to reach evidence-based conclusions related to how humans depend and impact on the ecosystems.	selects, analyses and interprets data to reach evidence-based conclusions related to how humans depend and impact on the ecosystems.	selects and explains data and concepts to reach valid conclusions related to how humans depend and impact on the ecosystems.

Criterion 8: apply principles and processes related to ecologically sustainable management of the environment.

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
evaluates strategies used for ecologically sustainable development	analyses strategies used for ecologically sustainable development	explains strategies used for ecologically sustainable development

evaluates strategies used for ecologically sustainable management	analyses strategies for ecologically sustainable management	explains strategies for ecologically sustainable management
evaluates complex challenges to environmental and economic sustainability	analyses challenges to environmental and economic sustainability	explains challenges to environmental and economical sustainability
applies concepts to critically analyse and interpret complex ecologically sustainable management problems and solutions	applies concepts to analyse ecologically sustainable management problems and solutions	applies concepts to explain ecologically sustainable management problems and solutions
makes evidence-based, ecologically sustainable management predictions in complex familiar and unfamiliar contexts	makes evidence-based, ecologically sustainable management predictions in familiar and simple unfamiliar contexts	makes plausible, ecologically sustainable management predictions using evidence in familiar contexts
selects, critically analyses and interprets data, identifying any limitations, to reach evidence-based conclusions related to ecologically sustainable management.	selects, analyses and interprets data to reach evidence-based conclusions related to ecologically sustainable management.	selects and explains data and concepts to reach valid conclusions related to ecologically sustainable management.

Qualifications Available

Environmental Science Level 3 (with the award of):

EXCEPTIONAL ACHIEVEMENT
HIGH ACHIEVEMENT
COMMENDABLE ACHIEVEMENT
SATISFACTORY ACHIEVEMENT
PRELIMINARY ACHIEVEMENT

Award Requirements

The final award will be determined by the Office of Tasmanian Assessment, Standards and Certification from 13 ratings (8 from the internal assessment, 5 from external assessment).

The minimum requirements for an award in *Environmental Science* Level 3, are as follows:

EXCEPTIONAL ACHIEVEMENT (EA)
11 'A' ratings, 2 'B' ratings (4 'A' ratings, 1 'B' rating from external assessment)

HIGH ACHIEVEMENT (HA)
5 'A' ratings, 5 'B' ratings, 3 'C' ratings (2 'A' ratings, 2 'B' ratings, 1 'C' rating from external assessment)

COMMENDABLE ACHIEVEMENT (CA)
7 'B' ratings, 5 'C' ratings (2 'B' ratings, 2 'C' ratings from external assessment)

SATISFACTORY ACHIEVEMENT (SA)
11 'C' ratings (3 'C' ratings from external assessment)

PRELIMINARY ACHIEVEMENT (PA)
6 'C' ratings

A learner who otherwise achieves the ratings for a CA (Commendable Achievement) or SA (Satisfactory Achievement) award but who fails to show any evidence of achievement in one or more criteria ('z' notation) will be issued with a PA (Preliminary Achievement) award.

Course Evaluation

The Department of Education's Curriculum Services will develop and regularly revise the curriculum. This evaluation will be informed by the experience of the course's implementation, delivery and assessment. In addition, stakeholders may request Curriculum Services to review a particular aspect of an accredited course.

Requests for amendments to an accredited course will be forward by Curriculum Services to the Office of TASC for formal consideration.

Such requests for amendment will be considered in terms of the likely improvements to the outcomes for learners, possible consequences for delivery and assessment of the course, and alignment with Australian Curriculum materials.

A course is formally analysed prior to the expiry of its accreditation as part of the process to develop specifications to guide the development of any replacement course.

Course Developer

The Department of Education acknowledges the significant leadership of Nicola Anderson, Marcel Brown, Kelly Hicks, Lynn Jarvis, Jane MacDonald, Perviz Marker, Ian Riley, Natalie Robinson, Tika Varma and Peter Wright in the development of this course.

Science Inquiry Skills - Earth and Environmental Science Units 3 & 4

- Identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes (ACSES057) and (ACSES084)
- Design investigations including the procedure/s to be followed, the information required and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics (ACSES058) and (ACSES085)
- Conduct investigations,... ...using... ...environmental sampling procedures, safely, competently and methodically for the collection of valid and reliable data (ACSES059) and (ACSES086)
- Represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error and instrumental accuracy and the nature of the procedure and sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions (ACSES060) and (ACSES087)
- Interpret a range of scientific and media texts and evaluate processes, claims and conclusions by considering the quality of available evidence, including interpreting confidence intervals in secondary data; use reasoning to construct scientific arguments (ACSES061) and (ACSES088)
- Select, construct and use appropriate representations,... ...to communicate conceptual understanding, solve problems and make predictions (ACSES062) and (ACSES089)
- Communicate to specific audiences and for specific purposes using appropriate language, genres and modes, including compilations of field data and research reports (ACSES063) and (ACSES090)

Science as a Human Endeavour - Earth and Environmental Science Units 3 & 4

- ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of data sets with which scientists work (ACSES064)
- Models and theories are contested and refined or replaced when new evidence challenges them, or when a new model or theory has greater explanatory power (ACSES065)
- The acceptance of scientific knowledge can be influenced by the social, economic and cultural context in which it is considered (ACSES066)
- People can use scientific knowledge to inform the monitoring, assessment and evaluation of risk (ACSES067)
- Science can be limited in its ability to provide definitive answers to public debate; there may be insufficient reliable data available, or interpretation of the data may be open to question (ACSES068)
- International collaboration is often required when... ...addressing issues for the Asia-Pacific region (ACSES069)
- Scientific knowledge can be used to develop and evaluate projected... ...and environmental impacts and to design action for sustainability (ACSES070)

Science Understanding - Earth and Environmental Science Units 3 & 4

Use of non-renewable Earth resources (Unit 3)

Examples in Context:

- Extraction of mineral and energy resources influences interactions between the abiotic and biotic components of ecosystems, including hydrologic systems (ACSES075)

Use of renewable Earth resources (Unit 3)

- *Examples in Context:*

- Ecosystems provide a range of renewable resources, including provisioning services (for example, food, water, pharmaceuticals), regulating services (for example, carbon sequestration, climate control), supporting services (for example, soil formation, nutrient and water cycling, air and water purification) and cultural services (for example, aesthetics, knowledge systems) (ACSES077)
- The availability and quality of fresh water can be influenced by human activities (for example, urbanisation, over-extraction, pollution) and natural processes (for example, siltation, drought, algal blooms) at local and regional scales (ACSES080)
- Any human activities that affect ecosystems (for example, species removal, habitat destruction, pest introduction, dryland salinity) can directly or indirectly reduce populations to beneath the threshold of population viability at local, regional and global scales and impact ecosystem services (ACSES081)
- Producing, harvesting, transporting and processing of resources for consumption, and assimilating the associated wastes, involves the use of resources; the concept of an 'ecological footprint' is used to measure the magnitude of this demand (ACSES083)

The cause and impact of Earth hazards (Unit 4)

Examples in Context:

- Human activities, including land clearing, can contribute to the frequency, magnitude and intensity of some natural hazards (for example, drought, flood, bushfire, landslides) at local and regional scales (ACSES102)

The cause and impact of global climate change (Unit 4)

Examples in Context:

- Human activities, particularly land-clearing and fossil fuel consumption, produce gases (including carbon dioxide, methane, nitrous oxide and hydrofluorocarbons) and particulate materials that change the composition of the atmosphere and climatic conditions (for example, the enhanced greenhouse effect) (ACSES105)

Accreditation

The accreditation period for this course has been renewed from 1 January 2022 until 31 December 2025.

During the accreditation period required amendments can be considered via established processes.

Should outcomes of the Years 9-12 Review process find this course unsuitable for inclusion in the Tasmanian senior secondary curriculum, its accreditation may be cancelled. Any such cancellation would not occur during an academic year.

Version History

Version 1 – Accredited on 13 August 2018 for use from1 January 2018. This course replaces ESS315114 *Environmental Science and Society* that expired on 31 December 2017.

Accreditation renewed on 22 November 2018 for the period 1 January 2019 until 31 December 2021.

Version 1.i - 17 December 2018. Minor refinements to Content.

Version 1.ii - Renewal of Accreditation on 14 July 2021 for the period 31 December 2021 until 31 December 2025, without amendments.

Appendix 1

Science Inquiry Skills

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure/s to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; observe risk assessments; and consider research ethics, including animal ethics
- safely, completely and methodically collect valid and reliable data from practical investigations
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error, and uncertainty and imitations in data; and select, synthesise and use evidence to make and justify conclusions
- select, construct and use appropriate representations to communicate conceptual understanding, solve problems and make predictions
- interpret a range of scientific resources, for example, research and media reports, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
- communicate to specific audiences for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports.

Science as a Human Endeavour

- scientific knowledge can enable scientists to offer valid explanations and make reliable predictions
- ICT and other technologies have dramatically increased the size, accuracy, and geographic and temporal scope of data sets with which scientists work
- the acceptance of scientific knowledge can be influenced by the context in which it is considered
- science can be limited in its ability to provide definitive answers to public debate; there may be insufficient reliable data available, or interpretation of the data may be open to question.

Glossary

Accuracy: The extent to which a measurement result represents the quantity it purports to measure; an accurate measurement result includes an estimate of the true value and an estimate of the uncertainty.

Analyse: To examine, scrutinise, explore, review, consider in detail for the purpose of finding meaning or relationships, and identifying patterns, similarities and differences.

Assess: Determine the value, significance or extent of (something).

Communicates: Conveys knowledge and/or understandings to others.

Complex: Consisting of multiple interconnected parts or factors.

Critically analyse: Examine the component parts of an issue or information, for example identifying the premise of an argument and its plausibility, illogical reasoning or faulty conclusions.

Critically evaluate: Evaluation of an issue or information that includes considering important factors and available evidence in making critical judgements that can be justified.

Data: The plural of datum; the measurement of an attribute, for example, the volume of gas or the type of rubber. This does not necessarily mean a single measurement: it may be the result of averaging several repeated measurements. Data may be quantitative or qualitative and be from primary or secondary sources.

Demonstrate: Give a practical exhibition as an explanation.

Describe: Give an account of characteristics or features.

Design (verb): Plan and evaluate the construction of a product or process.

Evaluate: Provide a detailed examination and substantiated judgment concerning the merit, significance or value of something.

Evidence: In science, evidence is data that is considered reliable and valid, which can be used to support a particular idea, conclusion or decision. Evidence gives weight or value to data by considering its credibility, acceptance, bias, status, appropriateness and reasonableness.

Explain: Provide additional information that demonstrates understanding of reasoning and/or application.

Familiar: Previously encountered in prior learning activities.

Genre: The categories into which texts are grouped; genre distinguishes texts on the basis of their subject matter, form and structure (for example, scientific reports, field guides, explanations, procedures, biographies, media articles, persuasive texts, narratives).

Hypothesis: A tentative explanation for an observed phenomenon, expressed as a precise and unambiguous statement that can be supported or refuted by experiment.

Identify: Establish or indicate who or what someone or something is.

Investigation: A scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities. Investigations can include observation, research, field work, laboratory experimentation and manipulation of simulations.

Justify: Show how an argument or conclusion is right or reasonable.

Law: A statement describing invariable relationships between phenomena in specified conditions, frequently expressed mathematically.

Mode: The various processes of communication – listening, speaking, reading/viewing and writing/creating.

Model: A representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea.

Primary data: Data collected directly by a person or group.

Reasoned argument/conclusion: one that is sound, well-grounded in evidence, considered and thought out.

Research: To locate, gather, record, attribute and analyse information in order to develop understanding.

Secondary data: Data collected by a person or group other than the person or group using the data.

Select: Choose in preference to another or others.

Solve: Work out a correct solution to a problem.

Synthesise: Combine elements (information/ideas/components) into a coherent whole.

System: A group of interacting objects, materials or processes that form an integrated whole. Systems can be open or closed.

Theory: A set of concepts, claims and/or laws that can be used to explain and predict a wide range of related observed or observable phenomena. Theories are typically founded on clearly identified assumptions, are testable, produce reproducible results and have explanatory power.

Understand: Perceive what is meant, grasp an idea, and to be thoroughly familiar with.

Unfamiliar: Not previously encountered in prior learning activities.

Validity: The extent to which tests measure what was intended; the extent to which data, inferences and actions produced from tests and other processes are accurate.

Learning Outcomes	Criteria	Criteria and Elements	Content / Work Requirements
plan activities, monitor and evaluate progress; use organisational strategies to complete activities and meet deadlines; contribute to completion of group activities in the context of environmental science and ecology	1. apply personal skills to plan, undertake and complete activities	Elements 3, 4 and 5 of standards	Across all content and work requirements
safely and competently use practical scientific techniques and equipment to collect data related to environmental science and ecology	1. apply personal skills to plan, undertake and complete activities	Elements 1, 2 and 5 of standards	Across all practical work (see Work Requirements)
use scientific inquiry to develop, conduct, interpret and evaluate experiments related to environmental science and ecology	2. *develop, interpret and analyse experiments and investigations	All elements of standards	Experimental Design, Biotic and abiotic surveys, and analyse, interpret and draw conclusions from data
apply discriminating research skills and apply the principles of academic integrity	3. collect, record, process and communicate information	Elements 1, 4, 5 and 6 of standards	Across all content and work requirements
communicate, predict and explain phenomena, using qualitative and quantitative representations in appropriate modes and genres, and following accepted conventions and terminology	3. collect, record, process and communicate information	Elements 1, 2, and 3 of standards	Across all content and work requirements
explain and discuss the personal, local and global interdependence of issues and responsibilities concerning social equity and environmental values	4. analyse the application and impact of environmental science in society	All elements of standards	related to all content and case study (see work requirements)
apply ecological concepts to describe and discuss processes; explaining how and why ecosystems change over time	5. *describe and apply ecological concepts and processes 6. *describe and apply concepts and processes	All elements of standards for each criterion	Ecological processes and Ecosystem change

	relating to ecosystem change		
utilise environmental science and ecological concepts; describing humans as an integral part of the biosphere, locally and globally including their impact	7. *describe and apply concepts relating to human dependence and impact on ecosystems	Elements 1 , 2 and 3 of standards	Importance of ecosystem services, ecological footprint, and concepts relating to pollution
identify and discuss personal and community values that humans attach to natural resources, alternative uses for natural resources, and the implications of decision making	7. *describe and apply concepts relating to human dependence and impact on ecosystems	Elements 4, 5 and 6 of standards	Impact of resource use
analyse, interpret and critically assess environmental issues, utilising legislative and policy tools, to draw socially responsible conclusions	8. *describe and apply principles and processes related to ecologically sustainable management of the environment.	Elements 1 , 2 and 3 of standards	Concept of commons, and ecologically sustainable development
create positive economically and environmentally sustainable management solutions to issues	8. *describe and apply principles and processes related to ecologically sustainable management of the environment.	Elements 4, 5 and 6 of standards	Development proposal process, other strategies for management, and management of challenges to sustainability

Supporting documents including external assessment material

- ESS315118 TASC Exam Paper 2018.pdf (2018-11-22 12:42pm AEDT)
- ESS315118 - Assessment Panel Report 2018.pdf (2019-02-06 02:04pm AEDT)
- ESS315118 Environmental Science TASC Exam Paper 2019.pdf (2019-11-13 11:12am AEDT)
- ESS315118 Assessment Report 2019.pdf (2020-02-05 01:19pm AEDT)
- ESS315118 Environmental Science TASC Exam Paper 2020.pdf (2020-11-10 11:16pm AEDT)
- ESS315118 Environmental Science Information Sheet.pdf (2021-03-22 01:02pm AEDT)
- ESS315118 Assessment Report 2020.pdf (2021-04-01 12:07pm AEDT)
- ESS315118 Environmental Science TASC Exam Paper 2021.pdf (2021-11-16 09:01am AEDT)
- ESS315118 Assessment Report 2021.pdf (2022-01-24 01:21pm AEDT)
- ESS315118 Environmental Science External Assessment Specifications.pdf (2023-03-27 11:20am AEDT)
- ESS315118 Environmental Science TASC Exam Paper 2022.pdf (2022-11-12 10:20am AEDT)
- ESS315118 Assessment Report 2022.pdf (2023-03-02 01:26pm AEDT)
- ESS315118 Environmental Science TASC Exam Paper 2023.pdf (2023-11-16 04:16pm AEDT)

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