Science Framework

FOR CALIFORNIA PUBLIC SCHOOLS

Kindergarten Through Grade Twelve

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Appropriate Alignments among *Environmental Principles and Concepts* (*EP&Cs*) and CA NGSS: Kindergarten

K-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
K-LS1-1: Use observations to describe patterns of what plants and animals (including humans) need to survive. **[Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]**	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Patterns** • Patterns in the natural and designed worlds can be observed and used as evidence. (K-LS1-1) **Science and Engineering Practices** **Analyzing and Interpreting Data** • Use observations (firsthand or from media) to describe patterns in the natural world to answer scientific questions. (K-LS1-1) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when observing the world. (K-LS1-1)	**Disciplinary Core Ideas** As students learn that: **LS1.C: Organization for Matter and Energy Flow in Organisms** All animals need food in order to live and grow; they obtain their food from plants or from other animals; and plants need water and light to live and grow. (K-LS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle I Concept a:** The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures. **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	*The World Around Me* *A Day In My Life*

APPENDIX 2

K-ESS2 EARTH'S SYSTEMS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
K-ESS2-2: Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. **[Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]**	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Patterns** • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1) **Systems and System Models** • Systems in the natural and designed worlds have parts that work together. (K-ESS2-2) **Science and Engineering Practices** **Engaging in Argument from Evidence** • Construct an argument with evidence to support a claim. (K-ESS2-2)	**Disciplinary Core Ideas** As students learn that: **ESS2.E: Biogeology** Plants and animals can change their environment. (K-ESS2-2) *Secondary DCI(s)* **ESS3.C: Human Impacts on Earth Systems** Things people do to live comfortably can affect the world around them, but they can make choices that reduce their impacts on the land, water, air, and other living things. (secondary to K-ESS2-2) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle I Concept c:** The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems. (ESS2.E) **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. (ESS3.C)	*The World Around Me* *A Day In My Life*

K-ESS3 EARTH AND HUMAN ACTIVITY

Performance Expectations	Connections Between EP&Cs, CCCs, and SEPs	Clarifications and Connections Between DCIs and EP&Cs	Relevant EEI Units that can Support NGSS Instruction
K-ESS3-1: Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. **[Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas; and, grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.]** **K-ESS3-3:** Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* **[Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]**	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Cause and Effect** • Events have causes that generate observable patterns. (K-ESS3-3) **Systems and System Models** • Systems in the natural and designed worlds have parts that work together. (K-ESS3-1) **Science and Engineering Practices** **Developing and Using Models** • Use a model to represent relationships in the natural world. (K-ESS3-1) **Obtaining, Evaluating, and Communicating Information** • Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3)	**Disciplinary Core Ideas** As students learn that: **ESS3.A: Natural Resources** Humans use natural resources for everything they do. (K-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** Things people do to live comfortably can affect the world around them. (K-ESS3-3) *Secondary DCI(s)* **ETS1.A: Defining and Delimiting an Engineering** Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2) **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to K-ESS3-3) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle I Concept c:** The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems. (ESS3.A) **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. (ESS3.C)	*The World Around Me* *A Day In My Life*

K–2-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
K–2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** None identified **Science and Engineering Practices** **Asking Questions and Defining Problems** • Ask questions based on observations to find more information about the natural and/or designed world(s). (K–2-ETS1-1) • Define a simple problem that can be solved through the development of a new or improved object or tool. (K–2-ETS1-1)	**Disciplinary Core Ideas** As students learn that: **ETS1.A: Defining and Delimiting Engineering Problems** A situation people want to change or create can be approached as a problem to be solved through engineering. (K–2-ETS1-1) **ETS1.A:** Asking questions, making observations, and gathering information are helpful in thinking about problems. (K–2-ETS1-1) *Secondary DCI(s)* **ETS1.A:** Before beginning to design a solution, it is important to clearly understand the problem. (K–2-ETS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept c:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*The World Around Me* *A Day In My Life*

Appropriate Alignments among *Environmental Principles and Concepts* (EP&Cs) and CA NGSS: Grade One

1-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
1-LS1-1: Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* **[Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Patterns** • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS1-2) **Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1) **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. (1-LS1-1)	**Disciplinary Core Ideas** As students learn that: **LS1.A: Structure and Function** All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** That direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	*Surviving and Thriving* *Finding Shelter* *Open Wide! Look Inside!*

1-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
1-LS1-2: Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. **[Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]**	**Science and Engineering Practices** **Constructing Explanations and Designing Solutions** • Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1) **Obtaining, Evaluating, and Communicating Information** • Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when making observations about the world. (1-LS1-2)		

K–2-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
K–2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Structure and Function**[b] • The shape and stability of structures of natural and designed objects are related to their function(s). (K–2-ETS1-2) **Science and Engineering Practices** **Asking Questions and Defining Problems** • Ask questions based on observations to find more information about the natural and/or designed world(s). (K–2-ETS1-1) • Define a simple problem that can be solved through the development of a new or improved object or tool. (K–2-ETS1-1)	**Disciplinary Core Ideas** As students learn that: **ETS1.A: Defining and Delimiting Engineering Problems** Asking questions, making observations, and gathering information are helpful in thinking about problems. (K–2-ETS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Surviving and Thriving* *Finding Shelter* *Open Wide! Look Inside!*

Appropriate Alignments among *Environmental Principles and Concepts* (EP&Cs) and CA NGSS: Grade Two

2-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
2-LS2-1: Plan and conduct an investigation to determine if plants need sunlight and water to grow. [***Assessment Boundary: Assessment is limited to testing one variable at a time.***] **2-LS2-2:** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Cause and Effect** • Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2) **Science and Engineering Practices** **Developing and Using Models** • Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **Planning and Carrying Out Investigations** • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)	**Disciplinary Core Ideas** As students learn that: **LS2.A: Interdependent Relationships in Ecosystems** Plants depend on water and light to grow. (2-LS2-1) **LS2.A:** Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) *Secondary DCI(s)* **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2)[b] **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Cycle of Life* *Flowering Plants in Our Changing Environment*

2-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
2-LS4-1: Make observations of plants and animals to compare the diversity of life in different habitats **[Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [*Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.*]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Cause and Effect** • Events have causes that generate observable patterns. (2-LS2-1) **Systems and System Models** • Systems in the natural and designed world have parts that work together. (K-ESS2-2) **Science and Engineering Practices** **Planning and Carrying Out Investigations** • Make observations (firsthand or from media) to collect data that can be used to make comparisons. (2-LS4-1) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when making observations about the world. (2-LS4-1)	**Disciplinary Core Ideas** As students learn that: **LS4.D: Biodiversity and Humans** There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	*Cycle of Life* *Flowering Plants in Our Changing Environment* *Alike and Different* *Surviving and Thriving*

K–2-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
K–2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Cause and Effect** • Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function**[b] • The shape and stability of structures of natural and designed objects are related to their function(s). (K–2-ETS1-2) **Science and Engineering Practices** **Asking Questions and Defining Problems** • Ask questions based on observations to find more information about the natural and/or designed world(s). (K–2-ETS1-1) • Define a simple problem that can be solved through the development of a new or improved object or tool. (K–2-ETS1-1)	**Disciplinary Core Ideas** As students learn that: **ETS1.A: Defining and Delimiting Engineering Problems** Asking questions, making observations, and gathering information are helpful in thinking about problems. (K–2-ETS1-1) **ETS1.A: Defining and Delimiting Engineering Problems** Before beginning to design a solution it is important to clearly understand the problem. (K–2-ETS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Cycle of Life* *Flowering Plants in Our Changing Environment* *The Earth Rocks*

Appropriate Alignments among *Environmental Principles and Concepts* (*EP&Cs*) and CA NGSS: Grade Three

3-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
3-LS1-1: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. **[Clarification Statement: Changes organisms go through during their life form a pattern.] [*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]**	**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from, and can alter. **Crosscutting Concepts** **Patterns** • Patterns of change can be used to make predictions. (3-LS1-1) **Science and Engineering Practices** **Developing and Using Models** • Develop models to describe phenomena. (3-LS1-1) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns. (3-LS1-1)	**Disciplinary Core Ideas** As students learn that: **LS1.B: Growth and Development of Organisms** Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle III Concept a:** Natural systems proceed through cycles and processes that are required for their functioning. **Principle III Concept b:** Human practices depend upon and benefit from the cycles and processes that operate within natural systems. **Principle III Concept c:** Human practices can alter the cycles and processes that operate within natural systems.	*Cycle of Life* *Flowering Plants in Our Changing Environment* *Structures for Survival in a Healthy Ecosystem* *Living Things in Changing Environments*

3-LS3 HEREDITY: INHERITANCE AND VARIATION OF TRAITS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
3-LS3-2: Use evidence to support the explanation that traits can be influenced by the environment. **[Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2) **Patterns** • Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1) **Science and Engineering Practices** **Constructing Explanations and Designing Solutions** • Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)	**Disciplinary Core Ideas** As students learn that: **LS3.A: Inheritance of Traits** Other characteristics result from individuals' interactions with the environment, which can range from diet to learning, and that many characteristics involve both inheritance and environment. (3-LS3-2) **LS3.B: Inheritance of Traits** The environment also affects the traits that an organism develops. (3-LS3-2) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	*Structures for Survival in a Healthy Ecosystem* *Living Things in Changing Environments* *Alike and Different* *Flowering Plants in Our Changing Environment*

3-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
3-LS4-2: Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. **[Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]** **3-LS4-3:** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **[Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change. (3-LS4-2) (3-LS4-3) **Systems and System Models** • A system can be described in terms of its components and their interactions. (3-LS4-4) **Connections to Engineering, Technology, and Applications of Science**[b] **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering. (3 LS4 3) **Connections to Nature of Science** **Science is a Human Endeavor** • Most scientists and engineers work in teams. (3-LS4-3)	**Disciplinary Core Ideas** As students learn that: **LS4.C: Adaptation** For any particular environment, some kinds of organisms survive well, some survive less well. (3-LS4-3) **LS4.D: Biodiversity and Humans** Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4) *Secondary DCI(s)* **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)	*Structures for Survival in a Healthy Ecosystem* *Living Things in Changing Environments*

3-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
up a system in which the parts depend on each other.] **3-LS4-4:** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* **[Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.]** ***[Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]***	**Science and Engineering Practices** **Constructing Explanations and Designing Solutions** • Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2) **Engaging in Argument from Evidence** • Construct an argument with evidence. (3-LS4-3) • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4)	**Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept b:** Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept c:** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.	

3–5-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
3–5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3–5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies. (3–5-ETS1-1) • Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3–5-ETS-2) **Science and Engineering Practices** **Asking Questions and Defining Problems** • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3–5-ETS1-1) **Constructing Explanations and Designing Solutions** • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3–5-ETS1-2)	**Disciplinary Core Ideas** As students learn that: **ETS1.A: Defining and Delimiting Engineering Problems** … Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3–5-ETS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Structures for Survival in a Healthy Ecosystem* *Living Things in Changing Environments*

Appropriate Alignments among *Environmental Principles and Concepts* (*EP&Cs*) and CA NGSS: Grade Four

4-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
4-LS1-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. **[Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin. Each structure has specific functions within its associated system.]** ***[Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]***	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Systems and System Models** • A system can be described in terms of its components and their interactions. (4-LS1-1) **Science and Engineering Practices** **Engaging in Argument from Evidence** • Construct an argument with evidence, data, and/or a model. (4-LS1-1)	**Disciplinary Core Ideas** As students learn that: **LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4 LS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept b:** Methods used to extract, harvest, transport, and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept c:** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.	*Structures for Survival in a Healthy Ecosystem* *Living Things in Changing Environments* *The Flow of Energy Through Ecosystems*

4-ESS3 EARTH AND HUMAN ACTIVITY

Performance Expectations	Connections Between EP&Cs, CCCs, and SEPs	Clarifications and Connections Between DCIs and EP&Cs	Relevant EEI Units that can Support NGSS Instruction
4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. **[Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]**	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Crosscutting Concepts** **Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1) **Energy and Matter**[b] • Energy can be transferred in various ways and between objects. **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1) **Influence of Science, Engineering and Technology on Society and the Natural World** • Over time, people's needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1) **Science and Engineering Practices** **Obtaining, Evaluating, and Communicating Information** • Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)	**Disciplinary Core Ideas** As students learn that: **ESS3.A: Natural Resources** Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways, and that some resources are renewable over time, and others are not. (4-ESS3-1) *Secondary DCI(s)* **ETS1.B: Designing Solutions to Engineering Problems** Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle I Concept a:** The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.	*Energy and Material Resources: Renewable or Not?* *Plants: The Ultimate Energy Resource*

3–5-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
3–5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies. (3–5-ETS1-1) **Science and Engineering Practices** **Asking Questions and Defining Problems** • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3–5-ETS1-1)	**Disciplinary Core Ideas** As students learn that: **ETS1.A: Defining and Delimiting Engineering Problems** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3–5-ETS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Life and Death with Decomposers* *Microorganisms and the Human World*

Appropriate Alignments among *Environmental Principles and Concepts* (*EP&Cs*) and CA NGSS: Grade Five

5-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

Performance Expectations	Connections Between EP&Cs, CCCs, and SEPs	Clarifications and Connections Between DCIs and EP&Cs	Relevant EEI Units that can Support NGSS Instruction
5-LS1-1: Support an argument that plants get the materials they need for growth chiefly from air and water. **[Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]**	**Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Energy and Matter** • Matter is transported into, out of, and within systems. (5-LS1-1) **Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) **Science and Engineering Practices** **Engaging in Argument from Evidence** • Support an argument with evidence, data, or a model. (5-LS1-1)	**Disciplinary Core Ideas** As students learn that: **LS1.C: Organization for Matter and Energy Flow in Organisms** Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle IV Concept a:** The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.	*Plants: The Ultimate Energy Resource* *The Flow of Energy Through Ecosystems* *Life and Death with Decomposers*

5-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
5-LS1-2: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. **[Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [*Assessment Boundary: Assessment does not include molecular explanations.*]**	**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from, and can alter. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Systems and System Models** • A system can be described in terms of its components and their interactions. (5-LS2-1) **Energy and Matter** • Matter is transported into, out of, and within systems. (5-LS1-1) **Science and Engineering Practices** **Developing and Using Models** • Develop a model to describe phenomena. (5-LS2-1) **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Science explanations describe the mechanisms for natural events. (5-LS2-1)	**Disciplinary Core Ideas** As students learn that: **LS2.A: Interdependent Relationships in Ecosystems** The food of almost any kind of animal can be traced back to plants; organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants; some organisms, such as fungi and bacteria, break down dead organisms (both plants or plant parts and animals) and therefore operate as "decomposers"; decomposition eventually restores (recycles) some materials back to the soil; organisms can survive only in environments in which their particular needs are met; a healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life; and newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die; organisms obtain gases, water, and solids from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	*Plants: The Ultimate Energy Resource* *The Flow of Energy Through Ecosystems* *Life and Death with Decomposers*

5-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
		Environmental Principles and Concept(s)	
		Students should be developing an understanding that: **Principle IV Concept a:** The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts. **Principle IV Concept b:** The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. **Principle III Concept a:** Natural systems proceed through cycles and processes that are required for their functioning; and that human practices can alter the cycles and processes that operate within natural systems. **Principle III Concept c:** Human practices can alter the cycles and processes that operate within natural systems.	

5-ESS2 EARTH'S SYSTEMS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. **[Clarification Statement: The geosphere, hydrosphere (including ice), atmosphere, and biosphere are each a system and each system is a part of the whole Earth System. Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [*Assessment Boundary: Assessment is limited to the interactions of two systems at a time.*]** **5-ESS2-2:** Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. **[*Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.*]**	**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Crosscutting Concepts** **Systems and System Models** • A system can be described in terms of its components and their interactions. (5-LS2-1) **Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) **Science and Engineering Practices** **Developing and Using Models** • Develop a model using an example to describe a scientific principle. (5-ESS2-1) **Using Mathematics and Computational Thinking** • Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)	**Disciplinary Core Ideas** As students learn that: **ESS2.A: Earth Materials and Systems** Earth's major systems are the geosphere, the hydrosphere, the atmosphere, and the biosphere, these systems interact in multiple ways to affect Earth's surface materials and processes, the ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate, and winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle III Concept a:** Natural systems proceed through cycles and processes that are required for their functioning. **Principle III Concept b**: Human practices depend upon and benefit from the cycles and processes that operate within natural systems. **Principle III Concept c**: Human practices can alter the cycles and processes that operate within natural systems.	*Earth's Water* *Changing States: Water, Natural Systems, and Human Communities* *Precipitation, People, and the Natural World* *Our Water: Sources and Uses*

5-ESS3 EARTH AND HUMAN ACTIVITY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Systems and System Models** • A system can be described in terms of its components and their interactions. (5-ESS3-1) **Connections to Nature of Science Science Addresses Questions About the Natural and Material World** • Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1) **Science and Engineering Practices** **Obtaining, Evaluating, and Communicating Information** • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)	**Disciplinary Core Ideas** As students learn that: **ESS3.C: Human Impacts on Earth Systems** Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space, but individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept b:** Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept c:** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.	*Earth's Water* *Changing States: Water, Natural Systems, and Human Communities* *Precipitation, People, and the Natural World* *Our Water: Sources and Uses* *Life and Death with Decomposers*

5-PS3 ENERGY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
5-PS3-1: Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. **[Clarification Statement: Examples of models could include diagrams, and flow charts.]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Energy and Matter** • Energy can be transferred in various ways and between objects. (5-PS3-1) **Science and Engineering Practices** **Developing and Using Models** • Use models to describe phenomena. (5-PS3-1)	**Disciplinary Core Ideas** As students learn that: **PS3.D: Energy in Chemical Processes and Everyday Life** Energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)[b] *Secondary DCI(s)* **LS1.C: Organization for Matter and Energy Flow in Organisms** Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (secondary to 5-PS3-1) **Environmental Principles ands Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle I Concept a:** The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures. **Principle I Concept b:** The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.	*Plants: The Ultimate Energy Resource* *The Flow of Energy Through Ecosystems*

3–5-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
3–5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies. (3–5-ETS1-1) • Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3–5-ETS-2) **Science and Engineering Practices** **Constructing Explanations and Designing Solutions** • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3–5-ETS1-2)	**Disciplinary Core Ideas** As students learn that: **ETS1.C: Optimizing the Design Solution** Different solutions need to be tested to determine which of them best solves the problem, given the criteria and the constraints. (3 5-ETS1-3) **ETS1.B: Developing Possible Solutions** Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3–5-ETS1-2)[b] **ETS1.B:** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3–5-ETS1-2) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Earth's Water* *Changing States: Water, Natural Systems, and Human Communities* *Precipitation, People, and the Natural World* *Our Water: Sources and Uses*

Appropriate Alignments among *Environmental Principles and Concepts* (*EP&Cs*) and CA NGSS: Grades Six, Seven and Eight

MS-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
MS-LS1-4: Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. **[Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds; and, creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]**	**Principle II:** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Principle IV:** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4) (MS-LS1-5) **Systems and System Models** • Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) **Energy and Matter** • Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6) **Science and Engineering Practices** **Constructing Explanations and Designing Solutions** • Construct a scientific explanation based on valid and reliable evidence obtained	**Disciplinary Core Ideas** As students learn that: **LS1.B: Growth and Development of Organisms** Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) **LS1.B:** Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) **LS1.C: Organization for Matter and Energy Flow in Organisms** Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)[b] **LS1.C:** Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7) *Secondary DCI(s)* **PS3.D: Energy in Chemical Processes and Everyday Life** The chemical reaction by which plants	*Energy: Pass It On!* *Shaping Natural Systems through Evolution* *Responding to Environmental Change*

MS-LS1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES			
MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. **[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [*Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*]** **MS-LS1-6:** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. **[Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [*Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.*]**	from sources (including the students' own experiments) 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. (MS-LS1-5) (MS-LS1-6) **Engaging in Argument from Evidence** • Use oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4) **Constructing Explanations and Designing Solutions** • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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. (MS-LS1-6) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)	produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept c:** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems. (LS1.B) **Principle IV Concept b:** The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. (LS1.B)	

MS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **[Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]** **MS-LS2-3:** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **[Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.]** **[*Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.*]**	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Patterns** • Patterns can be used to identify cause and effect relationships. (MS-LS2-2) **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1) **Energy and Matter** • The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)	**Disciplinary Core Ideas** As students learn that: **LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) ***Supplemental DCI PS1.B **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** … Transfers of matter into and out of the physical environment occur at every level… The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) ***Supplemental DCI PS1.B, ESS2.A **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) *Secondary DCI(s)* **LS2.D: Biodiversity and Humans** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) ***Supplemental DCI PS1.B	*Energy: Pass It On!* *Shaping Natural Systems through Evolution* *Responding to Environmental Change* *Playing the Same Role* *Extinction: Past and Present* *The Flow of Energy through Ecosystems* *Precipitation, People and the Natural World* *Energy and Material Resources: Renewable or Not?* *Made from Earth: How Natural Resources Become Things We Use*

MS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an affect populations. **[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]**

MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* **[Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]**

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (MS-LS2-4) (MS-LS2-5)

Connections to Engineering, Technology, and Applications of Science[b]

Influence of Engineering, Technology, and Science on Society and the Natural World

- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)

Science Addresses Questions About the Natural and Material World

- Science knowledge can describe consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

ETS1.B: Developing Possible Solutions Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5)

Environmental Principles and Concept(s)

Students should be developing an understanding that:

Principle I Concept c: The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems. (LS4.D)

Principle II Concept b: Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. (LS2.A)

Principle III Concept a: Natural systems proceed through cycles and processes that are required for their functioning. (LS2.B and LS2.C)

Principle III Concept b: Human practices depend upon and benefit from the cycles and processes that operate within natural systems.

Principle III Concept c: Human practices can alter the cycles and processes that operate within natural systems.

MS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
	Science and Engineering Practices **Developing and Using Models** • Develop a model to describe phenomena. (MS-LS2-3) **Analyzing and Interpreting Data** • Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) **Engaging in Argument from Evidence** • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4) • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)	**Principle IV Concept c:** The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts. **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions. (ETS1.B)	

MS-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Performance Expectations	Connections Between EP&Cs, CCCs, and SEPs	Clarifications and Connections Between DCIs and EP&Cs	Relevant EEI Units that can Support NGSS Instruction
MS-LS4-1: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. **[Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [*Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.*]** **MS-LS4-2:** Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. **[Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Patterns** • Patterns can be used to identify cause and effect relationships. (MS-LS4-2) • Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1) **Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-6) **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1) (MS-LS4-2) **Science and Engineering Practices** **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)	**Disciplinary Core Ideas** As students learn that: **LS4.C: Adaptation** Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6) **LS4.B: Natural Selection** Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** And indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	*Shaping Natural Systems through Evolution* *Extinction: Past and Present* *Responding to Environmental Change*

MS-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. **[Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.]** ***[Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]***	**Constructing Explanations and Designing Solutions** • Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1)	**Principle II Concept c:** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.	

MS-ESS2 EARTH'S SYSTEMS

Performance Expectations	Connections Between EP&Cs, CCCs, and SEPs	Clarifications and Connections Between DCIs and EP&Cs	Relevant EEI Units that can Support NGSS Instruction
MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. **[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.]** **[*Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.*]**	**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Crosscutting Concepts** **Energy and Matter** • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4) **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5) **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6) **Stability and Change** • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1) **Patterns** • Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Science and Engineering Practices** **Developing and Using Models** • Develop a model to describe unobservable mechanisms. (MS ESS2-4)	**Disciplinary Core Ideas** As students learn that: **ESS2.C: The Roles of Water in Earth's Surface Processes** Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) ***Supplemental DCI PS1.A **ESS2.C:** Complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) **ESS2.C:** Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle III Concept a:** Natural systems proceed through cycles and processes that are required for their functioning. **Principle III Concept b:** Human practices depend upon and benefit from the cycles and processes that operate within natural systems. **Principle III Concept c:** Human practices can alter the cycles and processes that operate within natural systems.	*Earth's Water* *Changing States: Water, Natural Systems, and Human Communities* *Precipitation, People, and the Natural World* *Our Water: Sources and Uses*

MS-ESS3 EARTH AND HUMAN ACTIVITY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. **[Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]** **MS-ESS3-2:** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. **[Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable**	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II:** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1) (MS-ESS3-4) • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) **Patterns** • Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Connections to Nature of Science** **Science Addresses Questions About the Natural and Material World** • Science knowledge can describe consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)	**Disciplinary Core Ideas** As students learn that: **ESS3.A: Natural Resources** Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources; minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes; and that these resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-4) **ESS3.B: Natural Hazards** Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)	*The Dynamic Nature of Rivers* *Energy and Material Resources: Renewable or Not?* *Made from Earth: How Natural Resources Become Things We Use* *Precipitation, People and the Natural World* *Energy: Pass it On!* *Energy: It's Not All the Same to You* *Responding to Environmental Change* *Extinction: Past and Present*

MS-ESS3 EARTH AND HUMAN ACTIVITY

predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1) (MS-ESS3-4)
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2) (MS-ESS3-3)

Science and Engineering Practices

Analyzing and Interpreting Data

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)

Constructing Explanations and Designing Solutions

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did

Environmental Principles and Concept(s)

Students should be developing an understanding that:

Principle I Concept c: The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems. (ESS3.A and ESS3.B)

Principle II Concept c: The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems. (ESS3.C)

MS-ESS3 EARTH AND HUMAN ACTIVITY			
MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. **Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]**	in the past and will continue to do so in the future. (MS-ESS3-1) • Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Engaging in Argument from Evidence** • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)		

MS-PS1 MATTER AND ITS INTERACTIONS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.]** **[*Assessment Boundary: Assessment is limited to qualitative information.*]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)	**Disciplinary Core Ideas** As students learn that: **PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3) ***Supplemental DCI ESS3.C, LS4.D[b] **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept b:** Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.	*Made from Earth: How Natural Resources Become Things We Use*

MS-PS1 MATTER AND ITS INTERACTIONS

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)

Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)

MS-PS3 ENERGY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* **[Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.]** ***[Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]*** **MS-PS3-4:** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	**Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) **Scale, Proportion, and Quantity** • Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-4) **Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flow within systems. (MS-PS2-1) (MS-PS2-4)	**Disciplinary Core Ideas** As students learn that: **PS3.B: Conservation of Energy and Energy Transfer** The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) **PS3.B:** When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3–5) *Secondary DCI(s)* **ETS1.A: Defining and Delimiting an Engineering Problem** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)	*Energy: It's Not All the Same to You!*

MS-PS3 ENERGY			
[Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]	**Science and Engineering Practices** **Planning and Carrying Out Investigations** • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4)	**Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle IV Concept a:** The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts. **Principle IV Concept c:** The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.	

MS-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Structure and Function** • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/ systems can be analyzed to determine how they function. (MS-LS3-1) **Science and Engineering Practices** **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)	**Disciplinary Core Ideas** As students learn that: **ETS1.B: Developing Possible Solutions** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-3) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	*Energy: It's Not All the Same to You!* *Energy and Material Resources: Renewable or Not?* *Made from Earth: How Natural Resources Become Things We Use* *The Dynamic Nature of Rivers*

Appropriate Alignments among *Environmental Principles and Concepts* (EP&Cs) and CA NGSS: Grades High School

HS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. **[Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [*Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.*]** **HS-LS2-2:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **[Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [*Assessment Boundary: Assessment is limited to provided data.*]**	**Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5) **Energy and Matter** • Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)	**Disciplinary Core Ideas** As students learn that: **LS2.A: Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from challenges such as predation, competition, and disease. **LS2.A:** Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1) (HS-LS2-2)[b] **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** … extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2) (HS-LS2-6)	*Biodiversity: The Keystone to Life on Earth* *Biological Diversity: The World's Riches* *Ecosystem Change in California* *Differential Survival of Organisms* *The Isolation of Species* *The Greenhouse Effect on Natural Systems* *Ocean Currents and Natural Systems* *Rainforests and Deserts: Distribution, Uses and Human Influences* *Life and Times of Carbon* *Living Under One Roof* *Liquid Gold: California's Water*

HS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **[Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.]** **[*Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.*]** **HS-LS2-5:** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. **[Clarification Statement: Examples of models could include simulations and mathematical models.]** **[*Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.*]**	**Stability and Change**[b] • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6) (HS-LS2-7) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8) **Scale, Proportion, and Quantity**[b] • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)	**LS2.C:** Moreover, anthropogenic changes (those induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) *Secondary DCI(s)* **LS4.D: Biodiversity and Humans** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) **LS4.D:** Humans depend on the living world for the resources and other benefits provided by biodiversity, but human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change, thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth, sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.(secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)	

HS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. **[Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and, extreme changes, such as volcanic eruption or sea level rise.]** **HS-LS2-7:** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* **[Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]**	**Science and Engineering Practices** **Scientific Knowledge is Open to Revision in Light of New Evidence** • Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2) • Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6)	**PS3.D: Energy in Chemical Processes** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5) **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 to HS-LS2-7) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** That direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept b:** That methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept c:** That the expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.	

HS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS			
		Principle IV Concept a: That the effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts. **Principle IV Concept b:** That the byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. **Principle IV Concept c:** That the capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.	

HS-LS3 HEREDITY: INHERITANCE AND VARIATION OF TRAITS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
HS-LS3-2: Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. **[Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [*Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.*]**	**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-2) **Science and Engineering Practices** **Engaging in Argument from Evidence** • Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)	**Disciplinary Core Ideas** As students learn that: **LS3.B: Variation of Traits** Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) **LS3.B:** Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population, thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle III Concept a:** Natural systems proceed through cycles and processes that are required for their functioning. **Principle III Concept c:** Human practices can alter the cycles and processes that operate within natural systems. **Principle IV Concept b:** The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. **Principle IV Concept c:** The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.	*High Tech Harvest: Genetic Engineering and the Environment* *The Isolation of Species*

HS-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. **[Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.]** **[*Assessment Boundary:***	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2) (HS-LS4-4) (HS-LS4-5) **Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1) (HS-LS4-3)	**Disciplinary Core Ideas** As students learn that: **LS4.C** Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) **LS4.C** Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) **LS4.C** Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5) (HS-LS4-6) **LS4.C** Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5) **LS4.D** Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on	*High Tech Harvest: Genetic Engineering and the Environment* *Differential Survival of Organisms* *Biodiversity: The Keystone to Life on Earth* *Ecosystem Change in California* *Biodiversity: The World's Riches* *The Isolation of Species* *Ocean Currents and Natural Systems* *Liquid Gold: California's Water*

HS-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.] **HS-LS4-4:** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. **[Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]** **HS-LS4-5:** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.	**Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-4) **Science and Engineering Practices** **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. (HS-LS4-2) (HS-LS4-4)	biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept b:** Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept c:** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems. **Principle I Concept a:** The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.	

HS-LS4 BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY			
[Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]	**Engaging in Argument from Evidence** • Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)	**Principle I Concept b:** The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures. **Principle I Concept c:** The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.	

HS-ESS2 EARTH'S SYSTEMS			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
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. **[Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]** **HS-ESS2-4:** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Crosscutting Concepts** **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) **Structure and Function**[b] • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)	**Disciplinary Core Ideas** As students learn that: **ESS2.A: Earth Materials and Systems** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2) **ESS2.A:** The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. (HS-ESS2-4) **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. (HS-ESS2-5) **ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6)	*The Greenhouse Effect on Natural Systems* *The Life and Times of Carbon* *Living Under One Roof* *Liquid Gold: California's Water* *Rainforests and Deserts: Distribution, Uses and Human Influences*

HS-ESS2 EARTH'S SYSTEMS

[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [*Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.*]

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. **[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]**

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

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. (HS-ESS2-2)

Science and Engineering Practices

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1) (HS-ESS2-3) (HS-ESS2-6)
- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

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

ESS2.D: Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) (HS-ESS2-4)

Secondary DCI(s)

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 to HS-ESS2-4)

Environmental Principles and Concept(s)

Students should be developing an understanding that:

Principle III Concept a: Natural systems proceed through cycles and processes that are required for their functioning.

Principle III Concept b: Human practices depend upon and benefit from the cycles and processes that operate within natural systems.

HS-ESS2 EARTH'S SYSTEMS			
HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. **[Clarification Statement: The carbon cycle is a property of the Earth system that arises from interactions among the hydrosphere, atmosphere, geosphere, and biosphere. Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]**	accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5) **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. (HS-ESS2-2) **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. (HS-ESS2-4)	**Principle III Concept c:** Human practices can alter the cycles and processes that operate within natural systems. **Principle IV Concept b:** The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. **Principle IV Concept c:** The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.	

HS-ESS3 EARTH AND HUMAN ACTIVITY			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
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. **[Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]** **HS-ESS3-2:** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*	**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both. **Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.	**Disciplinary Core Ideas** As students learn that: **ESS3.A: Natural Resources** Resource availability has guided the development of human society. (HS-ESS3-1) All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) **ESS3.B: Natural Hazards** 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-ESS3-1)[b] **ESS3.C: Human Impacts on Earth Systems** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) *Secondary DCI(s)*	*Biodiversity: The Keystone to Life on Earth* *The Greenhouse Effect on Natural Systems* *The Life and Times of Carbon* *Living Under One Roof* *High Tech Harvest: Genetic Engineering and the Environment* *Ocean Currents and Natural Systems* *Rainforests and Deserts: Distribution, Uses and Human Influences* *Liquid Gold: California's Water*

HS-ESS3 EARTH AND HUMAN ACTIVITY			
[Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.] **HS-ESS3-3:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **[Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [*Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.*]**	**Crosscutting Concepts** **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6) **Stability and Change** • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3) (HS-ESS3–5) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-ESS3-1) (HS-ESS3-3)	**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 to HS-ESS3-6) **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 to HS-ESS3-2) (secondary to HS-ESS3-4) **Environmental Principles and Concept(s)** Students should be developing an understanding that: **Principle I Concept c:** The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems. (ESS2.E) **Principle II Concept a:** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the	

HS-ESS3 EARTH AND HUMAN ACTIVITY			
HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* **[Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]** **HS-ESS3-5:** 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. **[Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).]**	• Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2) (HS-ESS3-4) • New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3) • Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2) **Connections to Nature of Science** **Science is a Human Endeavor** • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) **Science Addresses Questions About the Natural and Material World** • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) • Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2) • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)	geographic extent, composition, biological diversity, and viability of natural systems. **Principle II Concept b:** Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems. **Principle III Concept c:** Human practices can alter the cycles and processes that operate within natural systems. **Principle IV Concept b:** The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. **Principle IV Concept c:** The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts. **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions. **Principle V Concept b:** The process of making decisions about resources and natural systems, and how the assessment of social, economic, political, and environmental factors has changed over time.	

HS-ESS3 EARTH AND HUMAN ACTIVITY			
[*Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.*] **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. **[Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.]** **[*Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.*]**	**Science and Engineering Practices** **Analyzing and Interpreting Data** • Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5) **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions** • 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. (HS-ESS3-1) • Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS ESS3-4)		

HS-ESS3 EARTH AND HUMAN ACTIVITY			
	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). (HS-ESS3-2) **Connections to Nature of Science** **Scientific Investigations Use a Variety of Methods** • Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) • New technologies advance scientific knowledge. (HS-ESS3-5) **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based on empirical evidence. (HS-ESS3-5) • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)		

HS-ETS1 ENGINEERING DESIGN			
Performance Expectations	**Connections Between EP&Cs, CCCs, and SEPs**	**Clarifications and Connections Between DCIs and EP&Cs**	**Relevant EEI Units that can Support NGSS Instruction**
HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	**Principle V** Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. **Crosscutting Concepts** **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology 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. (HS-ETS1-3) **Science and Engineering Practices** **Constructing Explanations and Designing Solutions** • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	**Disciplinary Core Ideas** As students learn that: **ETS1.A: Defining and Delimiting Engineering Problems** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) **ETS1.A:** 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-ETS1-1) **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. (HS-ETS1-3) **ETS1.B:** 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-ETS1-3) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	*High Tech Harvest: Genetic Engineering and the Environment* *The Greenhouse Effect on Natural Systems* *Ocean Currents and Natural Systems* *The Life and Times of Carbon* *Living Under One Roof* *Liquid Gold: California's Water*

HS-ETS1 ENGINEERING DESIGN			
		Environmental Principles and Concept(s)	
		Students should be developing an understanding that: **Principle V Concept a:** The spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions. **Principle V Concept b:** The process of making decisions about resources and natural systems, and how the assessment of social, economic, political, and environmental factors has changed over time.	