Kinnelon Public School Curriculum Scope and Sequence

Curriculum Scope and Sequence			
Content Area	Science	**Course Title/Grade Level**	Environmental Science – 9 CP/CP CORE

General Overview and Pacing		
Topic/Unit Name		**Suggested Pacing (Days/Weeks)**
Topic/Unit 1	Literacy in Science	Ongoing
Topic/Unit 2	Introduction to Environmental Science and Environmental Issues	2 blocks
Topic/Unit 3.1	Earth's Physical Geography-Plate Tectonics	8 blocks
Topic/Unit 3.2	Earth Physical Geography-Land and Ocean Floor Features	8 blocks
Topic/Unit 3.3	Earth Physical Geography-Earth Internal Cycling of Matter	8 blocks
Topic/unit 3.4	Earth Physical Geography-Water's Effect on Earth Materials and Surface Properties	8 blocks
Topic/Unit 4.1	Global Climate Change-Global Warming and Feedback Loops	8 blocks
Topic/Unit 4.2	Global Climate Change-Energy Flow	8 blocks
Topic/Unit 4.3	Global Climate Change-Global Climate Models	8 blocks
Topic/Unit 5.1	Human Influence on the Planet-Natural Resources and Hazards	8 blocks
Topic/Unit 5.2	Human Influence on the Planet-Energy and Mineral Resources	8 blocks
Topic/Unit 5.3	Human Influence on the Planet-Human Population	8 blocks
Topic/Unit 5.4	Human Influence on the Planet-Pollution(Air, Soil)	16 blocks
Topic/Unit 5.4	Human Influence on the Planet-Water Pollution/Computation Models-Ocean Acidification	16 blocks

CREATED BY	Hope Kowalski	**DATE**	July 2016	**BOARD APPROVAL DATE**	10/27/2016

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Unit/Topic Title	**Literacy in Science**	**Approximate Pacing**	**Ongoing**
UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS			
Students will understand that: ● Reading is critical to building knowledge in science. ● Writing is a key means of asserting and defending claims, showing what they know about science, and conveying what they have experienced.			
NEW JERSEY STUDENT LEARNING STANDARDS			
NJSLS	RST.9-10 WHST.9-10		
NJSLS#	**STANDARD LANGUAGE**		
RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.		
RST.9-10.2.	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.		
RST.9-10.3.	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.		
RST.9-10.4.	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.		
RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).		
RST.9-10.6	. Determine the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.		
RST.9-10.7.	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.		
RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.		
RST.9-10.9.	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.		
RST.9-10.10.	By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.		
WHST.9-10.1.	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.		
WHST.9-10.2.	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.		
WHST.9-10.4.	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.		

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WHST.9-10.5.	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
WHST.9-10.6.	Use technology, including the Internet, to produce, share, and update writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
WHST.9-10.7.	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
WHST.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.
WHST.9-10.9.	Draw evidence from informational texts to support analysis, reflection, and research.
WHST.9-10.10.	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

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Unit/Topic Title	Unit 2 – Introduction to Environmental Science	**Approximate Pacing**	~2 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

Environmental scientist observe and investigate human impact on the earth system. They evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

New Jersey Student Learning Standards-S

NJSLS-S	
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

NJSLS#	**STANDARD LANGUAGE**

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
• 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.	**ESS3.C: Human Impacts on Earth Systems** • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ETS1.B: Developing Possible Solutions** • 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)*	**Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT

Are concepts being introduced, reviewed, or mastered in this Unit/topic?

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Key Knowledge	Process/Skills/Procedures/Application of Key Knowledge
Students will know: • Explain human impact on planet earth and describe how scientist use technology to study the earth. • Explain how the scientists document the impacts of human activities in the form of pollutants released, changes in biomass and species diversity, areal changes in land surface use, agricultural and livestock or surface mining.	***Students will be able to:*** 1. Students use scientific information to generate a number of possible refinements to a given technological solution. a. Describe the system being impacted and how the human activity is affecting that system; b. Identify the scientific knowledge and reasoning on which the solution is based; c. Describe how the technological solution functions and may be stabilizing or destabilizing the natural system; d. Refine a given technological solution that reduces human impacts on natural systems; and e. Describe that the solution being refined comes from scientists and engineers in the real world who develop technologies to solve problems of environmental degradation.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at the end of the unit/chapter.
Formative Assessments	Activity: Environmental Problem ranking/class discussion groups
RESOURCES	
The Habitable Planet by Annenberg – Unit 1, Section 1 http://www.learner.org/courses/envsci/ Unit 13: Looking Forward: Our Global Experiment // Section 1: Introduction- video introduction (28:28)	

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Unit/Topic Title	Unit 3.1 Earth's Physical Geography-Plate Tectonics	**Approximate Pacing**	~10 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

The 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.

New Jersey Student Learning Standards-S

NJSLS-S	HS-EES1-5
NJSLS#	**STANDARD LANGUAGE**
HS-ESS1-5	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.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Engaging in Argument from Evidence ● Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**ESS1.C: The History of Planet Earth** ● 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. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● 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)* **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● 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. 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)* **PS1.C: Nuclear Processes** ● 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)*	**Patterns** ● Empirical evidence is needed to identify patterns.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**

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CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: ● How to 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.	1. Identifying the given explanation and the supporting evidence a. Students identify the given explanation, which includes the following idea: that crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and formation of new rocks from magma rising where plates are moving apart. b. Students identify the given evidence to be evaluated. 2. Identifying any potential additional evidence that is relevant to the evaluation a. Students identify and describe additional relevant evidence (in the form of data, information, models, or other appropriate forms) that was not provided but is relevant to the explanation and to evaluating the given evidence, including: i. Measurement of the ratio of parent to daughter atoms produced during radioactive decay as a means for determining the ages of rocks; ii. Ages and locations of continental rocks; iii. Ages and locations of rocks found on opposite sides of mid-ocean ridges; and iv. The type and location of plate boundaries relative to the type, age, and location of crustal rocks. 3. Evaluating and critiquing a. Students use their additional evidence to assess and evaluate the validity of the given evidence. b. Students evaluate the reliability, strengths, and weaknesses of the given evidence along with its ability to support logical and reasonable arguments about the motion of crustal plates. 4. Reasoning/synthesis a. Students describe how the following patterns observed from the evidence support the explanation about the ages of crustal rocks: i. The pattern of the continental crust being older than the oceanic crust; ii. The pattern that the oldest continental rocks are located at the center of continents, with the ages decreasing from their centers to their margin; and iii. The pattern that the ages of oceanic crust are greatest nearest the continents and decrease in age with proximity to the mid-ocean ridges. iv. The oldest crustal rocks are found on the continents because oceanic crust is constantly being destroyed at places where plates are coming together, such as subduction zones. b. Students synthesize the relevant evidence to describe* the relationship between the motion of

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	continental plates and the patterns in the ages of crustal rocks, including that: i. At boundaries where plates are moving apart, such as mid-ocean ridges, material from the interior of the Earth must be emerging and forming new rocks with the youngest ages. ii. The regions furthest from the plate boundaries (continental centers) will have the oldest rocks because new crust is added to the edge of continents at places where plates are coming together, such as subduction zones. iii. The oldest, crustal rocks are found on the continents because oceanic crust is constantly being destroyed at places where plates are coming together, such as subduction zones.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at the end of the unit/chapter. Labs: Pangea activity, radioactive half-life activity,
Formative Assessments	locating plate boundaries using maps, and video clips/animations
RESOURCES	
Google Earth Chapter 33: Our Restless Planet in Conceptual Physical Science Exploration by Hewitt, Suchocki, and Hewitt Chapter 19 section 19.4-19.6 Radioactivity half-life text in Ch. 36 Section 36.3 of the Conceptual Physical Science Exploration textbook http://www.ucmp.berkeley.edu/geology/tectonics.html http://pubs.usgs.gov/of/1999/ofr-99-0132/ http://science.nasa.gov/earth-science/earth-science-at-nasa/	

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Unit/Topic Title	Unit 3.2– Earth's Physical Geography-Continental and Ocean Floor	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- The appearance of land features and sea-floor features are a result of both constructive forces and destructive mechanism.

New Jersey Learning Standards-S

NJSLS-S	HS-EES2-1
NJSLS#	**STANDARD LANGUAGE/**
HS-ESS2-1	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.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Developing and Using Models ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**ESS2.A: Earth Materials and Systems** ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● 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. 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)*	**Stability and Change** ● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know:	***Students will be able to:*** 1. Use evidence to develop a model in which they identify and describe the following components:

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• That the Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	a. Descriptions and locations of specific continental features and specific ocean-floor features; b. A geographic scale, showing the relative sizes/extents of continental and/or ocean- floor features; c. Internal processes (such as volcanism and tectonic uplift) and surface processes (such as weathering and erosion); and d. A temporal scale showing the relative times over which processes act to produce continental and/or ocean-floor features. 2. Describe the relationships between components in the model, including: a. Specific internal processes, mainly volcanism, mountain building or tectonic uplift, are identified as causal agents in building up Earth's surface over time. b. Specific surface processes, mainly weathering and erosion, are identified as causal agents in wearing down Earth's surface over time. c. Interactions and feedbacks between processes are identified (e.g., mountain-building changes weather patterns that then change the rate of erosion of mountains). d. The rate at which the features change is related to the time scale on which the processes operate. Features that form or change slowly due to processes that act on long time scales (e.g., continental positions due to plate drift) and features that form or change rapidly due to processes that act on short time scales (e.g., volcanic eruptions) are identified. 3. Students use the model to illustrate the relationship between 1) the formation of continental and ocean floor features and 2) Earth's internal and surface processes operating on different temporal or spatial scales.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Identifying and labeling appropriate features with explanations to the reason for the location.
Formative Assessments	Demos: Sea Floor Spreading, Plate Interactions, video clips/animations
RESOURCES	
Google earth Chapter 32: Architecture of the Earth in Conceptual Physical Science by Hewitt, Suchocki, and Hewitt The Habitable Planet by Annenberg – Unit 1 section 3 Reading Geologic Records http://www.learner.org/courses/envsci/	

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Unit/Topic Title	Unit 3.3 - Earth's Physical Geography- Earth Internal Cycling of Matter	Approximate Pacing	~8 blocks
UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS			
Students will understand that: ● Matter is cycled by thermal convention in the Earth's interior			
New Jersey Student Learning Standards-S			
NJSLS	HS-EES2-3		
NJSLS#	**STANDARD LANGUAGE**		
HS-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.		

Science and Engineering Practices	Disciplinary Core Idea	Cross Cutting Concepts
Developing and Using Models ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based on empirical evidence. • Science disciplines share common rules of evidence used to evaluate explanations about natural systems. • Science includes the process of coordinating patterns of evidence with current theory.	**ESS2.A: Earth Materials and Systems** • 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. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● 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. 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)*	**Energy and Matter** Energy drives the cycling of matter within and between systems. - ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

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21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)	
NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	Process/Skills/Procedures/Application of Key Knowledge
Students will know: ● The matter is cycled by thermal convention in the Earth's interior	***Students will be able to:*** 1. Students develop a model (i.e., graphical, verbal, or mathematical) in which they identify and describe the components based on both seismic and magnetic evidence (e.g., the pattern of the geothermal gradient or heat flow measurements) from Earth's interior, including: a. Earth's interior in cross-section and radial layers (crust, mantle, liquid outer core, solid inner core) determined by density; b. The plate activity in the outer part of the geosphere; c. Radioactive decay and residual thermal energy from the formation of the Earth as a source of energy; d. The loss of heat at the surface of the earth as an output of energy; and e. The process of convection that causes hot matter to rise (move away from the center) and cool matter to fall (move toward the center). 2. Relationships a. Students describe the relationships between components in the model, including: b. Energy released by radioactive decay in the Earth's crust and mantle and residual thermal energy from the formation of the Earth provide energy that drives the flow of matter in the mantle. c. Thermal energy is released at the surface of the Earth as new crust is formed and cooled. d. The flow of matter by convection in the solid mantle and the sinking of cold, dense crust back into the mantle exert forces on crustal plates that then move, producing tectonic activity. e. The flow of matter by convection in the liquid outer core generates the Earth's magnetic field. f. Matter is cycled between the crust and the mantle at plate boundaries. Where plates are pushed together, cold crustal material sinks back into the mantle, and where plates are pulled apart, mantle material can be integrated into the crust, forming new rock. 3. Connections

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	a. Students use the model to describe the cycling of matter by thermal convection in Earth's interior, including: b. The flow of matter in the mantle that causes crustal plates to move; c. The flow of matter in the liquid outer core that generates the Earth's magnetic field, including evidence of polar reversals (e.g., seafloor exploration of changes in the direction of Earth's magnetic field); d. The radial layers determined by density in the interior of Earth; and e. The addition of a significant amount of thermal energy released by radioactive decay in Earth's crust and mantle. .
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Lab: Earthquake wave activity
Formative Assessments	Convection demonstrations, magnetic pole reversal demonstration, Video clips/animations
RESOURCES	
Chapter 32: The Architecture of the Earth in Conceptual Physical Science by Hewitt, Suchocki, and Hewitt Pgs. 153-154 on Convection in the Conceptual Physical Science textbook	

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Unit/Topic Title	Unit 3.4- Earth's Physical Geography – Water's Effect on Earth Materials and Surface Properties	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- The many forces and processes that interact in the hydrosphere, geosphere, atmosphere and lithosphere cause the Earth to be a dynamic planet.

New Jersey Student Learning Standards-S

NJSLS-S	HS-ESS2-5
NJSLS#	**STANDARD LANGUAGE**
HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Planning and Carrying Out Investigations ● 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.	**ESS2.C: The Roles of Water in Earth's Surface Processes** ● 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.	**Structure and Function** ● 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.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT

Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know:	***Students will be able to:***

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• The properties of water and its effects on Earth materials and surface processes.	1. Identifying the phenomenon to be investigated Students describe* the phenomenon under investigation, which includes the following idea: a connection between the properties of water and its effects on Earth materials and surface processes. 2. Students develop an investigation plan and describe* the data that will be collected and the evidence to be derived from the data, including: a. Properties of water, including: i. The heat capacity of water; ii. The density of water in its solid and liquid states; and iii. The polar nature of the water molecule due to its molecular structure. b. The effect of the properties of water on energy transfer that causes the patterns of temperature, the movement of air, and the movement and availability of water at Earth's surface. c. Mechanical effects of water on Earth materials that can be used to infer the effect of water on Earth's surface processes. Examples can include: i. Stream transportation and deposition using a stream table, which can be used to infer the ability of water to transport and deposit materials; ii. Erosion using variations in soil moisture content, which can be used to infer the ability of water to prevent or facilitate movement of Earth materials; and iii. The expansion of water as it freezes, which can be used to infer the ability of water to break rocks into smaller pieces. d. Chemical effects of water on Earth materials that can be used to infer the effect of water on Earth's surface processes. Examples can include: i. The solubility of different materials in water, which can be used to infer chemical weathering and recrystallization; ii. The reaction of iron to rust in water, which can be used to infer the role of water in chemical weathering; iii. Data illustrating that water lowers the melting temperature of most solids, which can be used to infer melt generation; and iv. Data illustrating that water decreases the viscosity of melted rock, affecting the movement of magma and volcanic eruptions. e. In their investigation plan, students describe how the data collected will be relevant to determining the effect of water on Earth materials and surface processes. 3. In their investigation plan, students include a means to indicate or measure the predicted effect of water on Earth's materials or surface processes. Examples include: a. The role of the heat capacity of water to affect the temperature, movement of air and movement of water at the Earth's surface; b. The role of flowing water to pick up, move and deposit sediment; c. The role of the polarity of water (through cohesion) to prevent or facilitate erosion. d. The role of the changing density of water (depending on physical state) to facilitate the breakdown of rock;

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	e. The role of the polarity of water in facilitating the dissolution of Earth materials; f. Water as a component in chemical reactions that change Earth materials; and g. The role of the polarity of water in changing the melting temperature and viscosity of rocks. 4. Students collect and record measurements or indications of the predicted effect of a property of water on Earth's materials or surface. a. Students evaluate the accuracy and precision of the collected data. b. Students evaluate whether the data can be used to infer the effect of water on processes in the natural world. c. If necessary, students refine the plan to produce more accurate and precise data.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Stream Table Investigation, Physical and chemical weathering of rocks,
Formative Assessments	Demonstrations of the properties of water, rock cycle activity Video clips/animations
RESOURCES	
Google Earth Chapter 34: Water on Our World sections: 34.1, 34.3, & 34.4, Chapter 35: Our Natural landscape sections: 35.3, 35.4, & 35.6 Pg. 146-7 Expansion of water and Pgs. 141-143 Specific Heat of Water GLOBE: http://www.globe.gov/do-globe/globe-teachers-guide/teachers-guide-search	

Kinnelon Public School Curriculum Scope and Sequence

Unit/Topic Title	Unit 4.1 - Global Climate Change-Earth Feedback Loops	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- Earth feedback loops causes changes to other Earth systems.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-ESS2-2
NJSLS#	**STANDARD LANGUAGE**
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Analyzing and Interpreting 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.	**ESS2.A: Earth Materials and Systems** ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.D: Weather and Climate** ● 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.	**Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ● New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

Kinnelon Public School Curriculum Scope and Sequence

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT *Are concepts being introduced, reviewed, or mastered in this Unit/topic?*	
Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: ● Earth feedback loops causes changes to other Earth systems.	*Students will be able to:* 1. Organizing data a. Students organize data that represent measurements of changes in hydrosphere, cryosphere, atmosphere, biosphere or geosphere in response to a change in Earth's surface. b. Students describe what each data set represents. 2. Identifying relationships a. Students use tools, technologies, and/or models to analyze the data and identify and describe relationships in the datasets, including: i. The relationships between the changes in one system and changes in another (or within the same) Earth system; and ii. Possible feedbacks, including one example of feedback to the climate. b. Students analyze data to identify effects of human activity and specific technologies on Earth's systems if present. 3. Interpreting data a. Students use the analyzed data to describe a mechanism for the feedbacks between two of Earth's systems and whether the feedback is positive or negative, increasing (destabilizing) or decreasing (stabilizing) the original changes. b. Students use the analyzed data to describe a particular unanticipated or unintended effect of a selected technology on Earth's systems if present. c. Students include a statement regarding how variation or uncertainty in the data (e.g., limitations, accuracy, any bias in the data resulting from choice of sample, scale, instrumentation, etc.) may affect the interpretation of the data.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Season change in sunlight, Geologic Time Scale Activity, Data in the Classroom-El Nino
Formative Assessments	Demonstrations Video clips/animations
RESOURCES	
Google Earth Chapter 36: A Brief History of the Earth in Conceptual Physical Science by Hewitt, Suchocki, and Hewitt. Detail of sections 36.1-3 use to explain how the Earth's atmosphere and surface has changed over time to explain changes in Earth over decades, hundreds of years, thousands of years in million/billion years. Chapter 34: The Atmosphere, the Oceans and Their Interactions in Conceptual Physical Science by Hewitt, Suchocki, and Hewitt. Use to support how the input of energy changes the output of energy and their connections to climate change.	

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The Habitable planet by Annenberg – Unit 12 Earth's Changing Climate. http://www.learner.org/courses/envsci/

Data in the Classroom
El Nino: http://dataintheclassroom.noaa.gov/SitePages/el-nino/index#.V9AzY7VlorU

Kinnelon Public School Curriculum Scope and Sequence

Unit/Topic Title	Unit 4.2 - Global Climate Change-Energy Flow	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- The variations in the flow of energy into and out of Earth's systems result in changes in climate.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-ESS2-4
NJSLS#	**STANDARD LANGUAGE**
HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Developing and Using Models ● Use a model to provide mechanistic accounts of phenomena. - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	**ESS1.B: Earth and the Solar System** ● 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)* **ESS2.A: Earth Materials and Systems** ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.D: Weather and Climate** ● 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.	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.

Kinnelon Public School Curriculum Scope and Sequence

CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: ● The variations in the flow of energy into and out of Earth's systems result in changes in climate.	***Students will be able to:*** 1. Components of the model: a. From the given model, students identify and describe the components of the model relevant for their mechanistic descriptions. b. Given models include at least one factor that affects the input of energy, at least one factor that affects the output of energy, and at least one factor that affects the storage and redistribution of energy. Factors are derived from the following list: i. Atmospheric composition (including amount of water vapor and CO2); ii. Atmospheric circulation; iii. Changes in extent or type of vegetation cover; and iv. Human activities. c. From the given model, students identify the relevant different time scales on which the factors operate. 2. Relationships a. Students identify and describe the relationships between components of the given model, and organize the factors from the given model into three groups: i. Those that affect the input of energy; ii. Those that affect the output of energy; and iii. Those that affect the storage and redistribution of energy b. Students describe the relationships between components of the model as either causal or correlational. 3. Connections a. Students use the given model to provide a mechanistic account of the relationship between energy flow in Earth's systems and changes in climate, including: i. The specific cause and effect relationships between the factors and the effect on energy flow into and out of Earth's systems; and ii. The net effect of all of the competing factors in changing the climate.

EVIDENCE OF LEARNING

Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: The Greenhouse Effect Lab, Melting Glaciers-Teaching box
Formative Assessments	Demonstrations Video clips/animations

Kinnelon Public School Curriculum Scope and Sequence

	Carbon Cycle Game & Biogeochemical cycle relationships
RESOURCES	
The Habitable Planet by Annenberg – Unit 2 Atmosphere http://www.learner.org/courses/envsci/ Google Earth – rewind Antarctic ice shelf to show global ice change over time. Climate & Water Teaching Box-Melting Glaciers https://scied.ucar.edu/teaching-box/climate-water	

Kinnelon Public School Curriculum Scope and Sequence

Unit/Topic Title	Unit 4.3 - Global Climate Change-Global Climate Models	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- Altering any part of the Earth's interconnected systems impacts the planet's ability to adapt to the new variables being added/subtracted from the planet resulting in Global Climate Change.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-ESS3-5
NJSLS#	**STANDARD LANGUAGE**
HS-ESS3-5	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.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Analyzing and Interpreting 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. - **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. ● New technologies advance scientific knowledge. **Scientific Knowledge is Based on Empirical Evidence** ● Science knowledge is based on empirical evidence. ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	**ESS3.D: Global Climate Change** ● 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.	**Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. -

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

Kinnelon Public School Curriculum Scope and Sequence

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT *Are concepts being introduced, reviewed, or mastered in this Unit/topic?*	
Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: ● How to 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.	***Students will be able to:*** 1. Students organize data (e.g., with graphs) from global climate models (e.g., computational simulations) and climate observations over time that relate to the effect of climate change on the physical parameters or chemical composition of the atmosphere, geosphere, hydrosphere, or cryosphere. Students describe what each data set represents. 2. Students analyze the data and identify and describe relationships within the datasets, including: a. Changes over time on multiple scales; and b. Relationships between quantities in the given data. 3. Interpreting Data a. Students use their analysis of the data to describe a selected aspect of present or past climate and the associated physical parameters (e.g., temperature, precipitation, sea level) or chemical composition (e.g., ocean pH) of the atmosphere, geosphere, hydrosphere or cryosphere. b. Students use their analysis of the data to predict the future effect of a selected aspect of climate change on the physical parameters (e.g., temperature, precipitation, sea level) or chemical composition (e.g., ocean pH) of the atmosphere, geosphere, hydrosphere or cryosphere. c. Students describe whether the predicted effect on the system is reversible or irreversible. d. Students identify one source of uncertainty in the prediction of the effect in the future of a selected aspect of climate change. e. In their interpretation of the data, students: i. Make a statement regarding how variation or uncertainty in the data (e.g., limitations, accuracy, any bias in the data resulting from choice of sample, scale, instrumentation, etc.) may affect the interpretation of the data; and ii. Identify the limitations of the models that provided the simulation data and ranges for their predictions.

EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Glacier change lab. Lab: Ice core data
Formative Assessments	Demonstrations Video clips/animations
RESOURCES	

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Google Earth – measuring change in global ice coverage
The Habitable Planet by Annenberg – Unit 2 and 12 http://www.learner.org/courses/envsci/

GLOBE
https://scied.ucar.edu/teaching-box/climate-water
Data in the Classroom (NOAA)
Sea Level; http://dataintheclassroom.noaa.gov/SitePages/sea-level/index#.V9AyarVlorU

Unit/Topic Title	Unit 5.1 - Human Influence on the Planet-Natural Resource and Hazards	**Approximate Pacing**	8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-EES3-1
NJSLS#	**STANDARD LANGUAGE**
HS-ESS3-1	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.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Constructing Explanations and Designing Solutions ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, 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.	**ESS3.A: Natural Resources** ● Resource availability has guided the development of human society. **ESS3.B: Natural Hazards** ● Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● Modern civilization depends on major technological systems.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.

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CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: ● How to 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.	Students will be able to: 1. Students construct an explanation that includes: a. Specific cause and effect relationships between environmental factors (natural hazards, changes in climate, and the availability of natural resources) and features of human societies including population size and migration patterns; and b. That technology in modern civilization has mitigated some of the effects of natural hazards, climate, and the availability of natural resources on human activity. 2. Evidence a. Students identify and describe the evidence to construct their explanation, including: i. Natural hazard occurrences that can affect human activity and have significantly altered the sizes and distributions of human populations in particular regions; ii. Changes in climate that affect human activity (e.g., agriculture) and human populations, and that can drive mass migrations; iii. Features of human societies that have been affected by the availability of natural resources; and iv. Evidence of the dependence of human populations on technological systems to acquire natural resources and to modify physical settings. b. Students use a variety of valid and reliable sources for the evidence, potentially including theories, simulations, peer review, or students' own investigations. 3. Reasoning a. Students use reasoning that connects the evidence, along with 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, to describe: i. The effect of natural hazards, changes in climate, and the availability of natural resources on features of human societies, including population size and migration patterns; and ii. How technology has changed the cause and effect relationship between the development of human society and natural hazards, climate, and natural resources. b. Students describe reasoning for how the evidence allows for the distinction between causal and correlational relationships between environmental factors and human activity.

EVIDENCE OF LEARNING

Summative Assessment	Appropriate assessment at end of unit/chapter.

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	Labs: Biodiversity lab-GLOBE Land Cover Interactive Ecosystem Lab- https://www.learner.org/courses/envsci/interactives/ecology/
Formative Assessments	Demonstrations Video clips/animations
RESOURCES	
Google Earth The Habitable Planet by Annenberg – Unit 9 http://www.learner.org/courses/envsci/ GLOBE: Biosphere-Land cover http://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867717/3099387	

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Unit/Topic Title	Unit 5.2 - Human Influence on the Planet –Energy and Mineral Resources	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand

- How to evaluate competing design solution for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-EES3-2
NJSLS#	**STANDARD LANGUAGE**
HS-ESS3-2	Evaluate competing design solution for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Engaging in Argument from Evidence ● 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).	● **ESS3.A: Natural Resources** ● 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. **ETS1.B: Developing Possible Solutions** ● 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)*	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● Modern civilization depends on major technological systems. ● New technologies can have deep impacts on society and the environment, including some that were not anticipated ● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. ● Analysis of costs and benefits is a critical aspect of decisions about technology. --- **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.

		• 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. • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)	
NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: • How to evaluate competing design solution for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios	***Students will be able to:*** 1. Supported claims a. Students describe the nature of the problem each design solution addresses. b. Students identify the solution that has the most preferred cost-benefit ratios. 2. Identifying scientific evidence a. Students identify evidence for the design solutions, including: i. Societal needs for that energy or mineral resource; ii. The cost of extracting or developing the energy reserve or mineral resource; iii. The costs and benefits of the given design solutions; and iv. The feasibility, costs, and benefits of recycling or reusing the mineral resource, if applicable. 3. Evaluation and critique a. Students evaluate the given design solutions, including: i. The relative strengths of the given design solutions, based on associated economic, environmental, and geopolitical costs, risks, and benefits; ii. The reliability and validity of the evidence used to evaluate the design solutions; and

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	iii. Constraints, including cost, safety, reliability, aesthetics, cultural effects environmental effects. 4. Reasoning/synthesis a. Students use logical arguments based on their evaluation of the design solutions, costs and benefits, empirical evidence, and scientific ideas to support one design over the other(s) in their evaluation. b. Students describe that a decision on the "best" solution may change over time as engineers and scientists work to increase the benefits of design solutions while decreasing costs and risks.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Cookie mining Lab: Plastics and recycling Lab: Alternative Technologies GLOBE: Land Cover
Formative Assessments	Demonstrations Video clips/animations GLOBE activities and data
RESOURCES	
Google Earth – mining and reclamation locations The Habitable Planet by Annenberg – Unit 10 http://www.learner.org/courses/envsci/ GLOBE Land cover and remote sensing http://www.globe.gov/do-globe/for-teachers/globe-video	

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Unit/Topic Title	Unit 5.3 - Human Influence on the Planet-Human Population	**Approximate Pacing**	~8 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- computational simulation are used to illustrate the relationships among management of natural resources, the sustainability of human population and biodiversity.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-ESS3-3
NJSLS#	**STANDARD LANGUAGE**
HS-ESS3-3	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human population and biodiversity.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Using Mathematics and Computational Thinking ● Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**ESS3.C: Human Impacts on Earth Systems** ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	**Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● Modern civilization depends on major technological systems. ● New technologies can have deep impacts on society and the environment, including some that were not anticipated --- ***Connections to Nature of Science*** **Science is a Human Endeavor** ● Science is a result of human endeavors, imagination, and creativity.

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)

Kinnelon Public School Curriculum Scope and Sequence

NJSLS#	STANDARD LANGUAGE
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	Process/Skills/Procedures/Application of Key Knowledge
Students will know: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	***Students will be able to:*** 1. Representation a. Students create a computational simulation (using a spreadsheet or a provided multi- parameter program) that contains representations of the relevant components, including: i. A natural resource in a given ecosystem; ii. The sustainability of human populations in a given ecosystem; iii. Biodiversity in a given ecosystem; and iv. The effect of a technology on a given ecosystem. 2. Computational modeling a. Students describe simplified realistic (corresponding to real-world data) relationships between simulation variables to indicate an understanding of the factors (e.g., costs, availability of technologies) that affect the management of natural resources, human sustainability, and biodiversity. (For example, a relationship could be described that the amount of a natural resource does not affect the sustainability of human populations in a given ecosystem without appropriate technology that makes use of the resource; or a relationship could be described that if a given ecosystem is not able to sustain biodiversity, its ability to sustain a human population is also small.) b. Students create a simulation using a spreadsheet or provided multi-parameter program that models each component and its simplified mathematical relationship to other components. Examples could include: i. S=C*B*R*T, where S is sustainability of human populations, C is a constant, B is biodiversity, R is the natural resource, and T is a technology used to extract the resource so that if there is zero natural resource, zero technology to extract the resource, or zero biodiversity, the sustainability of human populations is also zero; and ii. B=B1+C*T, where B is biodiversity, B1 is a constant baseline biodiversity, C is a constant that expresses the effect of technology, and T is a given technology, so that a given technology could either increase or decrease biodiversity depending on the value chosen for C. c. The simulation contains user-controlled variables that can illustrate relationships among the components (e.g., technology having either a positive or negative effect on biodiversity).

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	3. Analysis a. Students use the results of the simulation to: i. Illustrate the effect on one component by altering other components in the system or the relationships between components; ii. Identify the effects of technology on the interactions between human populations, natural resources, and biodiversity; and iii. Identify feedbacks between the components and whether or not the feedback stabilizes or destabilizes the system. b. Students compare the simulation results to a real world example(s) and determine if the simulation can be viewed as realistic. c. Students identify the simulation's limitations relative to the phenomenon at hand.
EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Population dynamics https://www.learner.org/courses/envsci/unit/unit_lab.php?unit=5 GLOBE: Green up/Green Down, Land cover analysis
Formative Assessments	Demonstrations Video clips/animations GLOBE activities and data
RESOURCES	
Google Earth The Habitable Planet by Annenberg –http://www.learner.org/courses/envsci/ Unit 4 and Unit 5 GLOBE: Biosphere http://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867717/3099387	

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Unit/Topic Title	Unit 5.4 - Human Influence on the Planet-Pollution (Air/Soil)	**Approximate Pacing**	~16 blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- Human activity is affecting that Earth system in the form of air and soil pollution.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-EES3-4
NJSLS#	**STANDARD LANGUAGE**
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Constructing Explanations and Designing Solutions ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, 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. **Engaging in Argument from Evidence** ● 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). **Using Mathematics and Computational Thinking** ● Use a computational representation of phenomena or design solutions to describe	**ESS3.C: Human Impacts on Earth Systems** ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ETS1.B: Developing Possible Solutions** ● 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)*	**Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

and/or support claims and/or explanations.		

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)	
NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT
Are concepts being introduced, reviewed, or mastered in this Unit/topic?

Key Knowledge	Process/Skills/Procedures/Application of Key Knowledge
Students will know: • Evaluate or refine a technological solution that reduces impacts of human activities on natural systems	***Students will be able to:*** 1. Using scientific knowledge to generate the design solution a. Students use scientific information to generate a number of possible refinements to a given technological solution. Students: i. Describe* the system being impacted and how the human activity is affecting that system(Systems: air, water, soil); ii. Identify the scientific knowledge and reasoning on which the solution is based; iii. Describe how the technological solution functions and may be stabilizing or destabilizing the natural system; iv. Refine a given technological solution that reduces human impacts on natural systems; and v. Describe that the solution being refined comes from scientists and engineers in the real world who develop technologies to solve problems of environmental degradation. 2. Describing criteria and constraints, including quantification when appropriate a. Students describe and quantify (when appropriate): b. Criteria and constraints for the solution to the problem; and i. The tradeoffs in the solution, considering priorities and other kinds of research-driven tradeoffs in explaining why this particular solution is or is not needed. ii. Evaluating potential refinements 3. In their evaluation, students describe how the refinement will improve the solution to increase benefits and/or decrease costs or risks to people and the environment. a. Students evaluate the proposed refinements for: i. Their effects on the overall stability of and changes in natural systems; and ii. Cost, safety, aesthetics, and reliability, as well as cultural and environmental impacts.

Kinnelon Public School Curriculum Scope and Sequence

EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: water pollution labs, air pollution labs, soil pollution labs
Formative Assessments	Demonstrations Video clips/animations

RESOURCES

Google Earth
The Habitable Planet by Annenberg – http://www.learner.org/courses/envsci/
Unit 8 Water Resources
Unit 11 Atmospheric Pollution
Unit 7 Agriculture

GLOBE:
Air Quality
http://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867642/12267

https://scied.ucar.edu/teaching-box/air-quality

Soil Quality
http://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867724/12276

Videos
http://www.globe.gov/do-globe/for-teachers/globe-videos

Kinnelon Public School Curriculum Scope and Sequence

Unit/Topic Title	Unit 5.5 - Human Influence on the Planet-Water Pollution & Ocean Acidification	**Approximate Pacing**	16 Blocks

UNIT/TOPIC ENDURING OBJECTIVES/UNDERSTANDINGS

Students will understand that:

- Computational representation can be used to illustrate the relationship among Earth systems and how those relationships are being modified due to human activity.

NEXT GENERATION SCIENCE STANDARD

NJSLS#	HS-ESS3-4, HS-ESS3-6
NJSLS#	**STANDARD LANGUAGE**
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Science and Engineering Practices	**Disciplinary Core Idea**	**Cross Cutting Concepts**
Constructing Explanations and Designing Solutions ● 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. **Using Mathematics and Computational Thinking** ● Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**ESS2.D: Weather and Climate** ● 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)* **ESS3.C: Human Impacts on Earth Systems** ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ESS3.D: Global Climate Change** ● Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere	**Systems and System Models** ● 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. **Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Kinnelon Public School Curriculum Scope and Sequence

	interact and are modified in response to human activities. **ETS1.B: Developing Possible Solutions** ● 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)*	

21ST CENTURY LIFE AND CAREER (STANDARD 9) AND/OR TECHNOLOGY STANDARD (STANDARD 8)	
NJSLS#	**STANDARD LANGUAGE**
CRP 2	Apply appropriate academic and technical skills.
CRP 4	Communicate clearly and effectively and with reason.
CRP 5	Consider the environmental, social and economic impacts of decisions.
CRP 6	Demonstrate creativity and innovation.
CRP 8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP 11	Use technology to enhance productivity.

STUDENT LEARNING OBJECTIVES WITH CONCEPT ATTAINMENT ***Are concepts being introduced, reviewed, or mastered in this Unit/topic?***	
Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: ● To create a computational simulation to illustrate the relationships among management and natural resources, the sustainability of human populations, and biodiversity.	***Students will be able to:*** 1. Students identify and describe* the relevant components of each of the Earth systems modeled in the given computational representation, including system boundaries, initial conditions, inputs and outputs, and relationships that determine the interaction (e.g., the relationship between atmospheric CO2 and production of photosynthetic biomass and ocean acidification). 2. Students use the given computational representation of Earth systems to illustrate and describe relationships among at least two of Earth's systems, including how the relevant components in each individual Earth system can drive changes in another, interacting Earth system. 3. Students use evidence from the computational representation to describe how human activity could affect the relationships between the Earth's systems under consideration.

EVIDENCE OF LEARNING	
Summative Assessment	Appropriate assessment at end of unit/chapter. Labs: Ocean Acidification lab activity-Data in the Classroom website http://dataintheclassroom.noaa.gov/SitePages/oa/index#.V9AuhbVlorU
Formative Assessments	Demonstrations

Kinnelon Public School Curriculum Scope and Sequence

	Video clips/animations

RESOURCES

Google Earth
The Habitable Planet by Annenberg –http://www.learner.org/courses/envsci/

http://dataintheclassroom.noaa.gov/SitePages/oa/index#.V9AuhbVlorU

GLOBE

Water Quality
http://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867649/12273
http://www.globe.gov/do-globe/for-teachers/globe-videos