Bloomfield Public Schools
Bloomfield, New Jersey 07003

Curriculum Guide
Environmental Science
Grade 9

Prepared by:
Tara Anton

Salvatore Goncalves, Superintendent of Schools
Sandra Searing, Assistant Superintendent of Curriculum and Instruction
Louis Cappello, Supervisor of Science

Conforms to the Next Generation Science Standards and NJSLS Standards - Standards Revision

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Environmental Science - CP
Grade 9

Introduction: Students in the State of New Jersey and enrolled in Bloomfield High School must successfully complete three year-long science courses in order to meet the state mandated requirements for graduation. *Environmental Science* is a required course for all 9th grade students.

Environmental Science is a multidisciplinary field that draws from all others sciences, including: chemistry, biology, ecology, geography and Earth sciences, to help achieve practical goals. Such goals include the conservation and protection of natural resources on local, state and global levels through environmental education and research. Environmental science helps us to understand the connection between humans and the world in which we live. This course will allow students to identify and analyze environmental problems both natural and man-made, identify threats associated with these problems, and develop valid solutions to prevent these problems from reoccurring. Laboratory investigation and analysis as well as projects are an integral part of this course.

This curriculum is aligned with the *Next Generation Science Standards*, the C*ommon Core State Standards for English Language Arts & Literacy in Science, the Common Core State Standards for Math, and the New Jersey Core Curriculum Standards for Technology.*

This document is a tool that will provide an overview as to what to teach, when to teach it, and how to assess student progress. With considerations made for altered pacing, modifications, and accommodations; this document is to be utilized for all students enrolled in this course, regardless of ability level, native language, or classification. It is meant to be a dynamic tool that we, as educators, will revise and modify as it is used during the course of the school year.

Pacing: The Environmental Science course focuses on five topics:

Unit 1: History of Earth
Unit 2: Earth's Systems
Unit 3: Weather and Climate
Unit 4: Ecosystem Dynamics
Unit 5: Human Sustainability

Resources: Electronic and text resources are listed in each unit. Teachers will be able to access the curriculum document on the district website.

Textbook: *Environmental Science* by Karen Arms, Holt

Established Goals: New Jersey Student Learning Standards
Science: **http://www.nextgenscience.org/next-generation-science-standards**
Math Standards: **http://www.state.nj.us/education/aps/cccs/math/**
ELA Standards: **http://www.state.nj.us/education/aps/cccs/lal/**
Technology: **http://www.state.nj.us/education/cccs/2014/tech/**

Modifications:
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.   - Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).   - Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).   - Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).   - Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.   - Use project-based science learning to connect science with observable phenomena.   - Structure the learning around explaining or solving a social or community-based issue.   - Provide ELL students with multiple literacy strategies.   - Collaborate with after-school programs or clubs to extend learning opportunities.   - Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Unit #: 1	Unit Name: History of Earth	Unit Length: 35 days

ESSENTIAL QUESTIONS:

What is the importance of knowing our Earth's History?
How do people reconstruct and date events in Earth's planetary History?
In order to solve environmental problems, we must understand how our Earth works to obtain solutions for the future.

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.** *[Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]*	**HS-ESS1-6**
2	**Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.** *[Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).]*	**HS-ESS1-5**
3	**Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.** *[Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).]* *[Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.]*	**HS-ESS2-1**

4	**Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** *[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.]* *[Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]* *Teacher Note: This PE is used in both units 1 and 2. The emphasis of the PE is slightly different in each unit. The focus of HS-ESS2-7 in Unit 1 is on the how the diversity of organisms found in our fossil evidence as recorded over geologic time provides evidence for changing environments. The focus HS-ESS2-7 in Unit 2 is on how the chemical changes in the various Earth Systems have lead to the evolution of life over time.*	**HS-ESS2-7**
5	**Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** *[Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.* *Teacher Note: Within this unit the focus of this SLO is on the relationship of various life forms found in the fossil record over geologic time and the environmental conditions within the Earth system which may have precipitated the changes in life forms.*	**HS-LS4-5**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59) Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1) **Constructing Explanations and Designing Solutions** (pp. 67-71) Students construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ● Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6) **Engaging in Argument from Evidence** (pp. 71-74) Students use 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 evidence behind currently accepted explanations or solutions to	**ESS1.C: The History of Planet Earth** (pp. 177-179) ● Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5) ● Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6) **ESS2.A: Earth Materials and Systems** (pp. 179-182) ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), *(Note: This Disciplinary Core Idea is also addressed by HS-ESS2-2.)*	**Patterns** (pp. 85-87) ● Empirical evidence is needed to identify patterns. (HS-ESS1-5) **Stability and Change** (pp. 98-101) ● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6), (HS-ESS2-7) ● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1) **Cause and Effect** (pp. 87-89) Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-5)

determine the merits of arguments. (HS-ESS1-5), (HS-ESS2-7), (HS-LS4-5) -- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-6) ● Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1-6)	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** (pp. 182-183) ● Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5)*,(HS-ESS2-1) ● Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. *(ESS2.B Grade 8 GBE)* (HS-ESS2-1) **ESS2.D: Weather and Climate** (pp. 186-189) ● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7) **ESS2.E Biogeology** (189-190) ● The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)	

	PS1.C: Nuclear Processes (pp. 111-113) ● Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.(secondary to HS-ESS1-5),(secondary to HS-ESS1-6) **LS4.C: Adaptation** (pp. 164-166) ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline– and sometimes the extinction–of some species. (HS-LS4-5) ● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)	

Connections to other DCIs in this grade-band:
HS.PS2.A (HS-ESS1-6); **HS.PS2.B** (HS-ESS1-6),(HS-ESS2-1); **HS.PS3.B** (HS-ESS1-5); **HS.ESS2.A** (HS-ESS1-5); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.C** (HS-ESS2-7);**HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-7); **HS.LS4.D** (HS-ESS2-7) **HS.LS2.A** (HS-LS4-5); **HS.LS2.D** (HS-LS4-5); **HS.LS3.B** (HS-LS4-5); **HS.ESS2.E** (HS-LS4-5); **HS.ESS3.A** (HS-LS4-5)

Articulation of DCIs across grade-bands:
MS.PS2.B (HS-ESS1-6),(HS-ESS2-1); **MS.LS2.B** (HS-ESS2-1); **MS.ESS1.B** (HS-ESS1-6); **MS.ESS1.C** (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1); **MS.ESS2.A** (HS-ESS1-5),(HS- ESS1-6),(HS-ESS2-1); **MS.ESS2.B** (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1); **MS.ESS2.C** (HS-ESS2-1); **MS.ESS2.D** (HS-ESS1-1); **MS.LS2.A** (HS-ESS2-7); **MS.LS2.C** (HS-ESS2-7); **MS.LS4.A** (HS-ESS2-7); **MS.LS4.B** (HS-ESS2-7); **MS.LS4.C** (HS-ESS2-7); **MS.ESS1.C** (HS-ESS2-7); **MS.ESS2.A** (HS-ESS2-7); **MS.ESS2.C** (HS-ESS2-7); **MS.ESS3.C** (HS- ESS2-7) **MS.LS2.A** (HS-LS4-5); **MS.LS2.C** (HS-LS4-5); **MS.LS4.C** HS-LS4-5); **HS.ESS3.C** (HS-LS4-5)

Connections to Math & ELA Standards:
ELA:
RI.9-10.1. Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain (HS-ESS1-5),(HS-ESS1-6), (HS-LS4-4)
RI.9-10.8. Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning. (HS-ESS1-5),(HS-ESS1-6), (HS-LS4-5)
W.9-10.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. B. Develop claim(s) and counterclaims avoiding common logical fallacies, propaganda devices, and using sound reasoning, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns. (HS-ESS1-6); (HS-ESS2-7)
W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.(HS-ESS1-2), (HS-ESS1-5), (HS-LS4-4)
W.9-10.9. Draw evidence from literary or nonfiction informational texts to support analysis, reflection, and research**.** (HS-LS4-4),(HS-LS4-5)
SL.9-10.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest.(HS-ESS2-1)

MATH:
MP.2: Reason abstractly and quantitatively. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1),(HS-LS4-4),(HS-LS4-5)
MP.4: Model with mathematics. (HS-ESS2-1)
HSN-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)
HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)

HSN-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-5),(HS-ESS1-6),(HS-ESS2-1)
HSF-IF.B.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)
HSS-ID.B.6b: Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology. (HS-ESS1-6)

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Feedback effect Seismic activity Fossils Relative age Absolute age Paleontology Epochs Era Period Geological time scale Law of superposition Law of uniformitarianism Rock record Igneous Metamorphic Sedimentary Radiometric dating Radioactive decay Isotopes Asteroid Meteorite Co- evolution Evolution Continental crust Oceanic crust Pangea Magnetic Field Plate- tectonics Conduction Convection Continental Drift Deformation Mantle Extinction	Direct Observation Indirect Observation Density Accumulation Analysis Catastrophic Controls Independent variable Dependent variable Evidence Morphological Physiological Affect/ effect Billion Concentration Decipher Generation Phenomenon Stable/ stability Interval	*Environmental Science* by Karen Arms, Holt Chapter 1- Science and the Environment Chapter 2- Tools of Environmental Science Online access to internet websites and readings required are below.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Geological Timeline Challenge – Create a timeline of Earth history and learn about major changes to the Earth and life through time.	#1 / Asking questions and defining problem
	Earth and the Early Atmosphere – Intro video to earth's changing atmosphere	#1 and #2
	UC Davis Newswatch: Tectonic Plates No.1 – Intro video on faults and plate boundaries along the west coast, specifically California	#3
	Europe Starting to Dive Under Africa- Article Reading on tectonic plate movement and sea-floor features (i.e. subduction zones and trenches)	#2 / Obtaining, evaluating, and communicating information
EXPLORE	**Examples of Exploring Activities:**	
	Dating Popcorn – Students will simulate dating techniques of rocks that determine earth's age through popcorn. *Will require microwave use*	#1 – Using mathematics and computational thinking
	Fossil Identification Lab – Students will be investigating various fossils to determine its closest related species, cause of demise, and fossil formation. * See Ms. Anton/ Ms. Antola for fossils/ sedimentary rocks/ fossil books/ hand lenses *	#1 and #2 / Planning and carrying out investigations and engaging in argument from evidence
	Sinkholes in a Cup – Students are modeling how natural depressions can form within the land and rock layers.	#3 / Developing and using models
	A Model of Three Faults – Students will observe fault movements on a model of earth's surface.	#2
EXPLAIN	**Examples of Explaining Activities:**	
	Mt. St. Helens – Interpret reading and analyze how a disturbance can change environmental conditions including ecosystems, habitats, and species.	#2 and #5 / Asking questions and defining problems and engaging in argument from evidence
	Continental Movement by Plate Tectonics – Investigate evidence of Pangea, the Ring of Fire, and sea-floor spreading.	#3

ELABORATE	Examples of Elaborating Activities:	
	Continental Movement Over Long Time Scales – Mapping, Evaluating and Interpreting evidence of continental movement (i.e. fossils, continents, glacial striations) and engaging in argument on the evidence quality/ validity in the continental drift theory.	#2 and #4 / Analyzing and interpreting data and engaging in argument from evidence
	Crustal Movement Lab – Determining Hawaiian Hotspot locations	#3 / Using mathematics and computational thinking
	Conservation in Action – Who is Rachel Carson? Research and discuss her impact on protecting wildlife and their habitats.	#4 and #5 / Obtaining, evaluating. And communicating information
EVALUATE	**Examples of Evaluating Activities:**	
	Change Over Time – Research a mass extinction event and an extinct animal species, write up and present findings	#4 / Engaging in argument from evidence

Unit #: 2	Unit Name: Earth's Systems	Unit Length: 35 days

ESSENTIAL QUESTIONS:

How and why is Earth constantly changing?
How do changes in the geosphere affect the atmosphere?
How do the properties and movements of water shape Earth's surface and affect its systems?
How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** *[Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]*	**HS-ESS2-2**
2	**Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.** *[Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.]*	**HS-ESS2-3**
3	**Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** *[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and*	**HS-ESS2-5**

	recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]	
4	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** *[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]* *Teacher Note: HS-ESS2-6 appears in units 2 and 3. The focus of HS-ESS2-6 in Unit 2 is on the cycling of carbon among all of Earth's spheres including the residence time and spatial distribution of carbon in each of these spheres. The focus HS-ESS2-6 in Unit 3 is on link between the carbon cycle and our climate system including residence time and spatial distribution of carbon in each of these spheres.*	**HS-ESS2-6**
5	**Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** *[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.]* [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.*]* *Teacher Note: HS-ESS2-7 initially appears in Unit 1. In this unit the focus of HS-ESS2-7 is on how the chemical changes in the various Earth Systems have led to the evolution of life over time.*	**HS-ESS2-7**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59) Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed world(s). ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-3),(HS-ESS2-6) **Planning and Carrying Out Investigations** (pp.59-61) Students plan and carrying out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)	**ESS2.A: Earth Materials and Systems** (pp. 179- 182) ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) ● Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3) **ESS2.B: Plate Tectonics and Large-Scale System** **Interactions** (pp. 182-183)	**Energy and Matter** (pp. 94-96) ● The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) ● Energy drives the cycling of matter within and between systems. (HS-ESS2-3) **Structure and Function** (pp. 96-98) ● The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5) **Stability and Change** (pp. 98-101) ● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7) ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

Analyzing and Interpreting Data (pp. 61-63) Students analyze data using more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS- ESS2-2) **Engaging in Argument from Evidence** (pp. 71-74) Students use 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. ● Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7) -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based on empirical evidence. (HS-ESS2-3) ● Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-ESS2-3)	● The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) **ESS2.C: The Roles of Water in Earth's Surface Processes** (pp. 184-186) ● The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5) **ESS2.D: Weather and Climate** (pp. 186-189) ● The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)	

• Science includes the process of coordinating patterns of evidence with current theory. (HS- ESS2-3)	• Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) • Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) **ESS2.E Biogeology** (189-190) • The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)	

Connections to other DCIs in this grade-band: **HS.PS1.A** (HS-ESS2-5),(HS-ESS2-6); **HS.PS1.B** (HS-ESS2-5),(HS-ESS2-6); **HS.PS2.B** (HS-ESS2-3); **HS.PS3.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5); **HS.PS3.D** (HS-ESS2-3),(HS-ESS2-6); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS2-6); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.B** (HS-ESS2-2),(HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2),(HS-ESS2-7);**HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-7); **HS.LS4.D** (HS-ESS2-2),(HS-ESS2-7); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-6)
Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6); **MS.PS1.B** (HS-ESS2-3); **MS.PS2.B** (HS-ESS2-3); **MS.PS3.A** (HS-ESS2-3); **MS.PS3.B** (HS-ESS2-3) **MS.PS3.D** (HS-ESS2-2),(HS-ESS2-6); **MS.PS4.B** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **MS.LS2.A** (HS-ESS2-7); **MS.LS2.B**(HS-ESS2-2),(HS-ESS2-6); **MS.LS2.C** (HS-ESS2-2),(HS-ESS2-7); **MS.LS4.A** (HS-ESS2-7); **MS.LS4.B** (HS-ESS2-7); **MS.LS4.C** (HS-ESS2-2),(HS-ESS2-7); **MS.ESS1.C** (HS-ESS2-7); **MS.ESS2.A** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS- ESS2-6),(HS-ESS2-7); **MS.ESS2.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS2.D** (HS-ESS2-2),(HS- ESS2-5); **MS.ESS3.C** (HS-ESS2-2),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS3.D** (HS-ESS2-2),(HS-ESS2-6)
Connections to Math and ELA Standards:

ELA:
RI.9-10.1. Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.(HS-ESS2-2),(HS-ESS2-3)
RI.9-10.2. Determine a central idea of a text and analyze how it is developed and refined by specific details; provide an objective summary of the text. (HS-ESS2-2)
W.9-10.1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. B. Develop claim(s) and counterclaims avoiding common logical fallacies, propaganda devices, and using sound reasoning, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns. (HS-ESS2-7)
W.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation**.** (HS-ESS2-5)

MATH:
MP.2: Reason abstractly and quantitatively. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6)
MP.4: Model with mathematics. (HS-ESS2-3),(HS-ESS2-6)
HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas;
choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-6)
HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-3),(HS-ESS2-6)
HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6)

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Atmosphere Biosphere Earthquake Geosphere Hydrosphere Lithosphere Plateau Subduction Volcano Open/Closed system Fault Convergent Divergent Transformation Fold Sea floor spreading Mid Ocean Ridge Landform Precipitation Salinity Rift Zone Radioactive heating Magma Lava Erosion Weathering	Adaptation Alteration Combustion Cycling Geography Interaction Seasonal	*Environmental Science* by Karen Arms, Holt Chapter 3- The Dynamic Earth Chapter 11- Water Online access to internet websites and readings required are below.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Glacier National Park - video demonstrating a feedback of increased surface temperatures	#1
	Edible Plate Tectonics- Students dissect milky ways to introduce the major plate boundaries. *Link will directly open as a MS Word document*	#2 / Developing and using models
	How the Earth Changed History – Water (Documentary)	#3
	San Diego's Billion Dollar Water Bet – this video shows a current alternative project for reaching one of humans most vital resources for survival	#3
EXPLORE	**Examples of Exploring Activities:**	
	A Model of Three Faults – Students will observe faults movements on a model of earth's surface.	#2 / Analyzing and interpreting data
	Soil Properties - investigate the property of porosity *Will require outside field observation on school property*	#1 / Planning and Carrying out investigations
	Climate Change Lab Stations – Students will explore climate change causes and effects through a multi- media investigation. (Analyzing graphs, observing effects of climate change through photographs, video clip/animations on effects)	#1 / Asking questions and defining problems and using mathematics and computational thinking
	The Incredible Carbon Journey – Develop understanding of the carbon cycle and the carbon cycle pre and post- industrial.	#4
EXPLAIN	**Examples of Explaining Activities:**	
	Earth's Hydrologic Cycle – Students will construct a simple model of the hydrologic cycle to help them visualize and understand the movement of liquid water and heat.	#3 / Developing and using models
	Carbon on the Move – Students learn how carbon moves through terrestrial and aquatic food webs. Reading, animations, and checkpoint questions for understanding.	#4

ELABORATE	Examples of Elaborating Activities:	
	Layers of the Earth Through Egg Dissection http://www.perkinselearning.org/accessible-science/illustrating-layers-earth-through-egg-dissection	#2 / Developing and Using Models and Analyzing and Interpreting data
	Water Stations Lab- Test many of the various properties of water (i.e. absorption, freezing, melting point, universal solvent, adhesion/cohesion, capillary action)	#3/ Planning and Carrying out Investigations
	Water in the Atmosphere – understand the atmosphere by observing and taking measurements *Requires outside field observation, on school property*	#4 / Obtaining, evaluating, and communicating information
EVALUATE	**Examples of Evaluating Activities:**	
	Earth Spheres Web quest	#2 / Analyzing and interpreting data
	Various Article Readings on co-evolution of life amongst the geosphere, students will analyze, develop arguments, pair-share Example article: http://www.scientificamerican.com/article/origin-of-oxygen-in-atmosphere/	#5 / Engaging in argument from evidence

Unit #: 3	**Unit Name:** Weather and Climate	**Unit Length:** 35 days

ESSENTIAL QUESTIONS: What regulates weather and climate? What would happen to life on our planet without the sun? How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere? How do changes in the geosphere effect the atmosphere? What is the current rate of global or regional climate change and what are the associated future impacts to Earth's systems?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Construct scientific arguments using data to support claims that spatial and temporal patterns in weather and climate found around the Earth are created by complex global, regional, and local interactions involving sunlight, and all of the Earth's spheres.** *[Clarification Statement: Emphasis is on interpretation of weather and climate data and data representations that model how weather and climate elements (temperature, pressure, wind, moisture content) are affected by numerous controls of weather and climate such as latitude, distribution of land and water, general circulation of the atmosphere, general circulation of the oceans, altitude, topographic barriers, storms.]*	**HS-ESS2-4**
2	**Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** *[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.]* [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.*]*	**HS-ESS2-4**
3	**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere as it relates to our climate system.** *[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]*	**HS-ESS2-6**

	Teacher Note: *HS-ESS2-6 appears in both units 2 and 3. The HS-ESS2-6 in Unit 3 is a link between the carbon cycle and our climate system including residence time and spatial distribution of carbon in each of these spheres.*	

4	**Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** *[Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).]* [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]	**HS-ESS3-5**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59) Students use, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). ● Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6) **Analyzing and Interpreting Data** (pp. 61-63) Students use more detailed statistical analysis, the comparison of data sets for consistency,	**ESS1.B: Earth and the Solar System** (pp. 175-176) ● Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4) **ESS2.A: Earth Materials and Systems** (pp. 179-182)	**Patterns** (pp. 85-87) ● Empirical evidence is needed to identify patterns. (SLO-1) **Cause and Effect** (pp.87-89) ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) **Stability and Change** (pp. 98-101)

and the use of models to generate and analyze data. ● Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5) ● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (SLO-1) - ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ● Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) ● New technologies advance scientific knowledge. (HS-ESS3-5) **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based on empirical evidence. (HS-ESS3-5) ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4),(HS-ESS3-5)	● The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) **ESS2.D: Weather and Climate** (pp. 186-189) ● The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-4) (SLO 1) ● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6) ● Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS- ESS2-6),(HS-ESS2-4) **ESS3.D: Global Climate Change** (pp. 196-198)	● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)

	• Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)	

Connections to other DCIs in this grade-band: **HS.PS1.A** (HS-ESS2-6); **HS.PS1.B** (HS-ESS2-6); **HS.PS3.A** (HS-ESS2-4); **HS.PS3.B** (HS-ESS2-4),(HS-ESS3-5); **HS.PS3.D** (HS-ESS3-5), (HS-ESS2-6); **HS.LS1.C** (HS-ESS3-5), (HS-ESS2-6); **HS.LS2.B** (HS-ESS2-6); **HS.LS2.C** (HS-ESS2-4); **HS.ESS1.C** (HS-ESS2-4); **HS.ESS2.D**(HS-ESS3-5); **HS.ESS3.C** (HS-ESS2-4), (HS-ESS2-6); **HS.ESS3.D** (HS- ESS2-4), (HS-ESS2-6)
Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-ESS2-6); **MS.PS3.A** (HS-ESS2-4); **MS.PS3.B** (HS-ESS2-4),(HS-ESS3-5); **MS.PS3.D** (HS-ESS2-4),(HS-ESS3-5), (HS-ESS2-6); **MS.PS4.B** (HS-ESS2-4), (HS- ESS2-6); **MS.LS1.C** (HS-ESS2-4); **MS.LS2.B** (HS-ESS2-4), (HS-ESS2-6); **MS.LS2.C** (HS-ESS2-4); **MS.ESS2.A** (HS-ESS2-4), (HS-ESS2-6), (MS-ESS3-5); **MS.ESS2.B** (HS- ESS2-4), (HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-4), (HS-ESS2-6); **MS.ESS2.D** (HS-ESS2-4),(HS-ESS3-5);**MS.ESS3.B** (HS-ESS3-5); **MS.ESS3.C** (HS-ESS2-4), (HS-ESS2-6), (HS- ESS3-5); **MS.ESS3.D** (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5)
Connections to Math and ELA Standards: **ELA:** **RI.9-10.1.**Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain. (HS-ESS3-5) **RI.9-10.2**. Determine a central idea of a text and analyze how it is developed and refined by specific details; provide an objective summary of the text. (HS-ESS3-5) **RI.9-10.7.** Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.(HS-ESS3-5) **SL.9-10.5.** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest.(HS-ESS2-4) **MATH:** **MP.2:** Reason abstractly and quantitatively. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5) **MP.4:** Model with mathematics. (HS-ESS2-4), (HS-ESS2-6) **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas;

choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5)
HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5)
HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-4), (HS-ESS2-6), (HS-ESS3-5)

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Climate Change Greenhouse effect Seasons Equinoxes Solstices Oblate spheroid Ozone layer Doppler radar Relative humidity Latent heat Latitude Doldrums Polar easterlies Westerlies Altitude pressure tides Axis Topography Oscillation Poles Rotation Temperature Trade winds Spatial Pattern Temporal Pattern	Circulation Tilt Equator Measure Orientation Computational model timescale navigation phases	*Environmental Science* by Karen Arms, Holt Chapter 12- Air Chapter 13- Atmosphere and Climate Change Online access to internet websites and readings required are below.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	The Great Ocean Conveyor- Demonstration	#1 / Asking questions and defining problems
	Your Own El Nino – Demonstration of global wind patterns, El Nino due to temperature and air pressure fluctuations.	#1 and #4 / Analyzing and interpreting data
	Global Warming Video	#4
EXPLORE	**Examples of Exploring Activities:**	
	Ocean Currents - Students will map the patterns of the major ocean currents. Students will learn about the influences of wind, water temperature, landmasses, and water density on currents.	#1 /Using mathematics and computational thinking
	Energy Efficiency - Any large mass of earth tends to maintain a constant temperature. Students will test how long it takes for a thermometer buried in sand or soil to reach the temperature of surrounding air.	#1 /Analyzing and interpreting data
	Investigating El Nino- Series of five activities to choose from where students use real data to understand El Nino and its interactions with Earth's systems.	#4
EXPLAIN	**Examples of Explaining Activities:**	
	Dangerous Atmosphere – Students will investigate past severe storms based upon region of their choice.	#1-4/Analyzing and interpreting data and Obtaining, evaluating and communicating information
	Carbon Cycle Role Play – Students will be able to recognize that there is a finite amount of carbon on earth. Model how carbon moves around in the environment, from one place to another. Identify how humans influence the carbon cycle.	#3
	El Nino Southern Oscillation (ENSO LAB) - Students will learn about the climate phenomenon and regional impacts that occur on different sides of the Pacific.	#4 /Engaging in argument from evidence

ELABORATE	Examples of Elaborating Activities:	
	Exploring Environment: Drought Problem - Problem-based learning module takes students through a real-world scenario drought in Texas and has them use satellite images and other actual data to answer questions about how Texas and other states should respond to the situation.	#2,3, 4 /Analyzing and interpreting data and Constructing explanations and designing solutions
	Carbon Cycle in the Lab - Students will learn about different carbon sources and sinks and the release and storage processes for each of them.	#3 /Asking questions and defining problems
	Carbon Lab - Students will use the simulator experiment with the human factors that contribute to this rise and explore how different inputs to the carbon cycle might affect the concentrations of the greenhouse gas CO_2.	#3
EVALUATE	**Examples of Evaluating Activities:**	
	Weather and Climate Data Exploration - Students explore the relationship between weather and climate by graphing weather temperature data and comparing with climate averages.	#2 and #4 /Analyzing and interpreting data and Obtaining, evaluating and communication information as well as Using mathematics and computational thinking
	Carbon and Climate – Includes eight different modules that could be used to incorporate carbon and the climate.	#3

Unit #: 4	**Unit Name:** Ecosystem Dynamics	**Unit Length:** 35 days

ESSENTIAL QUESTIONS:

How do organisms interact with their environment?
Why do organisms rely on other organisms for survival?
What are the effects of organism interactions?
How does knowing cycles in nature provide us with better understanding of natural processes that influence our environment?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
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-LS2-1 and LS2.A**
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-LS2-2 and HS-LS2.A & HS-LS2.C**
3	**Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.]	**HS-LS2-4 and LS2.B**

	[Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]	
4	**Evaluate the 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-LS2-6 and LS2.C**
5	**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-LS2-7 and LS2.C & LS4.D**
6	**Evaluate the 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-LS2-8 and LS2.D**
* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.		

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking (pp. 64-67) Students use algebraic thinking and analysis, a range of linear and nonlinear 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	**LS2.A: Interdependent Relationships in Ecosystems** (pp. 150-152) • 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 nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce	**Cause and Effect** (pp. 87-89) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8) **Scale, Proportion, and Quantity** (pp. 91-94) • The significance of a phenomenon is dependent on the scale, proportion,

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) • Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) **Constructing Explanations and Designing Solutions** (pp. 67-71) Students construct 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** (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s).	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.B: Cycles of Matter and Energy Transfer in Ecosystems** (pp. 152-154) • Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)	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) **Energy and Matter** (pp. 94-96) • Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4) **Stability and Change** (pp. 98-101) • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7)

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 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)	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** (pp. 154-156) • 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** (pp. 156-157)	

	• Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS- LS2-8) **LS4.D: Biodiversity and Humans** (pp. 166-167) • 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) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.) **ETS1.B: Developing Possible Solutions** (pp. 206-208)	

	• When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.(secondary to HS-LS2-7)	

Connections to other DCIs in this grade-band:
HS.PS3.B (HS-LS2-4); **HS.PS3.D** (HS-LS2-4); **HS.ESS2.D** (HS-LS2-7);**HS.ESS2.E** (HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **HS.ESS3.A** (HS-LS2-2),(HS-LS2-7); **HS.ESS3.C** (HS- LS2-2),(HS-LS2-7); **HS.ESS3.D** (HS-LS2-2)

Articulation of DCIs across grade-bands:
MS.PS3.D (HS-LS2-4); **MS.LS1.B** (MS-LS2-8); **MS.LS1.C** (HS-LS2-4); **MS.LS2.A** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6); **MS.LS2.B** (HS-LS2-4); **MS.LS2.C**(HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **MS.ESS3.A** (HS-LS2-1); **MS.ESS3.C** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **MS.ESS3.D** (HS-LS2-7)

Connections to Math and ELA Standards:
ELA:
RI.9-10.1. Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain. (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-8)
RI.9-10.7. Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)
RI.9-10.8. Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)
W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. (HS- LS2-1),(HS-LS2-2)
W.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation**.** (HS-LS2-7)

MATH:
MP.2: Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),(HS-LS2-7)

MP.4: Model with mathematics. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4)
HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)
HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)
HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)
HSS-ID.A.1: Represent data with plots on the real number line. (HS-LS2-6)
HSS-IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS- LS2-6)
HSS-IC.B.6: Evaluate reports based on data. (HS-LS2-6)

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Abiotic factor Biotic factor Ecosystem Cellular respiration Photosynthesis Energy- flow Biogeochemical Ecological footprint Non-renewable resource Competition Decomposer Food web Invasive species Producer Community Niche Reproduction Group- behavior Migration Predation Renewable resource	Dominant Isolation Parameters Survival Interdependent Mutually beneficial Pollution Variation	*Environmental Science* by Karen Arms, Holt Chapter 6- Biomes Chapter 7- Aquatic Biomes Chapter 8- Understanding Populations Chapter 10- Biodiversity Online access to internet websites and readings are required below.

Consumer Speciation		

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	7 Billion: Where Do You Stand? - Students articulate their thoughts about the ethical issues related to population reaching seven billion and consider the opinions of their classmates.	#1
	Zebra Mussels- Reading on Invasive Species	#5/ Asking questions and defining problems
	Ecology- Listmania - An introductory discussion where students list ideas or issues related to the environment.	#5
	Can You Hide a Butterfly- Quick lab and scavenger hunt that demonstrates organism's adaptations	#6 /Obtaining, evaluating and communicating information
EXPLORE	**Examples of Exploring Activities:**	
	Where Have All the Eagles Gone? – Graphing on population	#1/Using mathematics and computational thinking
	African Lions: Modeling Populations – Explore exponential and logistic growth models to analyze population data for African lions and identify carrying capacity.	#1/ Analyzing and interpreting data
	Owl Pellet Dissection	#3 / Planning and carrying out investigations
	Evolution of Animal Behavior – Reading and group discussion questions	#6 /Obtaining, evaluating and communicating information
EXPLAIN	**Examples of Explaining Activities:**	
	Human Population Growth – Show how human population trends have changed from pre-industrial revolution to present through graphing.	#1/Using mathematics and computational thinking
	Yeast Population Demonstration – Yeast demo in test tubes, helps to introduce limiting factors and carrying capacity of a population	#1/Asking questions and defining problems
	Predation vs. Starvation – Graphing and Analysis	#2/Analyzing and interpreting data and Using mathematics and computational thinking

	Food Webs – Organizing energy flow from organism to organism, understanding organisms' interactions and need for survival	#3
ELABORATE	**Examples of Elaborating Activities:**	
	The Spread of an Infectious Disease – Simulation demonstrates exponential spread of infectious disease in a population, and discussion questions develop student understanding of how human diseases spread. Additional discussion questions and a graphing activity develop an understanding of exponential and logistic population growth.	#1/Asking questions and defining problems, Using mathematics and computational thinking and Obtaining, evaluating and communicating information
	Grow an Ecosystem – Students grow their own ecosystem to further understand succession on an ecosystem.	#4 /Planning and carrying out investigations
	Bye Bye, Birdie - Students determine which factors should be considered in deciding the fate of endangered species. They then conduct research to find out about an endangered species and prepare a short presentation, justifying the preservation of the species.	#5 /Asking questions and defining problems and Obtaining, evaluating and communicating information
	Beak Adaptation (predator vs. prey lab)	#6 / Obtaining, evaluating and communicating information
	POGIL – Energy Flow Through Ecosystems Student based inquiry learning modules, works best in small groups of three.	#3/ Asking questions and defining problems
EVALUATE	**Examples of Evaluating Activities:**	
	Virtual Lab: Population Biology – Online lab; How does competition affect population growth?	#1 /Analyzing and interpreting data
	Oh What a Tangled Web We Weave – Energy flow in Ecosystems	#3
	Environmental Impact Project- Students thoroughly research a local ecosystem and learn how humans affect that ecosystem. Students form groups and submit competing bids for a development of their choice.	#4 /Constructing explanations and designing solutions

Unit #: 5	**Unit Name:** Human Sustainability	**Unit Length:** 35 days

ESSENTIAL QUESTIONS:

How do man's activities impact our environment and future on Earth?
How do we ensure that we don't run out of natural resources?
What can you do to help maintain a stable Earth?
Is the damage done to the global life support system permanent?
How can the impacts of human activities on natural systems be reduced?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** *[Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]*	**HS-ESS3-1**
2	**Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** *[Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]*	**HS-ESS3-2**
3	**Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** *[Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new*	**HS-ESS3-3**

	*technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [*Assessment Boundary: Assessment for computational simulations is limited to using provided multi- parameter programs or constructing simplified spreadsheet calculations.*]*	
4	**Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** *[Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large- scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]*	**HS-ESS3-4**
5	**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** *[Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [*Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*]*	**HS-ESS3-6**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking (pp. 64-67) Students use algebraic thinking and analysis, a range of linear and nonlinear 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. ● Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) ● Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions** (pp. 67-71) Students construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations,	**ESS2.D: Weather and Climate** (pp. 186-189) ● Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6) **ESS3.A: Natural Resources** (pp. 191-192) ● Resource availability has guided the development of human society. (HS-ESS3-1) ● All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) **ESS3.B: Natural Hazards** (pp. 192-194) ● Natural hazards and other geologic events have shaped the course of	**Cause and Effect** (pp. 87-89) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) **Systems and System Models** (pp. 91-94) • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6) **Stability and Change** (pp. 98-101) • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) - ***Connections to Engineering, Technology, and***

models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS- ESS3-1) ● Design or refine a solution to a complex real- world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4) **Engaging in Argument from Evidence** (pp. 71-74) Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ● Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)	human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** (pp.194-196) ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) **ESS3.D: Global Climate Change** (pp. 196-198) • Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) **ETS1.B: Developing Possible Solutions** (pp. 206-208) • When evaluating solutions, it is important to take into account a range	***Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS- ESS3-4) • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3) • Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2) - **Connections to Nature of Science** **Science is a Human Endeavor**

	of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS3-2),(secondary HS-ESS3-4)	• Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) **Science Addresses Questions About the Natural and Material World** • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) • Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2) • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Connections to other DCIs in this grade-band: **HS.PS1.B** (HS-ESS3-3); **HS.PS3.B** (HS-ESS3-2); **HS.PS3.D** (HS-ESS3-2); **HS.LS2.A** (HS-ESS3-2),(HS-ESS3-3); **HS.LS2.B** (HS-ESS3-2), (HS-ESS3-3),(HS-ESS3-6); **HS.LS2.C**(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.LS4.D** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.ESS2.A** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); **HS.ESS2.E**(HS-ESS3-3)
Articulation of DCIs across grade-bands: **MS.PS1.B** (HS-ESS3-3); **MS.PS3.D** (HS-ESS3-2); **MS.LS2.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.LS2.B** (HS-ESS3-2),(HS-ESS3-3); **MS.LS2.C** (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.LS4.C** (HS-ESS3-3); **MS.LS4.D** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS2.A** (HS-ESS3-1),(HS-ESS3-3),(HS-ESS3- 4),(HS-ESS3-6);**MS.ESS2.A** HS-ESS3-1),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.ESS2.C** (HS-ESS3-6); **MS.ESS3.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **MS.ESS3.B** (HS-ESS3-1),(HS-ESS3-4); **MS.ESS3.C** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **MS.ESS3.D** (HS-ESS3-4),(HS-ESS3-6)
Connections to Math and ELA Standards:

ELA:
RI.9-10.1. Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-4)
RI.9-10.8. Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning. (HS-ESS3-2),(HS-ESS3-4)
W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.(HS- ESS3-1)

MATH:
MP.2: Reason abstractly and quantitatively. (HS-ESS3-1),(HS- ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6)
MP.4: Model with mathematics. (HS-ESS3-3),(HS-ESS3-6)
HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)
HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)
HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-6)

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan				
Content Vocabulary		**Academic Vocabulary**		**Required Resources**
Agriculture	Alternative energy	Computational Model	Constraint	*Environmental Science* by Karen Arms, Holt
Efficiency	Biodiversity	Cost-benefit analysis	Economics	
Commerce	Conservation	Extraction	Optimal	Chapter 14- Land
Deforestation	Disease	Prototype	Regulation	Chapter 15-Food and Agriculture
Natural hazard	Per-capita	Risk- assessment	Simulation	Chapter 17-Nonrenewable Energy
Consumption	Variation	Solution	Technology	Chapter 18- Renewable Energy
Pollutant	Population growth	Value	Waste	

Recycle Rural Sustainability Urbanization Natural resources Urban planning	Yield Endeavor Ethics	Online access to internet websites and readings required below.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Urban Sprawl: A Sim City 4 Demonstration (video to introduce urban sprawl and urbanization)	#4
	Investigating Water Use in Your Home	#3/ Obtaining, evaluating and communicating information
	Man by Steve Cutts (video on human sustainability)	#1
	Disaster Supplies Kit – Students develop an emergency/disaster relief plan.	#1/ Constructing explanations and designing solutions
	Climate Change / Human Impact Discovery Stations: Example Activity to Use: http://www.stumbleupon.com/su/1l1MMA/files.earthday.net/footprint/flash.html Students live in a virtual city and will discover how many planets support their lifestyle.	#1 and #5 / Asking questions and defining problems and Analyzing and interpreting data
EXPLORE	**Examples of Exploring Activities:**	
	One for All: A Natural Resources Game - Identify a strategy that would produce a sustainable use of resources in a simulation game. Draw parallels between the actions of participants in the game and the actions of people or governments in real-world situations.	#4
	Know Your Energy Costs - The goal of this activity is to become aware of how much energy you use at school — and the financial and environmental costs.	#5 /Asking questions and defining problems
	A Bit of Engineering - Discuss the drilling process. Why is it important to keep the core intact? Discuss the need for problem solving when coring the ocean floor. What might happen if sediment is too hard or too soft? What do would likely happen if the drillers or technicians were careless with samples?	#2 /Asking questions and defining problems
	Natural Gas Formation - In this investigation, you will make a simple model of how gases can form from decaying material. You will also explore the effects of temperature on gas formation.	#1 / Develop and using models
	National Climate Assessment - Students explore the simulations found at this website in order to create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	#5 /Using mathematics and computational thinking

EXPLAIN	**Examples of Explaining Activities:**	
	Traveling Nitrogen- In this classroom activity, students play the role of nitrogen atoms traveling through the nitrogen cycle to gain understanding of the varied pathways through the cycle and how nitrogen is relevant to living things.	#5 / Obtaining, evaluating and communicating information
	Eutrophication Lab – Textbook pgs.204-205	#2/ Planning and carrying out investigations
	Solid Waste in Your Lunch- Compute percentages of waste, by category, produced per person in a single meal. Generalize data from a small sample for a large population using calculators. Infer from small data samples the impact that waste production has on a large population. Evaluate how waste data can be used to communicate results and offer solutions.	#2 and #4 / Using mathematics and computational thinking
ELABORATE	**Examples of Elaborating Activities:**	
	Reefs at Risk - Students access and explore a series of interactive maps displaying coral reef data from around the globe and develop hypotheses related to the impacts of climate change (i.e. increased levels of carbon dioxide in our atmosphere) on coral reef health.	#5 /Asking questions and defining problems
	Schoolyard Biodiversity - Students assess the biodiversity in their schoolyards, and apply their model outputs to predict the changes in biodiversity as related to human impacts and the application of sustainable practices.	#3 /Planning and carrying out investigations
EVALUATE	**Examples of Evaluating Activities:**	
	Build A City – Create a model to understand the effects of urban sprawl on the environment. (pgs.402-403 in Holt textbook- *Create a Land-Use Model*) http://www.planitgreenlive.com/en/plan-it-green-trailer - Plan It Green Live is the ultimate in online educational video games. Make your own unique city. Manage the city's infrastructure and make improvements to create a sustainable and happy place for your citizens to live. Watch the Plan It Green Live trailer below to learn more.	#4 /Constructing explanations and designing solutions and Obtaining, evaluating and communicating information

	NSA Challenge: Recycle for A Cleaner World - Students will develop a strategy to increase recycling and waste diversion for their school.	#1, #2, and #4 /Constructing explanations and designing solutions and Obtaining, evaluating and communicating information