Fairfield Public Schools
Science Curriculum

Draft Units

Advanced Placement Environmental Science: Description

Standards for this course are taken from the *Next Generation Science Standards* and are of three types:

Disciplinary Core Ideas (DCIs): Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

Science and Engineering Practices (SEP): These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

Crosscutting Concepts: These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.

http://www.nextgenscience.org/next-generation-science-standards

CROSS CUTTING CONCEPTS

Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Advanced Placement Environmental Science

Course Essential Questions
• How do the Earth and humans interact and how do humans work to achieve……?

Course: Year-at-a Glance

Unit	Title		Unit Essential Questions
1	**The Living World**	Ecosystem Structure Energy Flow Ecosystem Diversity Natural Ecosystem Change Natural Biogeochemical Cycles	How are ecosystems structured? How do species interact? How is biodiversity achieved and what does it offer? How do ecosystems change? How does matter cycle in ecosystems?
2	**Populations**	Population Biology Concepts Human Population Human population Dynamics Population Size Impacts of population growth	How are populations sustained? How does the human population change globally? What are the effects of increased global populations?
3	**Earth Systems and Resources**	Earth Science Concepts The Atmosphere Global Water Resources and Use Soil and Soil Dynamics	How does solar intensity affect the Earth? How does plate movement affect the Earth? How is water used? How does matter cycle through the rock cycle?
4	**Land and Water Use**	Agriculture Controlling pests Forestry Rangelands Other Land Use Urban land development Transportation infrastructure Public and federal lands Land conservation options Sustainable land-use strategies Mining Fishing Global Economics	How do we feed a growing population? How do we manage forests? How do we manage rangelands? What practices degrade rangelands? By what means do we feed an ever-growing population? What are the costs and benefits of pesticide use? How is integrated pest management implemented? What are the characteristics of old growth forests? What are the benefits of forest fires? What are the characteristics of suburban sprawl? How are preservation, remediation, mitigation, and restoration use to counteract the effects of urban sprawl? By what means are mineral extracted? How does mineral extraction negatively impact the environment? How do the dynamics of the fishing industry lead to resource exploitation? What are the characteristics and impacts of globalization? What are some noteworthy examples of the Tragedy of the Commons?
5	**Energy Resources and Consumption**	Energy Concepts Energy Consumption Fossil Fuel Resources Nuclear Energy Hydroelectric Power Energy Conservation	What are the Laws of Thermodynamics? How has energy use changed over time? How will renewable energy technologies support our future energy needs? How do nonrenewable fossil fuels form? What are the advantages and disadvantages of biofuels? What is nuclear fission?

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		Renewable Energy	How is electricity produced in a nuclear reactor? What are the environmental advantages/disadvantages of nuclear power? What are the environmental advantages/disadvantages of dams? What are the environmental advantages/disadvantages of alternative energy resources?
6	**Pollution**	Pollution Types Air pollution Noise pollution Water pollution Solid waste Hazards to human health Hazardous chemicals in the environment Economic Impacts	What are the sources of primary and secondary; major air pollutants? How do the primary and secondary air pollutants cause environmental degradation? What atmospheric characteristics exacerbate air pollution? What are the primary indoor air pollutants? What factors reduce indoor air pollution? How does the Clean Air Act help to reduce air pollution? What are the common causes for water pollution? How does the Clean Water Act help to reduce water pollution? How do scientists analyze environmental risk? What are some common examples of hazardous waste? How is hazardous waste treated/disposed of? How is the superfund used in the cleanup of contaminated sites?
7	**Global Change**	Stratospheric Ozone Global Warming Loss of Biodiversity	How is stratospheric ozone formed? What are the effects of ozone depletion? What are the common greenhouse gases? What are the impacts and consequences of global warming?

Unit 1

Overview
The Living World unit will investigate ecosystem structure, ecosystem diversity, ecosystem change and how energy and matter cycle through ecosystems.

Unit Content Objectives
At the conclusion of this unit, students will be able to: HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors, including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.] HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood and extreme changes, such as volcanic eruption or sea-level rise.]

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

HS-LS2-8. Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce. [Clarification Statement: Emphasis is on (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* [Clarification Statement: Emphasis is on testing solutions for a proposed problem related to threatened or endangered species or to genetic variation of organisms for multiple species.]

Unit Essential Questions
• How are ecosystems structured? • How do species interact? • How is biodiversity achieved and what does it offer?

- How do ecosystems change?
- How does matter cycle in ecosystems?

Crosscutting Concepts

Cause and Effect

• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8), (HS-LS4-6)

Scale, Proportion, and Quantity

• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

• Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Stability and Change

• Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

LS2.A: Interdependent Relationships in Ecosystems

• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and non-living resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance

(number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)

• Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS2.D: Social Interactions and Group Behavior

• Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

LS4.C: Adaptation

• Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new and distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-6)

LS4.D: Biodiversity and Humans

• Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)

• Humans depend on the living world for the resources and other benefits provided by

biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7), (HS-LS4-6)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and non-linear functions, including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

• Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)

Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

• Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

• Design, evaluate, and refine a solution to a

complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8)

Connections to Nature of Science

Scientific Knowledge Is Open to Revision in Light of New Evidence

• Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2)

• Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

Corresponding CT Core Standards:
ELA/Literacy –
Mathematics –

Unit 2

Overview

- **Unit Content Objectives**

Unit Essential Questions

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Crosscutting Concepts

III.
A.
(Population ecology; carrying capacity; reproductive strategies; survivorship)
B.
1.
(Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)
2.
(Strategies for sustainability; case studies; national policies)
3.
(Hunger; disease; economic effects; resource use; habitat destruction)

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NGSS Unit Standards
DISCIPLINARY CORE IDEAS (DCI): • **SCIENCE AND ENGINEERING PRACTICES (SEP):** •
Corresponding CT Core Standards: **ELA/Literacy –** **Mathematics –**

Unit 3 Heredity: Inheritance and Variation of Traits

Overview

Unit Content Objectives

At the conclusion of this unit, students will be able to:

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Unit Essential Questions

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Crosscutting Concepts

A.
(Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar
intensity and latitude)
B.
(Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere–ocean interactions; ENSO)
C.
(Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)
D.
(Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

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NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI): **SCIENCE AND ENGINEERING PRACTICES (SEP):**
Corresponding CT Core Standards: **ELA/Literacy –** **Mathematics –**

Unit 3 Heredity: Inheritance and Variation of Traits

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Unit Content Objectives

At the conclusion of this unit, students will be able to:

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Crosscutting Concepts

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NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):
SCIENCE AND ENGINEERING PRACTICES (SEP):

Corresponding CT Core Standards:
ELA/Literacy –

Mathematics –

Unit 3 Heredity: Inheritance and Variation of Traits

Overview

Unit Content Objectives
At the conclusion of this unit, students will be able to: •

Unit Essential Questions
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Crosscutting Concepts
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NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI): **SCIENCE AND ENGINEERING PRACTICES (SEP):**
Corresponding CT Core Standards: **ELA/Literacy –** **Mathematics –**

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NGSS Unit Standards

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Unit 3 Heredity: Inheritance and Variation of Traits

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At the conclusion of this unit, students will be able to: •

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NGSS Unit Standards

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At the conclusion of this unit, students will be able to:

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Unit Essential Questions

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Crosscutting Concepts

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NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):
SCIENCE AND ENGINEERING PRACTICES (SEP):

Corresponding CT Core Standards:
ELA/Literacy –

Mathematics –

How do we feed a growing population?
How do we manage forests?
How do we manage rangelands?
What practices degrade rangelands?
By what means do we feed an ever-growing population?
What are the costs and benefits of pesticide use?
How is integrated pest management implemented?
What are the characteristics of old growth forests?
What are the benefits of forest fires?

(Planned development; suburban sprawl; urbanization)
2.
(Federal highway system; canals and channels; roadless areas; ecosystem impacts)
3.
(Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
4.
(Preservation; remediation; mitigation; restoration)
5.
E.
(Mineral formation; extraction; global reserves; relevant laws and treaties)
F.
(Fishing techniques; overfishing; aquaculture; relevant laws and treaties)
G.
(Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V.
A.
(Energy forms; power; units; conversions; Laws of Thermodynamics)
B.
1. History
(Industrial Revolution; exponential growth; energy crisis)
2. Present global energy use
3. Future energy needs
C.

(Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/ disadvantages of sources)
D.
(Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)
E.
(Dams; flood control; salmon; silting; other impacts)
F.
(Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)
G.
(Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

A.
1.
(Sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
2.
(Sources; effects; control measures)
3.
(Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
4.
(Types; disposal; reduction)
B. Impacts on the Environment and Human Health
1.
(Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
2.
(Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)
C.
(Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. (10–15%)
A.
(Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)
B.
(Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)
C.
1. _Habitat loss; overuse; pollution; introduced species; endangered and extinct species

2. Maintenance through conservation
3. Relevant laws and treaties