



# Soils and NGSS - perfect together!

Missy Holzer, PhD  
Chair, SSSA K12 Committee

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# Check-in!

Rate (1-4) your knowledge of the Next Generation Science Standards.

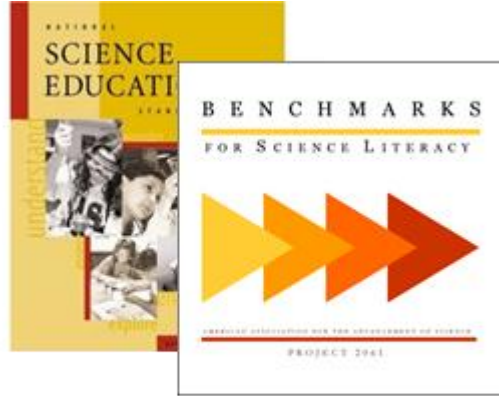
- 1 = no idea what they are
- 4 = I've been using them since they were published

Rate (1-4) comfort level with 3-D teaching and Learning. (*making sense of phenomenon / disciplinary core ideas using science and engineering practices and crosscutting concepts*)

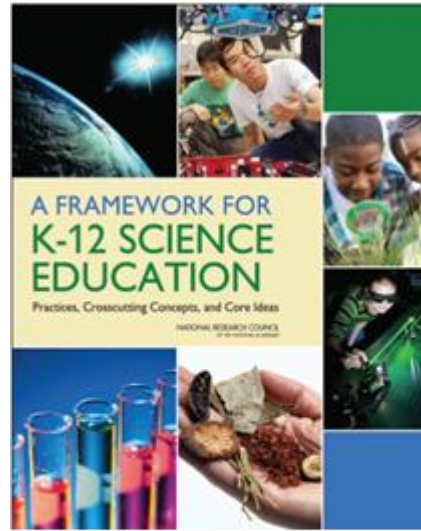
- 1 = I prefer to lecture
- 4 = My students are figuring out phenomena using science and engineering practices and crosscutting concepts



# An NGSS Overview



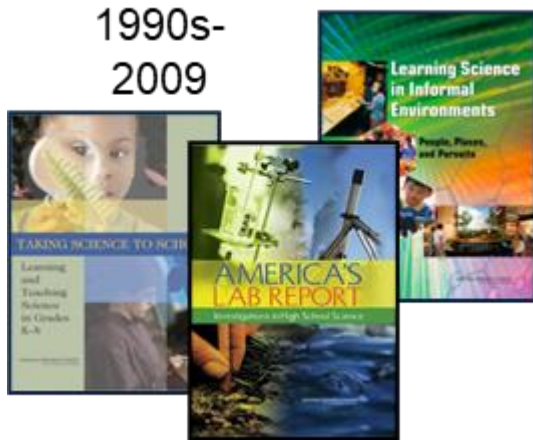
1990s



1/2010 -  
7/2011



7/2010 – April  
2013



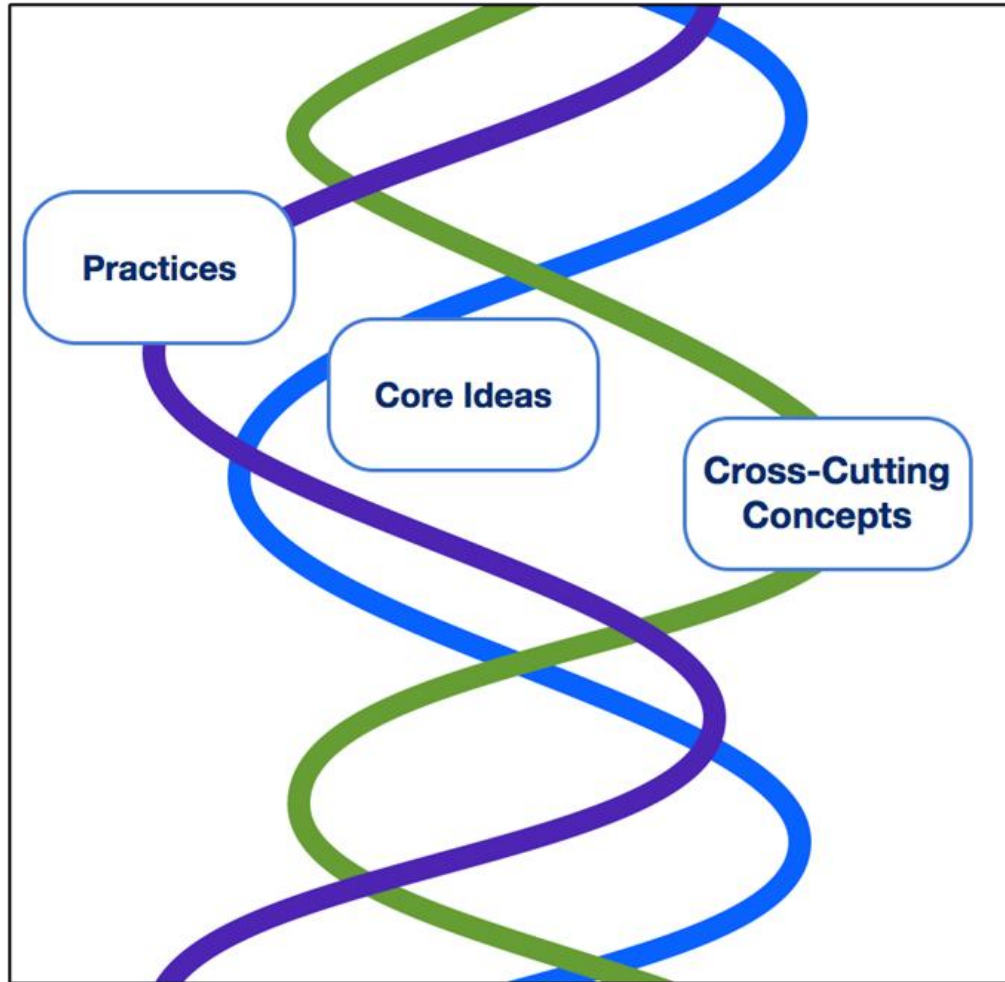
the work continues!



# An NGSS Overview

- K-12 Science Education Should Reflect the Interconnected Nature of Science as it is Practiced and Experienced in the Real World.
- The Next Generation Science Standards are student performance expectations – NOT curriculum.
- The Science Concepts in the NGSS Build Coherently from K–12.
- The NGSS Focus on Deeper Understanding of Content as well as Application of Content.
- Science and Engineering are Integrated in the NGSS, from K–12.
- The NGSS are designed to prepare students for college, career, and citizenship.
- The NGSS and Common Core State Standards (English Language Arts and Mathematics) are Aligned.

# An NGSS Overview - intertwined dimensions



- Move away from “learning about,” and move toward “figuring out”
- Scientific practices play a central role
- Each dimension is organized in “learning progressions”
- The NGSS are written as Performance Expectations
- NGSS requires the integration of the three dimensions by students.
- Focus is on how and why as well as what



# An NGSS Overview - Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information



# An NGSS Overview - Crosscutting Concepts

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

# An NGSS Overview - Disciplinary Core Ideas

## Life Science

- LS1: From Molecules to Organisms: Structures and Processes
- LS2: Ecosystems: Interactions, Energy, and Dynamics
- LS3: Heredity: Inheritance and Variation of Traits
- LS4: Biological Evolution: Unity and Diversity

## Earth & Space Science

- ESS1: Earth's Place in the Universe
- ESS2: Earth's Systems
- ESS3: Earth and Human Activity

## Physical Science

- PS1: Matter and Its Interactions
- PS2: Motion and Stability: Forces and Interactions
- PS3: Energy
- PS4: Waves and Their Applications in Technologies for Information Transfer

## Engineering & Technology

- ETS1: Engineering Design
- ETS2: Links Among Engineering, Technology, Science, and Society



# An NGSS Overview - Performance Expectations

## Performance Expectation

**Science & Engineering Practices**

**Disciplinary Core Ideas**

**Crosscutting Concepts**

### Connections to

- Other science disciplines at this grade level
- Other DCIs for older and younger students
- Common Core State Standards in Mathematics and Language Arts

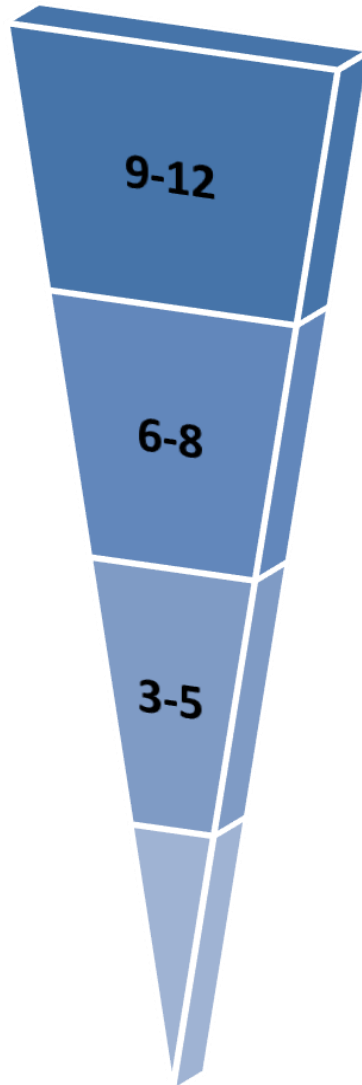
# An NGSS Overview - Performance Expectations



MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics		
Students who demonstrate understanding can: <b>MS-LS2-5.</b> 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.]		
The performance expectation above was developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<b>Engaging in Argument from Evidence</b> Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). <ul style="list-style-type: none"> <li>Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.</li> </ul>	<b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> <ul style="list-style-type: none"> <li>Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health.</li> </ul> <b>LS4.D: Biodiversity and Humans</b> <ul style="list-style-type: none"> <li>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)</li> </ul> <b>ETS1.B: Developing Possible Solutions</b> <ul style="list-style-type: none"> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary)</li> </ul>	<b>Stability and Change</b> <ul style="list-style-type: none"> <li>Small changes in one part of a system might cause large changes in another part.</li> </ul> <hr/> <b>Connections to Engineering, Technology, and Applications of Science</b>  <b>Influence of Science, Engineering, and Technology on Society and the Natural World</b> <ul style="list-style-type: none"> <li>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.</li> </ul> <hr/> <b>Connections to Nature of Science</b>  <b>Science Addresses Questions About the Natural and Material World</b> <ul style="list-style-type: none"> <li>Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.</li> </ul>
<i>Connections to other DCIs in this grade-band:</i> <b>MS.ESS3.C</b>		
<i>Articulation of DCIs across grade-bands:</i> <b>HS.LS2.A ; HS.LS2.C ; HS.LS4.D ; HS.ESS3.A ; HS.ESS3.C ; HS.ESS3.D</b>		
<i>Common Core State Standards Connections:</i> <b>ELA/Literacy -</b> <b>RST.6-8.8</b> Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5) <b>RI.8.8</b> Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-5)		
<b>Mathematics -</b> <b>MP.4</b> Model with mathematics. (MS-LS2-5) <b>6.RP.A.3</b> Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-LS2-5)		

Note of Caution: These are grade-band endpoints. Lessons and units “build towards” proficiency in the PEs.

# An NGSS Overview - Performance Expectations Across Grade Bands



HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

5-PS1-3. Make observations and measurements to identify materials based on their properties.

2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose

# An NGSS Overview - Adoptions & Adaptations

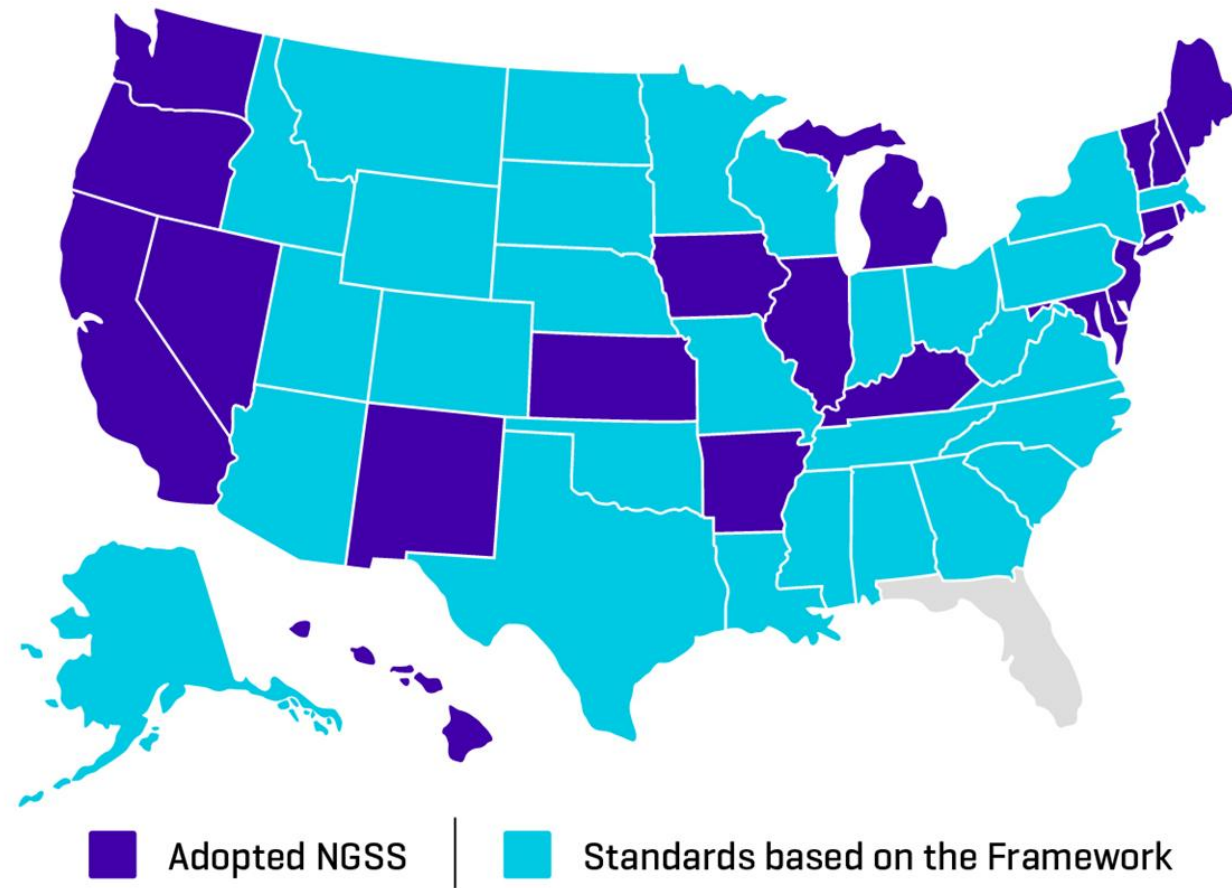


Figure: <https://www.nsta.org/science-standards>

# NGSS & Soils - Digging into the Connections

## Life Science

LS1: From Molecules to Organisms: Structures and Processes

LS2: Ecosystems: Interactions, Energy, and Dynamics

LS3: Heredity: Inheritance and Variation of Traits

LS4: Biological Evolution: Unity and Diversity

## Earth & Space Science

ESS1: Earth's Place in the Universe

ESS2: Earth's Systems

ESS3: Earth and Human Activity

## Physical Science

PS1: Matter and Its Interactions

PS2: Motion and Stability: Forces and Interactions

PS3: Energy

PS4: Waves and Their Applications in Technologies for Information Transfer

## Engineering & Technology

ETS1: Engineering Design

ETS2: Links Among Engineering, Technology, Science, and Society

# NGSS & Soils - Digging into the Connections

## The Matrices - where we find NGSS “elements”

### Disciplinary Core Ideas in the Next Generation Science Standards (NGSS) Final Release

Topic	Primary School (Grades K-2)	Elementary School (Grades 3-5)	Middle School (Grades 6-8)	High School (Grades 9-12)
<b>Life Science</b>				
<b>LS1: From Molecules to Organisms: Structures and Processes</b>				
LS1.A: Structure and Function	<ul style="list-style-type: none"> <li>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)</li> </ul>	<ul style="list-style-type: none"> <li>Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)</li> </ul>	<ul style="list-style-type: none"> <li>All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)</li> <li>Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MSLS3-2)</li> <li>Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)</li> <li>In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)</li> </ul>	<ul style="list-style-type: none"> <li>Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)</li> <li>All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (secondary to HS-LS3-1)</li> <li>Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)</li> <li>Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)</li> </ul>
LS1.B: Growth and Development of Organisms	<ul style="list-style-type: none"> <li>Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)</li> </ul>	<ul style="list-style-type: none"> <li>Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)</li> </ul>	<ul style="list-style-type: none"> <li>Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)</li> <li>Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)</li> <li>Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)</li> </ul>	<ul style="list-style-type: none"> <li>In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)</li> </ul>
LS1.C: Organization for Matter and Energy Flow in Organisms	<ul style="list-style-type: none"> <li>All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1)</li> </ul>	<ul style="list-style-type: none"> <li>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)</li> <li>Plants acquire their material for growth chiefly from air and water. (5-LS1-1)</li> </ul>	<ul style="list-style-type: none"> <li>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)</li> <li>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)</li> </ul>	<ul style="list-style-type: none"> <li>The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)</li> <li>The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)</li> <li>As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)</li> <li>As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature. Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. (HS-LS1-7)</li> </ul>



# NGSS & Soils - Digging into the Physical Science Connections

## PS1: Matter and its Interactions

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
<b>Physical Science</b>				
<b>PS1: Matter and Its Interactions</b>				
<b>PS1.A: Structure and Properties of Matter</b>	<ul style="list-style-type: none"> <li>Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)</li> <li>Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)</li> <li>A great variety of objects can be built up from a small set of pieces. (2-PS1-3)</li> </ul>	<ul style="list-style-type: none"> <li>Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model shows that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (5-PS1-1)</li> <li>The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)</li> <li>Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)</li> </ul>	<ul style="list-style-type: none"> <li>Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)</li> <li>Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2), (MS-PS1-3)</li> <li>Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)</li> <li>In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)</li> <li>Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)</li> <li>The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)</li> </ul>	<ul style="list-style-type: none"> <li>Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)</li> <li>The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2)</li> <li>The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6)</li> <li>Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)</li> </ul>
<b>PS1.B: Chemical Reactions</b>	<ul style="list-style-type: none"> <li>Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)</li> </ul>	<ul style="list-style-type: none"> <li>When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)</li> <li>No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)</li> </ul>	<ul style="list-style-type: none"> <li>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-PS1-2),(MS-PS1-3),(MS-PS1-5)</li> <li>The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)</li> <li>Some chemical reactions release energy, others store energy. (MS-PS1-6)</li> </ul>	<ul style="list-style-type: none"> <li>Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HSPS1-4),(HS-PS1-5)</li> <li>In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)</li> <li>The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)</li> </ul>
<b>PS1.C: Nuclear Processes</b>				<ul style="list-style-type: none"> <li>Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HSPS1-8)</li> <li>Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6)</li> </ul>



# NGSS & Soils - Digging into the Physical Science Connections

## Physical Science

Construct an explanation based on evidence from an investigation on soil color (SEP.6.4) to identify the cause and effect relationship (CC.2.2) between chemical changes and color changes found in soil (PS1.B.1).

- SEP.6.4: Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.
- CC.2.2: Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- PS1.B.1: 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.

# NGSS & Soils - Digging into the Life Science Connections

## LS2: Ecosystems: Interactions, Energy, and Dynamics

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
<b>LS2: Ecosystems: Interactions, Energy, and Dynamics</b>				
LS2.A: Interdependent Relationships in Ecosystems	<ul style="list-style-type: none"> <li>Plants depend on water and light to grow. (2-LS2-1)</li> <li>Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>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 plants 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. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)</li> </ul>	<ul style="list-style-type: none"> <li>Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)</li> <li>In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)</li> <li>Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)</li> <li>Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce 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),(HLSL2-2)</li> </ul>
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems		<ul style="list-style-type: none"> <li>Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</li> </ul>	<ul style="list-style-type: none"> <li>Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. 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)</li> </ul>	<ul style="list-style-type: none"> <li>Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)</li> <li>Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)</li> <li>Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)</li> </ul>
LS2.C: Ecosystem Dynamics, Functioning, and Resilience		<ul style="list-style-type: none"> <li>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)</li> </ul>	<ul style="list-style-type: none"> <li>Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)</li> <li>Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)</li> </ul>	<ul style="list-style-type: none"> <li>A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)</li> <li>Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)</li> </ul>



# NGSS & Soils - Digging into the Life Science Connections

## Life Science

Ask questions that can be investigated (SEP.1.6) to determine the role of soil in the cycling (CC.5.1) of nutrients in a local ecosystem (LS.2.B.1).

- SEP.1.6: Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
- CC.5.1: Matter is conserved because atoms are conserved in physical and chemical processes
- LS.2.B.1: Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. **Transfers of matter into and out of the physical environment occur at every level.** Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.

# NGSS & Soils - Digging into the Earth & Space Science Connections

## ESS2: Earth's Systems and ESS3: Earth and Human Activity

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
<b>ESS2: Earth's Systems</b>				
<b>ESS2.A: Earth Materials and Systems</b>	<ul style="list-style-type: none"> <li>Wind and water can change the shape of the land. (2-ESS2-1)</li> </ul>	<ul style="list-style-type: none"> <li>Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)</li> <li>Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). 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. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)</li> </ul>	<ul style="list-style-type: none"> <li>All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)</li> <li>The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2)</li> <li>Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3)</li> <li>The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</li> </ul>
<b>ESS2.B: Plate Tectonics and Large-Scale System Interactions</b>	<ul style="list-style-type: none"> <li>Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)</li> </ul>	<ul style="list-style-type: none"> <li>The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3)</li> <li>Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (ESS2.B Grade 8 GBE) (HS-ESS2-1) (secondary to HS-ESS1-5)</li> </ul>
<b>ESS2.C: The Roles of Water in Earth's Surface Processes</b>	<ul style="list-style-type: none"> <li>Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS2-3)</li> </ul>	<ul style="list-style-type: none"> <li>Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>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)</li> <li>The 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)</li> <li>Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)</li> <li>Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)</li> <li>Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)</li> </ul>	<ul style="list-style-type: none"> <li>The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)</li> </ul>



# NGSS & Soils - Digging into the Earth & Space Science Connections

## Earth & Space Science

Develop and use a model (SEP.2.5) to demonstrate the role of water (ESS2.C.5) in earthquake caused liquefaction (CC.2.2).

- SEP.2.5: Develop and/or use a model to predict and/or describe phenomena.
- CC.2.2: Cause and effect relationships may be used to predict phenomena in natural or designed systems
- ESS2.C.5: Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.



# NGSS & Soils - Digging into the Connections

Where to begin with NGSS!

- Are you designing curriculum or
- Are you reviewing/vetting or “tagging” previously designed and implemented curriculum?

Designing curriculum considerations:

- Grade band (K-2, 3-5, 6-8, 9-12), interesting phenomenon for students to figure out using science practices and crosscutting concepts

Vetting/reviewing and tagging curriculum considerations:

- Are the instructional materials three-dimensional? Are they at grade-level? What can be done to adjust the materials for a NGSS classroom?



# NGSS & Soils - Some Resources

Designing and Reviewing for a NGSS classroom:

- Critically review examples that have already been curated as “high quality instructional materials.”
- Keep a review tool, such as the NGSS Lesson Screener, handy while designing!

Searching for Soil-related NGSS connected materials:

visit [soils4teachers.org](https://soils4teachers.org)

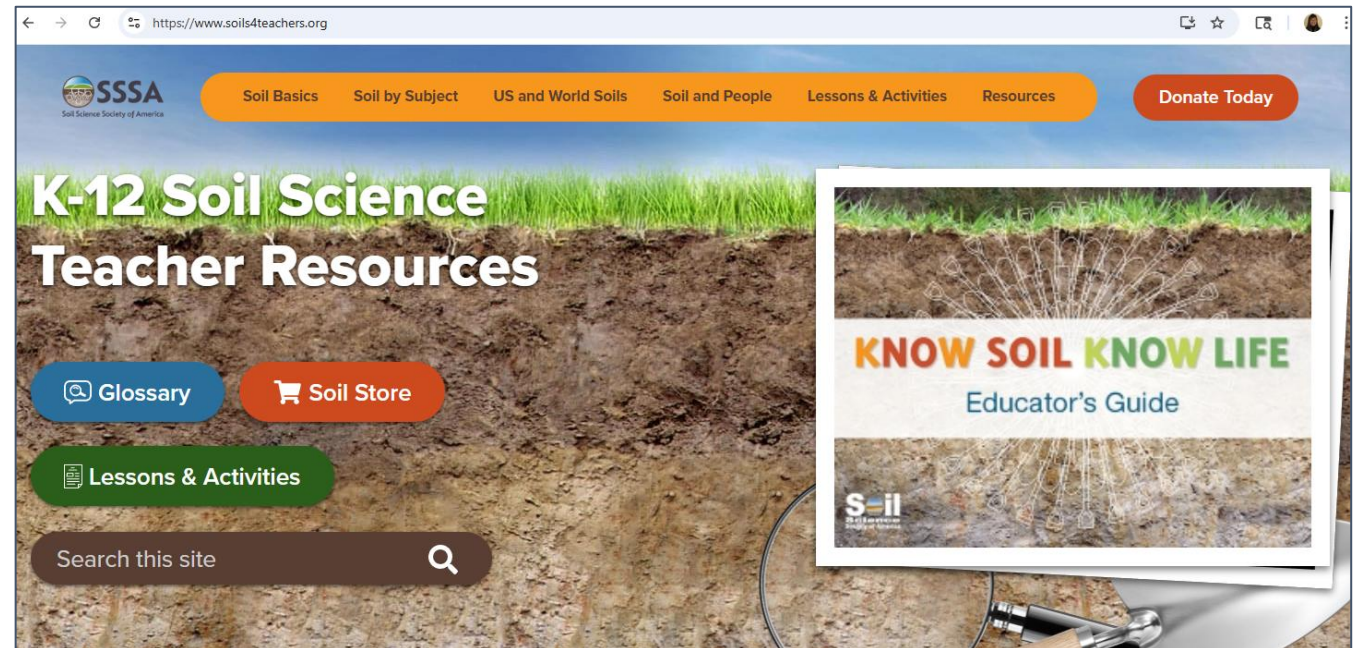
- MS unit
- Instructional Materials database searchable by DCI
- Know Soil - Know Life Teacher's Guide



# Thank you!

Missy Holzer, PhD  
Chair, SSSA K12 committee  
Science Curriculum Design Consultant  
missy.holzer@gmail.com

<https://www.soils4teachers.org/>



The screenshot shows the homepage of the website <https://www.soils4teachers.org/>. The page features a navigation bar with the SSSA logo and several menu items: "Soil Basics", "Soil by Subject", "US and World Soils", "Soil and People", "Lessons & Activities", "Resources", and a "Donate Today" button. The main heading is "K-12 Soil Science Teacher Resources". Below this, there are buttons for "Glossary", "Soil Store", and "Lessons & Activities". A search bar is located at the bottom left. On the right side, there is a featured resource titled "KNOW SOIL KNOW LIFE Educator's Guide" with a corresponding image of soil and roots.