

Environmental Science Course Content and Process Guidelines

The Virginia Environmental Science Course Content and Process Guidelines are designed to continue the student investigations that began in grades K-8. These outcomes integrate the study of many components of our environment, including the human impact on our planet. These outcomes focus on scientific inquiry, the physical world, the living environment, resource conservation, humans' impact on the environment, and legal and civic responsibility. Instruction should focus on student data collection and analysis through laboratory experiences and field work. These should include descriptive and comparative studies as well as investigation (i.e. meaningful watershed educational experiences). It is expected that teachers will collaborate with museums, aquaria, nature centers, government agencies, associations, foundations, and private industry in efforts to engage the community, provide diverse points of view about the management of natural resources, and offer a variety of learning experiences and career education opportunities.

Science and Engineering Practices

ENV.1 The student will demonstrate an understanding of scientific and engineering practices by

- a) asking questions and defining problems
 - ask questions that arise from careful observation of phenomena and/or organisms, from examining models and theories, and/or to seek additional information
 - determine which questions can be investigated within the scope of the school laboratory or field to determine relationships between independent and dependent variables
 - generate hypotheses based on research and scientific principles
 - make hypotheses that specify what happens to a dependent variable when an independent variable is manipulated
 - define design problems that involve the development of a process or system with multiple components and criteria
- b) planning and carrying out investigations
 - individually and collaboratively plan and conduct observational and experimental investigations
 - plan and conduct investigations or test design solutions in a safe and ethical manner including considerations of environmental, social, and personal effects
 - determine appropriate sample size and techniques
 - select and use appropriate tools and technology to collect, record, analyze, and evaluate data
- c) interpreting, analyzing, and evaluating data
 - construct and interpret data tables showing independent and dependent variables, repeated trials, and means
 - construct, analyze, and interpret graphical displays of data
 - use data in building and revising models, supporting an explanation for phenomena, or testing solutions to problems
 - analyze data using tools, technologies, and/or models to make valid and reliable scientific claims or determine an optimal design solution
- d) constructing and critiquing conclusions and explanations
 - make quantitative and/or qualitative claims regarding the relationship between dependent and independent variables
 - construct and revise explanations based on valid and reliable evidence obtained from a variety of sources including students' own investigations, models, theories, simulations, and peer review
 - apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and design solutions
 - compare and evaluate competing arguments or design solutions in light of currently accepted explanations and new scientific evidence

- construct arguments or counterarguments based on data and evidence
- e) developing and using models
- evaluate the merits and limitations of models
 - develop, revise, and/or use models based on evidence to illustrate or predict relationships
 - develop and/or use models to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems
 - read and interpret topographic and basic geologic maps and globes, including location by latitude and longitude
- f) obtaining, evaluating, and communicating information
- compare, integrate, and evaluate sources of information presented in different media or formats to address a scientific question or solve a problem
 - gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and credibility of each source
 - communicate scientific and/or technical information about phenomena in multiple formats

The Physical World

ENV.2 The student will investigate and understand that matter has fundamental properties and interactions. Key content includes

- all things are made up of atoms and elements;
- atoms and elements can interact in different ways and can be expressed as different types of chemical reactions;
- chemical processes involve energy;
- the law of conservation of energy and matter applies to all closed systems;
- water has unique properties and characteristics which plays a critical role in the environment; and
- the distribution and movement of water across the Earth affects the biosphere, hydrosphere, lithosphere, and atmosphere.

ENV.3 The student will investigate and understand how matter flows in the fundamental processes of Earth systems. Key content includes

- the movement of atoms and elements through the biosphere, lithosphere, hydrosphere, and atmosphere as biogeochemical processes to include the carbon, oxygen, nitrogen, and water cycles;
- the atmosphere, lithosphere, and hydrosphere each have processes through which matter flows; and
- interrelationships exist among the atmosphere, geosphere, anthrosphere, and the hydrosphere.

ENV.4 The student will investigate and understand that major ongoing processes and systems leads to the formation and change of the Earth's surface. Key content includes

- water, living things, and rock processes impact the shape of landforms;
- physical processes such as erosion and the rock cycle lead to the formation of distinctive landforms;
- plate tectonic theory explains Earth's internal and external geologic processes; and
- both natural and manmade events may alter the Earth's land surface.

The Living World

ENV.5 The student will investigate and understand that the Earth is one interconnected system through which energy and matter flow. Key content includes

- Earth's terrestrial and aquatic biomes have distinct characteristics and components;
- an ecosystem is composed of both biotic and abiotic factors;
- energy and matter flow within an ecosystem;

- the movement of energy through the living world to include food webs, food chains, trophic levels; and
- biotic and abiotic factors may limit population growth in a given area (carrying capacity).

ENV.6 The student will describe that stability and change impact both populations and ecosystems. Key content includes

- the Earth in a state of dynamic equilibrium;
- interactions exist between individuals and populations (i.e. commensalism, mutualism, parasitism, predation, and competition);
- factors such as birth, death, and migration rates determine growth rates in populations;
- genetic diversity and population size both play roles in the conservation of a species;
- natural processes such as succession, evolution, and extinction occur as a result of change in the environment;
- factors such as the introduction of an invasive species, loss of biodiversity, and catastrophic events influence patterns of ecological succession;
- changes in the hydrosphere, atmosphere, geosphere, or anthrosphere impact the biosphere; and
- biodiversity may lead to co-evolution in ecosystems.

IV. Resources

ENV.7 The student will investigate and understand that Earth's resources are finite. Key content includes

- certain resources are nonrenewable because they are replenished at timescales of thousands to millions of years;
- environmental and commercial benefits and drawbacks of different energy sources to include fossil fuels, biomass, wind, solar, geothermal, hydroelectric, and nuclear power.

ENV.8 The student will investigate and understand that Earth's resources should be conserved. Key content includes

- the trend in human consumption of energy will affect future availability of nonrenewable resources;
- the effects of natural and human-caused activities may either contribute to or challenge an ecologically sustainable environment;
- individuals can alter their own behavior to reduce their environmental impact; and
- availability of energy will affect society and human activities, such as transportation, agricultural systems, and manufacturing.

Human impact, global climate change, and civic responsibility

ENV.9 The student will investigate and understand how human actions impact the environment. Key content includes

- advantages and disadvantages of balancing short term interests with long term welfare of society;
- individual activities and decisions can have an impact on the environment;
- people affect their environment through the use of natural resources to include how agriculture, forestry, ranching, mining, urbanization, transportation, and commercial fishing impact the land, water, air, and organisms; and
- the allocation of state and federal lands impacts environmental decisions.

ENV.10 The student will investigate and understand that pollution and waste management affect an ecosystem. Key content includes

- pollution and resource depletion have potential environmental implications at the local and global levels. These include air and water pollution, solid waste disposal, waste water disposal, depletion of the stratospheric ozone, global warming, and land uses;
- bioaccumulation and biomagnification directly affect organisms in a food chain or web;
- there are multiple ways to address pest management resulting in varied impacts on the environment; and
- different methods are used for remediation of land, air, and water pollution.

ENV.11 The student will investigate and understand that global climate change is occurring. Key content includes

- scientific evidence such as changes in average global temperature, greenhouse gases, quantities of arctic and land ice, ocean temperature, ocean acidification, and sea level rise are indicators of climate change;
- there exists a relationship between global climate change and the frequency or magnitude of extreme weather events;
- sea level rise is currently affecting coastal areas of Virginia and will lead to the destruction of current habitats; and
- consequences of climate change will affect the biosphere on many levels including species migration and extinction, disease spread, and ecosystem health (e.g. bleaching corals and dying forests).

ENV.12 The student will investigate and understand that their actions as an environmentally literate citizen will play a role in environmental policies. Key content includes

- consumer choices in Virginia impact jobs, resources, pollution, and waste here and around the world;
- environmental justice is the study of the impact of environmental policy including resource allocation, pollution regulations, and waste disposal across all communities;
- political, legal, social, and economic decisions may affect global and local ecosystems;
- the media impacts public opinion and public policy;
- individuals and interest groups influence public policy;
- environmental decisions should include a cost-benefit analysis and may lead to trade-offs in conservation policy; and
- different methods are used by local, state, national, and international governments and organizations with varying results to protect the environment.