UTAH CORE STANDARDS

UTAH SCIENCE WITH ENGINEERING EDUCATION (SEEd) STANDARDS

UTAH STATE BOARD OF EDUCATION 250 EAST 500 SOUTH P.O. BOX 144200 SALT LAKE CITY, UTAH 84114-4200 SYDNEE DICKSON, ED.D., STATE SUPERINTENDENT OF PUBLIC INSTRUCTION

UTAH K–12 SCIENCE WITH ENGINEERING EDUCATION (SEEd) STANDARDS

Grades 6–8 Standards
Adopted December 2015

Grades K–2, 3–5, High School (Biology, Chemistry, Earth and Space Science, and Physics) Standards
Adopted June 2019

by the
Utah State Board of Education
250 East 500 South
P.O. Box 144200
Salt Lake City, UT 84114-4200

Sydnee Dickson, Ed.D.
State Superintendent of Public Instruction

https://www.schools.utah.gov

The Utah State Board of Education, in January of 1984, established policy requiring the identification of specific core standards to be met by all K–12 students in order to graduate from Utah's secondary schools. The Utah State Board of Education regularly updates the Utah Core Standards, while parents, teachers, and local school boards continue to control the curriculum choices that reflect local values.

The Utah Core Standards are aligned to scientifically based content standards. They drive high quality instruction through statewide comprehensive expectations for all students. The standards outline essential knowledge, concepts, and skills to be mastered at each grade level or within a critical content area. The standards provide a foundation for ensuring learning within the classroom.

UTAH STATE BOARD OF EDUCATION

250 East 500 South P. O. Box 144200 Salt Lake City, UT 84114-4200
https://schools.utah.gov/board

District	*Name*	*City*
District 1	**Jennie L. Earl**	Morgan, UT
District 2	**Scott L. Hansen**	Liberty, UT
District 3	**Linda B. Hansen**	West Valley City, UT
District 4	**Jennifer Graviet**	South Ogden, UT
District 5	**Laura Belnap**	Bountiful, UT
District 6	**Brittney Cummins**	West Valley City, UT
District 7	**Carol Barlow Lear**	Salt Lake City, UT
District 8	**Janet A. Cannon**	Holladay, UT
District 9	**Cindy Davis**	American Fork, UT
District 10	**Shawn E. Newell**	Cottonwood Heights, UT
District 11	**Lisa Cummins**	Herriman, UT
District 12	**Alisa Ellis**	Heber City, UT
District 13	**Scott B. Neilson**	Spanish Fork, UT
District 14	**Mark Huntsman**	Fillmore, UT
District 15	**Michelle Boulter**	St. George, UT
	Sydnee Dickson	State Superintendent of Public Instruction
	Lorraine Austin	Secretary to the Board

5/2019

Utah Science with Engineering Education Standards

Utah's Science and Engineering Education (SEEd) standards were written by Utah educators and scientists, using a wide array of resources and expertise. A great deal is known about good science instruction. The writing team used sources including *A Framework for K–12 Science Education*[1], the *Next Generation Science Standards*[2], and related works to craft research-based standards for Utah. These standards were written with students in mind, including developmentally appropriate progressions that foster learning that is simultaneously age-appropriate and enduring. The aim was to address what an educated citizenry should know and understand to embrace the value of scientific thinking and make informed decisions. The SEEd standards are founded on what science is, how science is learned, and the multiple dimensions of scientific work.

Principles of Scientific Literacy

Science is a way of knowing, a process for understanding the natural world. Engineering applies the fields of science, technology, and mathematics to produce solutions to real-world problems. The process of developing scientific knowledge includes ongoing questioning, testing, and refinement of ideas when supported by empirical evidence. Since progress in modern society is tied so closely to this way of knowing, scientific literacy is essential for a society to be engaged in political and economic choices on personal, local, regional, and global scales. As such, the Utah SEEd standards are based on the following essential elements of scientific literacy.

Science is valuable, relevant, and applicable.
Science produces knowledge that is inherently important to our society and culture. Science and engineering support innovation and enhance the lives of individuals and society. Science is supported from and benefited by an equitable and democratic culture. Science is for all people, at all levels of education, and from all backgrounds.

Science is a shared way of knowing and doing.
Science learning experiences should celebrate curiosity, wonder, skepticism, precision, and accuracy. Scientific habits of mind include questioning, communicating, reasoning, analyzing, collaborating, and thinking critically. These values are shared within and across scientific disciplines, and should be embraced by students, teachers, and society at large.

Science is principled and enduring.
Scientific knowledge is constructed from empirical evidence; therefore, it is both changeable and durable. Science is based on observations and inferences, an understanding of scientific laws and theories, use of scientific methods, creativity, and collaboration. The Utah SEEd standards are based on current scientific theories, which are powerful and broad explanations of a wide range of phenomena; they are not simply guesses nor are they unchangeable facts. Science is principled in that it is limited to observable evidence. Science is also enduring in that theories are only accepted when they are robustly supported by multiple lines of peer reviewed evidence. The history of science demonstrates

how scientific knowledge can change and progress, and it is rooted in the cultures from which it emerged. Scientists, engineers, and society, are responsible for developing scientific understandings with integrity, supporting claims with existing and new evidence, interpreting competing explanations of phenomena, changing models purposefully, and finding applications that are ethical.

Principles of Science Learning

Just as science is an active endeavor, students best learn science by engaging in it. This includes gathering information through observations, reasoning, and communicating with others. It is not enough for students to read about or watch science from a distance; learners must become active participants in forming their ideas and engaging in scientific practice. The Utah SEEd standards are based on several core philosophical and research-based underpinnings of science learning.

Science learning is personal and engaging.
Research in science education supports the assertion that students at all levels learn most when they are able to construct and reflect upon their ideas, both by themselves and in collaboration with others. Learning is not merely an act of retaining information but creating ideas informed by evidence and linked to previous ideas and experiences. Therefore, the most productive learning settings engage students in authentic experiences with natural phenomena or problems to be solved. Learners develop tools for understanding as they look for patterns, develop explanations, and communicate with others. Science education is most effective when learners invests in their own sense-making and their learning context provides an opportunity to engage with real-world problems.

Science learning is multi-purposed.
Science learning serves many purposes. We learn science because it brings us joy and appreciation but also because it solves problems, expands understanding, and informs society. It allows us to make predictions, improve our world, and mitigate challenges. An understanding of science and how it works is necessary in order to participate in a democratic society. So, not only is science a tool to be used by the future engineer or lab scientist but also by every citizen, every artist, and every other human who shares an appreciation for the world in which we live.

All students are capable of science learning.
Science learning is a right of all individuals and must be accessible to all students in equitable ways. Independent of grade level, geography, gender, economic status, cultural background, or any other demographic descriptor, all K–12 students are capable of science learning and science literacy. Science learning is most equitable when students have agency and can engage in practices of science and sense-making for themselves, under the guidance and mentoring of an effective teacher and within an environment that puts student experience at the center of instruction. Moreover, all students are capable learners of science, and all grades and classes should provide authentic, developmentally appropriate science instruction.

Three Dimensions of Science

Science is composed of multiple types of knowledge and tools. These include the processes of doing science, the structures that help us organize and connect our understandings, and the deep explanatory pieces of knowledge that provide predictive power. These facets of science are represented as "three dimensions" of science learning, and together these help us to make sense of all that science does and represents. These include science and engineering practices, crosscutting concepts, and disciplinary core ideas. Taken together, these represent how we use science to make sense of phenomena, and they are most meaningful when learned in concert with one another. These are described in *A Framework for K–12 Science Education*, referenced above, and briefly described here:

Science and Engineering Practices (SEPs): Practices refer to the things that scientists and engineers do and how they actively engage in their work. Scientists do much more than make hypotheses and test them with experiments. They engage in wonder, design, modeling, construction, communication, and collaboration. The practices describe the variety of activities that are necessary to do science, and they also imply how scientific thinking is related to thinking in other subjects, including math, writing, and the arts. For a further understanding of science and engineering practices see Chapter 3 in *A Framework for K–12 Science Education*.

Crosscutting Concepts (CCCs): Crosscutting concepts are the organizing structures that provide a framework for assembling pieces of scientific knowledge. They reach across disciplines and demonstrate how specific ideas are united into overarching principles. For example, a mechanical engineer might design some process that transfers energy from a fuel source into a moving part, while a biologist might study how predators and prey are interrelated. Both of these would need to model systems of energy to understand how all of the features interact, even though they are studying different subjects. Understanding crosscutting concepts enables us to make connections among different subjects and to utilize science in diverse settings. Additional information on crosscutting concepts can be found in Chapter 4 of *A Framework for K-12 Science Education*.

Disciplinary Core Ideas (DCIs): Core ideas within the SEEd Standards include those most fundamental and explanatory pieces of knowledge in a discipline. They are often what we traditionally associate with science knowledge and specific subject areas within science. These core ideas are organized within physical, life, and earth sciences, but within each area further specific organization is appropriate. All these core ideas are described in chapters 5 through 8 in the K–12 *Framework* text, and these are employed by the Utah SEEd standards to help clarify the focus of each strand in a grade level or content area.

Even though the science content covered by SEPs, CCCs, and DCIs is substantial, the Utah SEEd standards are not meant to address every scientific concept. Instead, these standards were written to address and engage in an appropriate depth of knowledge, including perspectives into how that knowledge is obtained and where it fits in broader contexts, for students to continue to use and expand their understandings over a lifetime.

Articulation of SEPs, CCCs, and DCIs

Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas
Asking questions or defining problems: Students engage in asking testable questions and defining problems to pursue understandings of phenomena. **Developing and using models:** Students develop physical, conceptual, and other models to represent relationships, explain mechanisms, and predict outcomes. **Planning and carrying out investigations:** Students plan and conduct scientific investigations in order to test, revise, or develop explanations. **Analyzing and interpreting data:** Students analyze various types of data in order to create valid interpretations or to assess claims/conclusions. **Using mathematics and computational thinking:** Students use fundamental tools in science to compute relationships and interpret results. **Constructing explanations and designing solutions:** Students construct explanations about the world and design solutions to problems using observations that are consistent with current evidence and scientific principles. **Engaging in argument from evidence:** Students support their best explanations with lines of reasoning using evidence to defend their claims. **Obtaining, evaluating, and communicating information:** Students obtain, evaluate, and derive meaning from scientific information or presented evidence using appropriate scientific language. They communicate their findings clearly and persuasively in a variety of ways including written text, graphs, diagrams, charts, tables, or orally.	Patterns: Students observe patterns to organize and classify factors that influence relationships Cause and effect: Students investigate and explain causal relationships in order to make tests and predictions. Scale, proportion, and quantity: Students compare the scale, proportions, and quantities of measurements within and between various systems. Systems and system models: Students use models to explain the parameters and relationships that describe complex systems. Energy and matter: Students describe cycling of matter and flow of energy through systems, including transfer, transformation, and conservation of energy and matter. Structure and function: Students relate the shape and structure of an object or living thing to its properties and functions. Stability and change: Students evaluate how and why a natural or constructed system can change or remain stable over time.	Physical Sciences: (PS1) Matter and Its Interactions (PS2) Motion and Stability: Forces and Interactions (PS3) Energy (PS4) Waves Life Sciences: (LS1) Molecules to Organisms (LS2) Ecosystems (LS3) Heredity (LS4) Biological Evolution Earth and Space Sciences: (ESS1) Earth's Place in the Universe (ESS2) Earth's Systems (ESS3) Earth and Human Activity Engineering Design: (ETS1.A) Defining and Delimiting an Engineering Problem (ETS1.B) Developing Possible Solutions (ETS1.C) Optimizing the Design Solution

Organization of Standards

The Utah SEEd standards are organized into **strands** which represent significant areas of learning within grade level progressions and content areas. Each strand introduction is an orientation for the teacher in order to provide an overall view of the concepts needed for foundational understanding. These include descriptions of how the standards tie together thematically and which DCIs are used to unite that theme. Within each strand are **standards**. A standard is an articulation of how a learner may demonstrate their proficiency, incorporating not only the disciplinary core idea but also a crosscutting concept and a science and engineering practice. While a standard represents an essential element of what is expected, it does not dictate curriculum—it only represents a proficiency level for that grade. While some standards within a strand may be more comprehensive than others, all standards are essential for a comprehensive understanding of a strand's purpose.

The standards of any given grade or course are not independent. SEEd standards are written with developmental levels and learning progressions in mind so that many topics are built upon from one grade to another. In addition, SEPs and CCCs are especially well paralleled with other disciplines, including English language arts, fine arts, mathematics, and social sciences. Therefore, SEEd standards should be considered to exist not as an island unto themselves, but as a part of an integrated, comprehensive, and holistic educational experience.

Each standard is framed upon the three dimensions of science to represent a cohesive, multi-faceted science learning outcome.

- Within each SEEd Standard **Science and Engineering Practices are bolded**.
- Crosscutting Concepts are underlined.
- Disciplinary Core Ideas are added to the standard in normal font with the relevant DCIs codes from the *K–12 Framework* (indicated in parentheses after each standard) to provide further clarity.
- Standards with *specific engineering expectations are italicized*.
- Many standards contain additional emphasis and example statements that clarify the learning goals for students.
  - Emphasis statements highlight a required and necessary part of the student learning to satisfy that standard.
  - Example statements help to clarify the meaning of the standard and are not required for instruction.

An example of a SEEd standard:

- **Standard K.2.4** **Design and communicate a solution** to address the effects that living things (plants and animals, including humans) experience while trying to survive in their surroundings. *Define the problem by asking questions and gathering information, convey designs through sketches, drawings, or physical models, and compare designs*. Emphasize students working from a plant, animal, or human perspective. Examples could include a plant growing to get more sunlight, a beaver building a dam, or humans caring for the Earth by reusing and recycling natural resources. (ESS3.C, ETS1.A, ETS1.B, ETS1.C)

Each part of the above SEEd standard is identified in the following diagram:

Science and Engineering Practices (SEP) are bolded:

Design and communicate a solution to address the effects that living

Crosscutting Concepts (CCC) are underlined:

Design and communicate a solution to address the effects that living

Disciplinary Core Ideas (DCI) are added in the standard in regular/normal font:

Design and communicate a solution to address the effects that living things (plants and animals, including humans) experience while trying to survive in their surroundings. *Define the problem by asking questions*

Disciplinary Core Idea (DCI) codes are listed in parentheses at the end of each standard:

for the Earth by reusing and recycling natural resources. (ESS3.C, ETS1.A, ETS1.B, ETS1.C)

Engineering Expectations are italicized:

to survive in their surroundings. *Define the problem by asking questions and gathering information, convey designs through sketches, drawings, or physical models, and compare designs***.** Emphasize students working from

Emphasis Statements start with the word "Emphasize…":

physical models, and compare designs. Emphasize students working from a plant, animal, or human perspective. Examples could include a plant

Example Statements start with "Examples could include…":

a plant, animal, or human perspective. Examples could include a plant growing to get more sunlight, a beaver building a dam, or humans caring for the Earth by reusing and recycling natural resources. (ESS3.C, ETS1.A,

Goal of the SEEd Standards

The Utah SEEd Standards is a research-grounded document aimed at providing accurate and appropriate guidance for educators and stakeholders. But above all else, the goal of this document is to provide students with the education they deserve, honoring their abilities, their potential, and their right to utilize scientific thought and skills for themselves and the world that they will build.

[1] National Research Council. 2012. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165. This consensus research document and its chapters are referred to throughout this document as a research basis for much of Utah's SEEd standards.

[2] Most Utah SEEd Standards are based on the Next Generation Science Standards (NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press) http://www.nextgenscience.org

EARTH AND SPACE SCIENCE

INTRODUCTION

The Earth and space science SEEd Standards investigate processes and mechanisms that have resulted in the formation of our Earth, galaxy, and universe. Students develop models to illustrate the life span of the Sun and the role of nuclear fusion releasing energy in the Sun's core. Students analyze and interpret data to construct an explanation for Earth's 4.6 billion year history and explore changes to Earth's systems. Students develop and use a model of Earth's interior to describe the cycling of matter by thermal convection. Students plan and carry out an investigation on the properties of water to determine its effects on Earth materials. Students use computational thinking to explain sustainable and natural resources, focusing on responsible stewardship. Additionally, students design and evaluate solutions to problems that exist in these areas.

Strand ESS.1: MATTER AND ENERGY IN SPACE

The Sun releases energy that eventually reaches Earth in the form of electromagnetic radiation. The Big Bang theory is supported by observations of distant galaxies receding from our own as well as other evidence. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, releasing electromagnetic energy. Heavier elements are produced when certain massive stars reach a supernova stage and explode. New technologies advance science knowledge including space exploration.

- **Standard ESS.1.1** **Develop a model** based on evidence to illustrate the life span of the Sun and the role of nuclear fusion releasing energy in the Sun's core. Emphasize energy transfer mechanisms that allow energy from nuclear fusion to reach Earth. Examples of evidence for the model could include observations of the masses and lifetimes of other stars, or non-cyclic variations over centuries. (PS1.C, PS3.D, ESS1.A, ESS1.B)

- **Standard ESS.1.2** **Construct an explanation** of the Big Bang theory based on astronomical evidence of electromagnetic radiation, motion of distant galaxies, and composition of matter in the universe. Emphasize redshift of electromagnetic radiation, cosmic microwave background radiation, and the observed composition and distribution of matter in the universe. (PS4.B, ESS1.A)

- **Standard ESS.1.3** **Develop a model** to illustrate the changes in matter occurring in a star's life cycle. Emphasize that the way different elements are created varies as a function of the mass of a star and the stage of its lifetime. (PS3.D, ESS1.A)

- **Standard ESS.1.4** **Design a solution** to a space exploration challenge by *breaking it down into smaller, more manageable problems that can be solved through the* structure and function of *a device. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution*. Examples of problems could include, cosmic radiation exposure, transportation on other planets or moons, or supplying energy to space travelers. (ESS1.A, ESS1.B, ETS1.A, ETS1.B, ETS1.C)

Strand ESS.2: PATTERNS IN EARTH'S HISTORY AND PROCESSES

Although active geologic processes have destroyed or altered most of Earth's early rock record, evidence from within Earth and from other objects in the solar system are used to infer Earth's geologic history. 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. 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 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 and co-evolution of life.

- **Standard ESS.2.1** **Analyze and interpret data** to construct an explanation for the changes in Earth's formation and 4.6 billion year history. Examples of data could include the absolute ages of ancient Earth materials, the size and composition of solar system objects like meteorites, or the impact cratering record of planetary surfaces. (ESS1.C)

- **Standard ESS.2.2** **Develop and use a model** based on evidence of Earth's interior and describe the cycling of matter by thermal convection. Emphasize the density of Earth's layers and mantle convection driven by radioactive decay and heat from Earth's early formation. Examples of evidence could include maps of Earth's three-dimensional structure obtained from seismic waves or records of the rate of change of Earth's magnetic field. (PS1.C, ESS2.A, ESS2.B)

- **Standard ESS.2.3** **Construct an explanation** for how plate tectonics results in patterns on Earth's surface. Emphasize past and current plate motions. Examples could include continental and ocean floor features such as mountain ranges and mid-ocean ridges, magnetic polarity preserved in seafloor rocks, or regional hot spots. (ESS2.B)

- **Standard ESS.2.4** **Develop and use a model** to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales. Emphasize how the appearance of land and seafloor features are a result of both constructive forces and destructive mechanisms. Examples of constructive forces could include tectonic uplift or mountain building. Examples of destructive mechanisms could include weathering or mass wasting. (ESS2.B)

(Continued)

- **Standard ESS.2.5** **Engage in argument from evidence** for how the simultaneous co-evolution of Earth's systems and life on Earth led to periods of stability and change over geologic time. Examples could include how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants or how the evolution of corals created reefs that altered patterns of coastal erosion and deposition providing habitats for the evolution of new life forms. (LS4.D, ESS2.D, ESS2.E)

- **Standard ESS.2.6** Evaluate **design solutions** that reduce the effects of natural disasters on humans. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution*. Examples of natural disasters could include earthquakes, tsunamis, hurricanes, drought, landslides, floods, or wildfires. (ESS3.B, ETS1.A, ETS1.B, ETS1.C)

Strand ESS.3: SYSTEM INTERACTIONS: ATMOSPHERE, HYDROSPHERE, AND GEOSPHERE

The abundance of liquid water on Earth's surface and its unique properties are central to the planet's dynamics and system interactions. The foundation for Earth's global weather and climate systems is electromagnetic radiation from the Sun. The ocean exerts a major influence on weather and climate by absorbing energy from the Sun, releasing it over time, and globally redistributing it through ocean currents. Changes in the atmosphere due to human activity increase carbon dioxide concentrations and thus affect climate. Current scientific models predict that future average global temperatures will continue to rise, although regional climate changes will be complex and varied.

- **Standard ESS.3.1** **Plan and carry out an investigation** of the properties of water and its effects on Earth materials and surface processes. Examples of properties could include water's capacity to expand upon freezing, dissolve and transport material, or absorb, store, and release energy. (ESS2.C)

- **Standard ESS.3.2** **Construct an explanation** of how heat (energy) and water (matter) move throughout the oceans causing patterns in weather and climate. Emphasize the mechanisms for surface and deep ocean movement. Examples of mechanisms for surface movement could include wind, Sun's energy, or the Coriolis effect. Examples of mechanisms for deep ocean movement could include water density differences due to temperature or salinity. (ESS2.C, ESS2.D)

- **Standard ESS.3.3** **Construct an explanation** for how energy from the Sun drives atmospheric processes and how atmospheric currents transport matter and transfer energy. Emphasize how energy from the Sun is reflected, absorbed, or scattered; how the greenhouse effect contributes to atmospheric energy; and how uneven heating of Earth's atmosphere combined with the Coriolis effect creates an atmospheric circulation system. (PS3.A, ESS1.B, ESS2.A, ESS2.D)

- **Standard ESS.3.4** **Analyze and interpret** patterns in **data** about the factors influencing weather of a given location. Emphasize the amount of solar energy received due to latitude, elevation, the proximity to mountains and/or large bodies of water, air mass formation and movement, and air pressure gradients. (ESS2.D)

(Continued)

- **Standard ESS.3.5** **Develop and use** a quantitative **model** to describe the cycling of carbon among Earth's systems. Emphasize each of Earth's systems (hydrosphere, atmosphere, geosphere, and biosphere) and how the movement of carbon from one system to another can result in changes to the system(s). Examples could include more carbon absorbed in the oceans leading to ocean acidification or more carbon present in the atmosphere leading to a stronger greenhouse effect. (LS2.B, ESS2.D, ESS3.D)

- **Standard ESS.3.6** **Analyze and interpret data** from global climate records to illustrate changes to Earth's systems throughout geologic time and make predictions about future variations using modern trends. Examples of data could include average sea surface temperature, average air temperature, composition of gasses in ice cores, or tree rings. (ESS2.D, ESS3.D)

- **Standard ESS.3.7** **Engage in argument from evidence** to support the claim that one change to Earth's surface can create climate feedback loops that cause changes to other systems. Examples of climate feedbacks could include ice-albedo or warming oceans. (PS3.B, ESS2.A)

Strand ESS.4: STABILITY AND CHANGE IN NATURAL RESOURCES

Humans depend on Earth's systems for many different resources, including air, water, minerals, metals, and energy. Resource availability has guided the development of human society and is constantly changing due to societal needs. Natural hazards and other geologic events have shaped the course of human history. The sustainability of human societies, and the biodiversity that supports them, requires responsible management of natural resources. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that reduce ecosystem degradation. They also evaluate solutions to resolve complex global and localized problems that contain inherent social, cultural, and environmental impacts in an effort to improve the quality of life for all.

- **Standard ESS.4.1** **Construct an explanation** for how the availability of natural resources, the occurrence of natural hazards, and changes in climate affect human activity. Examples of natural resources could include access to fresh water, clean air, or regions of fertile soils. Examples of factors that affect human activity could include that rising sea levels cause humans to move farther from the coast or that humans build railroads to transport mineral resources from one location to another. (ESS3.A, ESS3.B)

- **Standard ESS.4.2** **Use computational thinking** to explain the relationships between the sustainability of natural resources and biodiversity within Earth systems. Emphasize the importance of responsible stewardship of Earth's resources. Examples of factors related to sustainability could include costs of resource extraction, per-capita consumption, waste management, agricultural efficiency, or levels of conservation. Examples of natural resources could include minerals, water, or energy resources. (ESS3.A)

- **Standard ESS.4.3** Evaluate **design solutions** for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios on large and small scales. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution*. Emphasize the conservation, recycling, and reuse of resources where possible and minimizing impact where it is not possible. Examples of large-scale solutions could include developing best practices for agricultural soil use or mining and production of conventional, unconventional, or renewable energy resources. Examples of small-scale solutions could include mulching lawn clippings or adding biomass to gardens. (ESS3.A, ETS1.A, ETS1.B, ETS1.C)

- **Standard ESS.4.4** Evaluate **design solutions** for a major global or local environmental problem based on one of Earth's systems. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution*. Examples of major global or local problems could include water pollution or availability, air pollution, deforestation, or energy production. (ESS3.C, ETS1.A, ETS1.B, ETS1.C)

Utah State Board of Education
250 East 500 South
P.O. Box 144200
Salt Lake City, UT 84114-4200

Sydnee Dickson, Ed.D.
State Superintendent of Public Instruction

www.schools.utah.gov