Government of Western Australia
School Curriculum and Standards Authority

EARTH AND ENVIRONMENTAL SCIENCE

GENERAL COURSE

Year 12 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2017.

Users of this syllabus are responsible for checking its currency.

Syllabuses are formally reviewed by the School Curriculum and Standards Authority on a cyclical basis, typically every five years.

Content

Rationale

Science is a dynamic, collaborative and creative human endeavour arising from our desire to make sense of our world. Science knowledge is contestable and is constantly revised, refined and extended as new evidence arises. Students can experience scientific discovery and nurture their natural curiosity about the world around them.

Earth and environmental scientists integrate knowledge drawn from diverse scientific disciplines in the study of Earth's ancient and modern environments. Scientists strive to understand past and present processes so that reliable and scientifically-defensible predictions can be made about the future.

In this course, students develop their investigative, analytical and communication skills. They develop critical and creative thinking skills, and challenge themselves to identify questions and draw evidence-based conclusions using scientific methods. This development of scientific literacy enables students to investigate the natural world and the effects of human activity on our environment. They can apply these skills to their understanding of science issues in order to engage in public debate, solve problems and make evidence-based decisions about contemporary local, national and global issues. The knowledge, understanding and skills introduced in this course will provide a foundation for further studies or employment in a wide range of fields.

Aims

The Earth and Environmental Science course aims to develop students':

- interest in Earth and Environmental Science and their appreciation of how this multidisciplinary knowledge can be used to understand contemporary issues
- understanding of Earth as a dynamic planet consisting of interacting spheres including the geosphere, atmosphere, hydrosphere and biosphere
- appreciation of the complex interactions that continually change Earth systems over geological timescales
- understanding of the importance of Earth resources for sustaining and enhancing quality of life
- ability to use an understanding of Earth and Environmental Science to make balanced and informed decisions and evaluate others' decisions about sustainable practice
- ability to conduct a variety of field, research and laboratory investigations involving collection and analysis of qualitative and quantitative data, and interpretation of evidence
- ability to critically evaluate science concepts, interpretations, claims and conclusions
- ability to communicate science understandings, findings, arguments and conclusions using appropriate representations and formats.

Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

Structure of the syllabus

The Year 12 syllabus is divided into two units which are delivered as a pair. The notional time for the pair of units is 110 class contact hours.

Unit 3 – Earth's resources

Students gain an understanding of the timescales over which geological processes occur, and methods for determining the relative ages of rock strata. They learn about the importance of the resources industry to the economy of Western Australia.

Students learn how resource deposits are located and extracted. They have the opportunity to discuss the effect of resource use on society and to look at ways to use resources more efficiently.

Unit 4 – Sustainable Earth

Students explore the effects of natural hazards on humans and environments, and identify strategies for reducing the impact of natural disasters.

Conserving natural resources and promoting their sustainable use is important to managing our future. Students understand how renewable energy sources can provide energy, and investigate the benefits and challenges facing different energy sources. The important issue of global climate change is explored.

Students conduct investigations and use their scientific understanding to answer real-world questions and make evidence-based decisions.

Each unit includes:

- a unit description – a short description of the focus of the unit
- unit content – the content to be taught and learned.

Organisation of content

Science strand descriptions

The Earth and Environmental Science course has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding. The three strands of the Earth and Environmental Science General course should be taught in an integrated way. The content descriptions for Science Inquiry Skills, Science as a Human Endeavour and Science Understanding have been written so that this integration is possible in each unit.

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. This strand focuses on evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions, and developing evidence-based arguments.

Investigations can involve a range of activities, including experimental testing, field work, sample analysis, locating and using information sources, conducting surveys, and using modelling and simulations.

Science as a Human Endeavour

Science concepts, models and theories are reviewed as their predictions and explanations are continually re-assessed through new evidence, often through the application of new technologies. This review process involves a diverse range of scientists working within an increasingly global community of practice.

The application of science may provide great benefits to individuals, the community and the environment, but may also pose risks and have unintended consequences. As an ever-evolving body of knowledge, science frequently informs public debate, but is not always able to provide definitive answers.

Science Understanding

Science understanding is evident when a person selects and integrates appropriate science concepts, models and theories to explain and predict phenomena, and applies those concepts, models and theories to new situations.

The Science understanding content in each unit develops students' understanding of the key concepts, models and theories that underpin the subject, and of the strengths and limitations of different models and theories for explaining and predicting complex phenomena.

Safety

Science learning experiences may involve the use of potentially hazardous substances and/or 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 and that school practices meet the requirements of the *Work Health and Safety Act 2011*, in addition to relevant state or territory health and safety guidelines.

Animal ethics

Through a consideration of research ethics as part of Science Inquiry Skills, students will examine their own ethical position, draw on ethical perspectives when designing investigation methods, and ensure that any activities that impact on living organisms comply with the *Australian code of practice for the care and use of animals for scientific purposes 8th edition 2013* (www.nhmrc.gov.au/guidelines/publications/ea28).

Any teaching activities that involve the care and use of, or interaction with, animals must comply with the *Australian code of practice for the care and use of animals for scientific purposes 8th edition 2013*, in addition to relevant state or territory guidelines.

The Animal Welfare Act 2002 can be found at www.slp.wa.gov.au. The related animal welfare regulations, along with the licences required for the use and supply of animals, can be downloaded from www.dlg.wa.gov.au

Information regarding the care and use of animals in Western Australian schools and agricultural colleges can be viewed at www.det.wa.edu.au/curriculumsupport/animalethics/detcms/portal/

Mathematical skills expected of students studying the Earth and Environmental Science General course

The Earth and Environmental Science General course requires students to use the mathematical skills they have developed through the Year 7–10 Mathematics curriculum, in addition to the numeracy skills they have developed through the Science Inquiry Skills strand of the Science curriculum.

Within the Science Inquiry Skills strand, students are required to gather, represent and analyse numerical data to identify the evidence that forms the basis of their scientific arguments, claims or conclusions. In gathering and recording numerical data, students are required to make measurements using appropriate units to an appropriate degree of accuracy.

It is assumed that students will be able to:

- perform calculations involving addition, subtraction, multiplication and division of quantities
- perform approximate evaluations of numerical expressions
- express fractions as percentages, and percentages as fractions
- calculate percentages
- translate information between graphical and numerical forms
- distinguish between discrete and continuous data and then select appropriate forms, variables and scales for constructing graphs
- construct and interpret tables and graphs
- describe and compare data sets using mean.

Representation of the general capabilities

The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. Teachers may find opportunities to incorporate the capabilities into the teaching and learning program for Earth and Environmental Science. The general capabilities are not assessed unless they are identified within the specified unit content.

Literacy

Literacy is important in students' development of Science Inquiry Skills and their understanding of content presented through the Science Understanding and Science as a Human Endeavour strands. Students gather, interpret and analyse information presented in a range of formats and representations (including text, flow diagrams, symbols, graphs and tables). They evaluate information sources and compare and contrast ideas, information and opinions presented within and between texts. They communicate processes and ideas logically and fluently and structure evidence-based arguments, selecting genres and employing appropriate structures and features to communicate for specific purposes and audiences.

Numeracy

Numeracy is vital to students' ability to apply a wide range of Science Inquiry Skills, including making and recording observations; ordering, representing and analysing data; and interpreting trends and relationships. They employ numeracy skills to interpret spatial and graphic representations, and to appreciate the ways in which Earth systems are structured, interact and change.

Information and communication technology capability

Information and communication technology (ICT) capability is a key part of Science Inquiry Skills. Students use a range of strategies to locate, access and evaluate information from multiple digital sources; to collect, analyse and represent data; to model and interpret concepts and relationships; and to communicate and share science ideas, processes and information. Students assess the impact of ICT on the development of science and the application of science in society, particularly with regard to collating, storing, managing and analysing large data sets.

Critical and creative thinking

Critical and creative thinking is particularly important in the science inquiry process. Science inquiry requires the ability to construct, review and revise questions and hypotheses and to design related investigation methods. Students interpret and evaluate data; select evidence; and analyse processes, interpretations, conclusions and claims for validity and reliability. Science is a creative endeavour and students devise innovative solutions to problems, predict possibilities, envisage consequences and speculate on possible outcomes. They also appreciate the importance of critique and review in the development and innovative application of science.

Personal and social capability

Personal and social capability is integral to a wide range of activities in the Earth and Environmental Science General course, as students develop and practise skills of communication, teamwork, decision-making, initiative-taking and self-discipline with increasing confidence and sophistication. In particular, students develop skills in both independent and collaborative investigation; they employ self-management skills to plan effectively, follow procedures efficiently and work safely; and they use collaboration skills to conduct investigations, share research and discuss ideas. In considering aspects of Science as a Human Endeavour, students also recognise the role of their own beliefs and attitudes in their response to science issues and applications, consider the perspectives of others, and gauge how science can affect people's lives.

Ethical understanding

Ethical understanding is a vital part of science inquiry. Students explore what integrity means in science, and they understand, critically analyse and apply ethical guidelines in their investigations. They consider the implications of their investigations on others, the environment and living organisms. They use scientific information to evaluate the claims and actions of others and to inform ethical decisions about a range of social, environmental and personal issues and applications of science.

Intercultural understanding

Students appreciate the contributions of diverse cultures to developing science understanding and the challenges of working in culturally diverse collaborations. They develop awareness that raising some debates within culturally diverse groups requires cultural sensitivity, and they develop open-mindedness to the positions of others. Students also develop an understanding that cultural factors affect the ways in which science influences and is influenced by society.

Representation of the cross-curriculum priorities

The cross-curriculum priorities address the contemporary issues which students face in a globalised world. Teachers may find opportunities to incorporate the priorities into the teaching and learning program for Earth and Environmental Science. The cross-curriculum priorities are not assessed unless they are identified within the specified unit content.

Aboriginal and Torres Strait Islander histories and cultures

Contexts that draw on Aboriginal and Torres Strait Islander histories and cultures could provide students with opportunities to investigate the importance of Aboriginal and Torres Strait Islander Peoples' knowledge in developing a richer understanding of the Australian environment. Students could develop an appreciation of the unique Australian biota and its interactions, the impacts of Aboriginal and Torres Strait Islander Peoples on their environments and the ways in which the Australian landscape has changed over tens of thousands of years. They could examine the ways in which Aboriginal and Torres Strait Islander knowledge of ecosystems has developed over time and the spiritual significance of Country/Place, and their relationship with life-forms through totemic connections.

Asia and Australia's engagement with Asia

Contexts that draw on Asian scientific research and development, and collaborative endeavours in the Asia Pacific region, provide an opportunity for students to investigate Asia and Australia's engagement with Asia. The Asia region plays an important role in scientific research and development, including through collaboration with Australian scientists, in such areas as natural hazard prediction and management, natural resource management, energy security and food security.

Sustainability

The Sustainability priority is explicitly addressed in Earth and Environmental Science. The curriculum requires students to understand the interconnectedness of Earth's biosphere, geosphere, hydrosphere and atmosphere and how these systems operate and interact. Relationships including cycles and cause and effect are explored, and students develop skills of observation and analysis to examine these relationships in the world around them now and into the future.

Students appreciate that Earth and Environmental Science provides the basis for decision-making in many areas of society and that these decisions can impact the Earth system, its environments and its resources. They understand the importance of using science to predict possible effects of human and other activity, and to develop management plans, or alternative technologies, that minimise these effects and provide for a more sustainable future.

Unit 3 – Earth's resources

Unit description

Students gain an understanding of the timescales over which geological processes occur and methods for determining the relative ages of rock strata. They learn about the importance of the resources industry to the economy of Western Australia.

Students learn how resource deposits are located and extracted. They discuss the effect of resource use on society and look at ways to use resources more efficiently.

Unit content

An understanding of the Year 11 content is assumed knowledge for students in Year 12. It is recommended that students studying Unit 3 and Unit 4 have completed Unit 1 and Unit 2.

This unit includes the knowledge, understandings and skills described below.

Science Inquiry Skills

- follow sets of written or verbal instruction accurately
- construct questions for investigation, propose hypotheses, identify variables and predict possible outcomes
- plan, select and use appropriate investigation methods, including field work, sampling techniques, laboratory experimentation and control variables to collect reliable data
- assess risk and address ethical issues associated with these methods
- organise and clearly represent data in tables and graphs to identify trends, patterns and relationships
- describe sources of experimental error
- use evidence to make and justify conclusions
- interpret a range of texts, and evaluate the conclusions by considering the quality of available evidence
- use appropriate representations, including classification keys, tables, diagrams, maps and images to communicate understanding, solve problems and make predictions
- communicate scientific ideas and information for a particular purpose, using appropriate scientific language, conventions and representations

Science as a Human Endeavour

- the Western Australian resources industry makes an important contribution to Australia's economy and employment opportunities
- Barrow Island oil and gas field is managed according to environmental and cultural guidelines

Science Understanding

- exploration methods for locating ore deposits and energy resources, such as seismic survey, magnetic survey, gravity survey, soil and stream sampling, geological mapping
- the type of mining used is related to the depth, size and grade of the ore body, and the application of underground and surface methods of extraction reflects this
- social and environmental guidelines need to be adhered to in order to responsibly manage a mining operation
- environmental strategies are employed to rehabilitate an area after extraction operations have ceased
- the formation and preservation of fossils
- the study of fossils and their distribution provides information about our understanding of paleoecology and the changes that have taken place during Earth's history, such as meteorite impacts, climate change, volcanic eruptions
- the formation and accumulation of fossil fuels
- the unsustainable use of Earth’s resources has environmental implications

Unit 4 – Sustainable Earth

Unit description

Students explore the effects of natural hazards on humans and environments, and identify strategies for reducing the impact of natural disasters.

Conserving natural resources and promoting their sustainable use is important to managing our future. Students understand how renewable energy sources can provide energy, and investigate the benefits and challenges facing different energy sources. The important issue of global climate change is explored.

Unit content

This unit builds on the content covered in Unit 3.

This unit includes the knowledge, understandings and skills described below.

Science Inquiry Skills

- follow sets of written or verbal instruction accurately
- construct questions for investigation, propose hypotheses, identify variables and predict possible outcomes
- plan, select and use appropriate investigation methods, including field work, sampling techniques, laboratory experimentation and control variables to collect reliable data
- assess risk and address ethical issues associated with these methods
- organise and clearly represent data in tables and graphs to identify trends, patterns and relationships
- describe sources of experimental error
- use evidence to make and justify conclusions
- interpret a range of texts, and evaluate the conclusions by considering the quality of available evidence
- use appropriate representations, including classification keys, tables, diagrams, maps and images to communicate understanding, solve problems and make predictions
- communicate scientific ideas and information for a particular purpose, using appropriate scientific language, conventions and representations

Science as a Human Endeavour

- the climate change debate – scientific evidence for and against
- renewable energy research and development in Western Australia, such as solar farms, geothermal cooling
- a Western Australian example of a biotic resources development, including possible future impacts due to climate change

Science Understanding

- natural hazards, including cyclones, floods, drought, earthquakes, tsunamis and volcanic eruptions; impact on the environment and on human societies. Planning for natural hazards may reduce their impact
- the climatic events, El Niño and La Niña, can have significant effects on society and biodiversity
- the mechanism and significance of the enhanced greenhouse effect; the causes of climate change; the effects of climate change; strategies to adapt to climate change effects; and the occurrence of climate change throughout geological history
- the effects of climate change on biodiversity and industries, such as fisheries, viticulture, agriculture
- renewable energy resources, including geothermal, wave, tidal, biofuels, solar or wind and their effects on the environment. Sites for alternative energy sources in Western Australia can be identified

School-based assessment

The Western Australian Certificate of Education (WACE) Manual contains essential information on principles, policies and procedures for school-based assessment that needs to be read in conjunction with this syllabus.

Teachers design school-based assessment tasks to meet the needs of students. The table below provides details of the assessment types for the Earth and Environmental Science General Year 12 syllabus and the weighting for each assessment type.

Assessment table – Year 12

Type of assessment	Weighting
Investigation Investigations are practical tasks or exercises designed to develop and assess a range of practical skills, conceptual understanding, and skills associated with processing data. Investigations can be communicated in any appropriate format, including written, oral or graphic. Tasks can take the form of: a practical skills exercise; design and/or conduct of an investigation; a laboratory report; analysis of second-hand data; a descriptive field study; or a short in-class test to validate the knowledge gained during the investigation.	30%
Extended task Tasks can take the form of: individual research assignments involving interpretation of a range of scientific and media texts; case studies; responses to discussions, presentations and questions; multimedia presentations. Appropriate strategies should be used to authenticate student achievement that has been completed as a part of a group, or as an out-of-class task.	20%
Test Tasks can involve comprehension and interpretation exercises; analysis and evaluation of qualitative and quantitative information; application of scientific principles to explain situations; use of reasoning to construct scientific arguments, and problem-solving. This assessment type is conducted in a supervised classroom setting.	35%
Externally set task A written task or item or set of items of 50 minutes duration developed by the School Curriculum and Standards Authority and administered by the school.	15%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units.

The assessment outline must:

- include a set of assessment tasks
- include a general description of each task
- indicate the unit content to be assessed
- indicate a weighting for each task and each assessment type
- include the approximate timing of each task (for example, the week the task is conducted, or the issue and submission dates for an extended task).

All assessment types must be included in the assessment outline at least twice with the exception of the externally set task which only occurs once.

The set of assessment tasks must provide a representative sampling of the content for Unit 3 and Unit 4.

Assessment tasks not administered under test/controlled conditions require appropriate validation/authentication processes.

Externally set task

All students enrolled in the Earth and Environmental Science General Year 12 course will complete the externally set task developed by the Authority. Schools are required to administer this task in Term 2 at a time prescribed by the Authority.

Externally set task design brief – Year 12

Time	50 minutes
Format	Written
	Conducted under invigilated conditions
	Typically between two and six questions
Content	The Authority informs schools during Term 3 of the previous year of the Unit 3 syllabus content on which the task will be based

Refer to the WACE Manual for further information.

Grading

Schools report student achievement in terms of the following grades:

Grade	Interpretation
A	Excellent achievement
B	High achievement
C	Satisfactory achievement
D	Limited achievement
E	Very low achievement

The teacher prepares a ranked list and assigns the student a grade for the pair of units. The grade is based on the student's overall performance as judged by reference to a set of pre-determined standards. These standards are defined by grade descriptions and annotated work samples. The grade descriptions for the Earth and Environmental Science General Year 12 syllabus are provided in Appendix 1. They can also be accessed, together with annotated work samples, through the Guide to Grades link on the course page of the Authority website at www.scsa.wa.edu.au

To be assigned a grade, a student must have had the opportunity to complete the education program including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the WACE Manual for further information about the use of a ranked list in the process of assigning grades.

Appendix 1 – Grade descriptions Year 12

A	**Understanding and applying concepts** Applies concepts to describe systems and explain processes in detail. Uses scientific language, conventions and clearly labelled diagrams to explain concepts. Selects and assesses the relevance of scientific information from a variety of sources to support a point of view. Analyses issues, organises information and presents clear, logical arguments which are supported by evidence.
	Science inquiry skills Formulates a testable hypothesis stating the relationship between dependent and independent variables. Plans and conducts an investigation to collect appropriate data. Identifies controlled variables and provides specific detail on how they will be controlled. Provides a clear and logical experimental procedure with sufficient detail to allow the investigation to be repeated by others. Organises data logically and presents it in a range of forms, including appropriate graphs and tables. Analyses experimental data to describe trends and relationships, and explains these using relevant scientific concepts. Uses evidence to make and justify conclusions that relate to the hypothesis. Evaluates the experimental method and makes specific relevant suggestions to improve the design of the investigation. Communicates information and concepts logically, using correct scientific language, conventions and representations.

B	**Understanding and applying concepts** Applies concepts to describe systems and partially explain processes. Uses scientific language, conventions and diagrams to explain concepts. Selects scientific information from a variety of sources to support a point of view. Organises information and presents arguments or statements which are supported by some evidence.
	Science inquiry skills Formulates a testable hypothesis stating the relationship between dependent and independent variables. Plans and conducts an investigation to collect appropriate data; identifies some controlled variables without detail. Provides a clear experimental procedure. Presents data in a range of forms, including appropriate graphs and tables. Describes trends and relationships in data and briefly explains these using relevant scientific concepts. Uses evidence to make conclusions that relate to the hypothesis. Evaluates the experimental method and makes relevant suggestions to improve the design of the investigation. Communicates information and concepts logically, generally using correct scientific language, conventions and representations.

C	**Understanding and applying concepts** Describes some systems and processes in a general way. Uses some scientific language, conventions and diagrams lacking detail to describe concepts. Selects some scientific information to support a point of view. Organises some information and presents general statements supported by limited evidence.
	Science inquiry skills Formulates a hypothesis that includes dependent and independent variables, within a context that has been provided. Plans and conducts an investigation to collect appropriate data. Identifies some controlled variables without detail. Outlines the main steps in the experimental procedure. Presents data using basic tables and graphs. Describes trends and relationships in data. Makes general conclusions that may not be linked to the hypothesis. Describes difficulties experienced in conducting the investigation, and suggests general improvements to the investigation. Communicates information and concepts without detail, using some scientific language and conventions. Provides responses which may not be supported by appropriate examples.

D	**Understanding and applying concepts** Identifies some systems and processes. Uses everyday language and simple diagrams to describe concepts. Makes little use of evidence to support a point of view. Presents statements which are incomplete and include irrelevant or incorrect information.
	Science inquiry skills Makes a simple prediction for an investigation. Does not distinguish between dependent, independent and controlled variables. Follows a provided experimental procedure to collect data. Presents data that is disorganised and lacks appropriate processing. Provides incomplete or incorrect tables and graphs. Identifies trends in data incorrectly or overlooks trends. Makes conclusions that are not supported by the data. Identifies difficulties experienced in conducting the investigation. Communicates information using everyday language with frequent errors in the use of conventions. Provides responses which are often incomplete or irrelevant.

E	Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade.