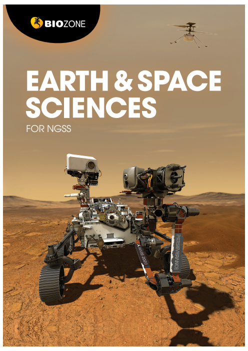

Alignment of BIOZONE's Earth and Space Sciences for NGSS (2nd edition) to Louisiana Student Standards for Environmental Science

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Note 1: Correlation locations are activity numbers (not page numbers).

Note 2: Correlations do not usually include reference to the Science practices chapter

Note 3: Correlations include background material to address the specific standard

Louisiana: Student Standards for Environmental Science

Standards source:
https://www.louisianabelieves.com/resources/library/academic-standards

TITLE: Earth and Space Sciences for NGSS (2ed):

Correlation locations are activity numbers (not page numbers)**.**

Standard	Components	Correlation location
Resources and Resource Management **HS.EVS1.1** Analyze and interpret data to identify the factors that affect sustainable development and natural resource management in Louisiana.		
Science and Engineering Practices	**4. Analyzing and interpreting data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	134, 136, 140, 141
	4. 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	134, 136, 140, 141
Disciplinary Core Ideas	**Louisiana's natural resources** Ecosystem capital can be characterized as goods (removable products) and services such as the functions and values of wetlands. (HS.EVS1A.a)	104, 133- 136, 139-141 (background, not LA specific)
Crosscutting Concepts	**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..	133-136,139-141

Resources and Resource Management **HS.EVS1.2** Obtain, evaluate and communicate information on the effectiveness of management or conservation practices for one of Louisiana's natural resources with respect to common considerations such as social, economic, technological, and influencing political factors over the past 50 years.		
Science and Engineering Practices	**8. Obtaining, evaluating, and communicating information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	108
	8. Obtaining, evaluating, and communicating information Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem	108
	8. Obtaining, evaluating, and communicating information Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.	108
Disciplinary Core Ideas	**Resource management for Louisiana** Population growth along with cultural and economic factors impact resource availability, distribution and use. (HS.EVS1B.a)	111, 113, 118, 119, 121 134, 136, 139, 140, 141, 142 (background, not LA specific)
	Resource management for Louisiana Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts. (HS.EVS1.B.b)	107, 108 129 (LA specific)
Crosscutting Concepts	**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.	N/A

Resource and Resource Management **HS.EVS1.3** Analyze and interpret data about the consequences of environmental decisions to determine the risk-benefit values of actions and practices implemented for selected issues.		121, 129, 131
Science and Engineering Practices	**4. Analyzing and interpreting data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	121, 131
	4. Analyzing and interpreting data Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.	121, 131
Disciplinary Core Ideas	**Resource management for Louisiana** Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts. (HS.EVS1B.b)	107, 108, 131 129 (LA specific)
Crosscutting Concepts	**Cause and effect** Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system.	121

Environmental Awareness and Protection **HS.EVS2.1** Design and evaluate a solution to limit the introduction of non-point source pollution into state waterways.		
Science and Engineering Practices	**6. Constructing explanations and designing solutions** Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	121, 144
	6. Constructing explanations and designing solutions Design, evaluate and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria and trade-off considerations.	121, 144
Disciplinary Core Ideas	**Pollution and the environment** Pollution includes both natural and man-made substances which occur at rates or levels which incur harm (i.e. combustion of fossil fuels, agricultural waste, and industrial byproducts). Pollution can be categorized as point-source pollution and non-point source pollution. (HS.EVS2A.a)	107, 110, 112, 116, 135, 138, 139, 142
	Environmental choices Different approaches can be used to manage impacts to our environment. Generally speaking, we can change human activities to limit negative impacts. Alternately, we can use technologies that reduce impact or we can perform restoration work to recover natural functions and values. (HS.EVS2C.a)	116, 143, 144
	Environmental choices Trade-offs occur when we make environmental choices. (HS.EVS2C.b)	121
	Designing and delimiting engineering problems Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS.ETS1A.b)	143, 144
Crosscutting Concepts	**Structure and function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.	116

Environmental Awareness and Protection **HS.EVS2.2** Use a model to predict the effects that pollution as a limiting factor has on an organism's population density.		
Science and Engineering Practices	**2. Developing and using models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	N/A
	2. Developing and using models Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems and/or solve problems.	N/A
Disciplinary Core Ideas	**Pollution and the environment** Different organisms have unique tolerances to pollution hazards. Many of the organisms most tolerant of pollution are the least desirable to humans (e.g., for food, for recreation, for ecosystem services). (HS.EVS2A.b)	N/A
Crosscutting Concepts	**Cause and effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	N/A

Environmental Awareness and Protection **HS.EVS2.3** Use multiple lines of evidence to construct an argument addressing the negative impacts that introduced organisms have on Louisiana's native species.		
Science and Engineering Practices	**7. Engaging in argument from evidence** Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using 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.	N/A
	7. Engaging in argument from evidence Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence.	N/A
Disciplinary Core Ideas	**Ecosystem change** The introduction of exotic/invasive species causes a disruption in natural ecosystems and can lead to the loss of native species (i.e. threatened/endangered). (HS.EVS2B.a)	N/A
	Ecosystem change Changes in ecosystems impact the availability of natural resources (e.g. sediment starvation, climate change). (HS.EVS2B.b)	152, 153
Crosscutting Concepts	**Cause and effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	

Personal Responsibilities **HS.EVS3.1** Construct and evaluate arguments about the positive and negative consequences of using disposable resources versus reusable resources.		119, 146
Science and Engineering Practices	**7. Engaging in argument from evidence** Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using 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.	119
	7. Engaging in argument from evidence Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	119
	7. Engaging in argument from evidence Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence.	119
Disciplinary Core Ideas	**Stewardship** Ecosystem sustainability can be used as a model for a sustainable society (e.g. recycling, energy efficiency, diversity). (HS.EVS3A.a)	N/A
	Stewardship Louisiana citizens are responsible for conserving our state's natural resources. Personal actions can have a positive or negative impact. (HS.EVS3A.b)	N/A
Crosscutting Concepts	**Energy and matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	N/A

Earth's Systems **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's systems.		60
Science and Engineering Practices	**4. Analyzing and interpreting data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	60, 63, 64
	4. 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.	60, 63, 64
Disciplinary Core Ideas	**Earth materials and systems** Earth's systems, being dynamic and interacting, include feedback effects that can increase or decrease the original changes. (HS.ESS2A.a)	59, 60, 62-65, 67
	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, hydrosphere, and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	88, 100, 102
Crosscutting Concepts	**Stability and change** Feedback (negative or positive) can stabilize or destabilize a system.	60, 62-65

Earth's Systems **HS.ESS2.5** Plan and conduct an investigation on the properties of water and its effects on Earth materials and surface processes.		82, 83
Science and Engineering Practices	**3. Planning and carrying out investigations**: Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	82,83
	3. Planning and carrying out investigations: Plan an investigation (science) or test a design (engineering) individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.	82, 83
Disciplinary Core Ideas	**The role 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 (HS.ESS2C.a)	77,78, 80-84
Crosscutting Concepts	**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.	77-86

Earth's Place in the Universe **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.		45, 53, 75
Science and Engineering Practices	**7. Engaging in argument from evidence**: Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science	45-49, 53
	7. Engaging in argument from evidence: Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	45, 53
Disciplinary Core Ideas	**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. (HS.ESS1C.b)	45
	The history of planet Earth 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.ESS1C.c)	47, 58
	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. (HS.ESS2B.a)	71, 72
	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. (HS.PS1C.b)	46, 47, 69
Crosscutting Concepts	**Patterns**: Empirical evidence is needed to identify patterns.	45-47, 49, 53

History of Earth **HS.ESS1.6** 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.		48, 49, 53
Science and Engineering Practices	**6. Constructing explanations and designing solutions**: Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	48, 49, 53
	6. Constructing explanations and designing solutions: Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	46-49, 53
Disciplinary Core Ideas	**The history of planet Earth** 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.ESS1C.c)	47-49, 53
	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. (HS.PS1C.b)	46
Crosscutting Concepts	**Stability and change**: Much of science deals with constructing explanations of how things change and how they remain stable.	46, 48, 49, 53

Earth's Place in the Universe **HS.ESS1.4** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.		31, 32, 42
Science and Engineering Practices	**5. Using mathematics and computational thinking**: Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions (e.g. trigonometric, exponential and logarithmic) 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.	31-36
	5. Using mathematics and computational thinking: Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.	31-36
Disciplinary Core Ideas	**Earth and the solar system** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS.ESS1B.a)	32-36
Crosscutting Concepts	**Scale, proportion, and quantity**: Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	31-36, 42

Earth's Systems **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.		71, 75
Science and Engineering Practices	**2. Developing and using models**: Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds	59, 71, 75
	2. Developing and using models: Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.	71, 75
Disciplinary Core Ideas	**Earth materials and systems** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS.ESS2A.a)	59
	Plate tectonics and large-scale system interactions Plate tectonics is the unifying theory that explains the past and current movements of rocks at Earth's surface and provides a framework for understanding its geologic history. (HS.ESS2B.a)	71, 72
	Plate tectonics and large-scale system interactions Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (HS.ESS2B.b)	72, 73
Crosscutting Concepts	**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.	59, 73

Earth's Systems **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's systems.		59, 64, 67
Science and Engineering Practices	**4. Analyzing and interpreting data**: Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data	59, 63, 64, 65, 67
	4. 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	59, 63, 64, 65, 67
Disciplinary Core Ideas	**Earth materials and systems** Earth's systems, being dynamic and interacting, include feedback effects that can increase or decrease the original changes. (HS.ESS2A.a)	59, 60, 62- 65
	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, hydrosphere, and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	60
Crosscutting Concepts	**Stability and change**: Feedback (negative or positive) can stabilize or destabilize a system.	59-65, 67

Earth's Systems **HS.ESS2.3** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.		72, 75
Science and Engineering Practices	**2. Developing and using models**: Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	56, 69-72, 75
	2. Developing and using models: Develop a model based on evidence to illustrate the relationships between systems or components of a system.	56, 71, 72, 75
Disciplinary Core Ideas	**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 viscous mantle and solid crust. (HS.ESS2A.b)	56, 75
	Earth materials and systems 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.ESS2A.c)	69, 70, 71
	Plate tectonics and large-scale system interactions 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.ESS2B.c)	69, 71
	Wave properties Geologists use seismic waves and their reflections at interfaces between layers to probe structures deep in the planet. (HS.PS4A.c)	56, 75
Crosscutting Concepts	**Energy and matter**: Energy drives the cycling of matter within and between systems.	69-72

Earth's Systems **HS.ESS2.4** Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.		39, 64, 65, 67, 99, 101
Science and Engineering Practices	**4. Analyzing and interpreting data**: Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	39, 64, 65, 67, 101
	4. 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.	39, 64, 65, 67, 101
Disciplinary Core Ideas	**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 Earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (HS.ESS1B.b)	39
	Earth materials and systems 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, hydrosphere 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.ESS2A.d)	63-65, 67
	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, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	88, 89, 91
	Weather and climate Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b)	92-94
	Weather and climate Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	98-101
Crosscutting Concepts	**Cause and effect**: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	39, 88, 89, 91, 101

Earth's Systems **HS.ESS2.6** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.		98, 99, 102
Science and Engineering Practices	**2. Developing and using models**: Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	92, 94, 98-102
	2. Developing and using models: Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	98, 99
Disciplinary Core Ideas	**Weather and climate:** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b)	92-94
	Weather and climate: Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	100-102, 150
Crosscutting Concepts	**Energy and matter**: The total amount of energy and matter in closed systems is conserved.	98-102

Earth's Systems **HS.ESS2.7** Construct an argument based on evidence about the simultaneous coevolution of Earth systems and life on Earth.		92-94
Science and Engineering Practices	**7. Engaging in argument from evidence**: Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	92-96
	7. Engaging in argument from evidence: Construct an oral and written argument or counterarguments based on data and evidence.	92-96
Disciplinary Core Ideas	**Weather and climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b)	92-94
	Biogeology 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.ESS2E.a)	92-96
Crosscutting Concepts	**Stability and change**: Much of science deals with constructing explanations of how things change and how they remain stable.	92-96

<table>
<tr><td colspan="2">Human Sustainability
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.</td><td>105-108, 123-125</td></tr>
<tr><td rowspan="2">Science and Engineering Practices</td><td>6. Constructing explanations and designing solutions:
Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</td><td>105-108, 123-125</td></tr>
<tr><td>6. 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.</td><td>104-108, 125</td></tr>
<tr><td rowspan="2">Disciplinary Core Ideas</td><td>Natural resources
Resource availability has guided the development of human society. (HS.ESS3A.a)</td><td>104-108</td></tr>
<tr><td>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. (HS.ESS3B.a)</td><td>123-125</td></tr>
<tr><td>Crosscutting Concepts</td><td>Cause and effect:
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td><td>104-108</td></tr>
</table>

Human Sustainability **HS.ESS3.2** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.		112, 121
Science and Engineering Practices	**6. Constructing explanations and designing solutions**: Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	112, 121
	6. Constructing explanations and designing solutions: Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	112, 121
Disciplinary Core Ideas	**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. (HS.ESS3A.b)	108, 111, 112, 119, 121
	Designing solutions to engineering problems 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. (HS.ETS1B.a)	108, 110-112, 116, 114, 121
Crosscutting Concepts	**System and system models**: Systems can be designed to do specific tasks.	N/A

Human Sustainability **HS.ESS3.3** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.		146
Science and Engineering Practices	**5. Using mathematics and computational thinking**: Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions (e.g. trigonometric, exponential and logarithmic) 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.	146
	5. Using mathematics and computational thinking: Create a computational model or simulation of a phenomenon, designed device, process, or system.	146
Disciplinary Core Ideas	**Human impacts on Earth systems** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS.ESS3C.a)	114-119, 136, 146
Crosscutting Concepts	**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.	146

Earth's Systems **HS.ESS3.4** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		137, 138, 144, 154
Science and Engineering Practices	**6. Constructing explanations and designing solutions**: Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	137, 138, 144, 154
	6. 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	137, 138, 144, 154
Disciplinary Core Ideas	**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.(HS.ESS3C.b)	116, 119, 137, 138, 143, 144, 154
	Designing solutions to engineering problems 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. (HS.ETS1B.a)	116, 119, 144, 154
Crosscutting Concepts	**Stability and change**: Feedback (negative or positive) can stabilize or destabilize a system.	137, 138, 143, 144, 154

Human Sustainability **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.		150, 156
Science and Engineering Practices	**4. Analyzing and interpreting data**: Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data	150, 156
	4. 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.	150, 156
Disciplinary Core Ideas	**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. (HS.ESS3D.a)	148-150, 156
Crosscutting Concepts	**Stability and change**: Change and rates of change can be quantified and modeled over very short or long periods of time. Some system changes are irreversible.	148-150, 156

Human Sustainability **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.		99, 151, 156
Science and Engineering Practices	**5. Using mathematics and computational thinking**: Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions (e.g. trigonometric, exponential and logarithmic) 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	99, 151
	5. Using mathematics and computational thinking: Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	99, 151
Disciplinary Core Ideas	**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. (HS.ESS2D.d)	100, 101, 150
	Global climate change Important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities (e.g., through computer simulations and other discoveries satellite imagery). (HS.ESS3D.b)	151
Crosscutting Concepts	**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.	150, 151, 156