The EUHSD Earth Systems curriculum document identifies what students should be able to know by grade level in a comprehensive Next Generation Science Standards-based course of study. The curriculum document is updated annually based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD curriculum document contains the following documents and/or information:

A. Course Description
B. Course Guidelines/Requirements - graduation credit information, transcript information, adopted materials, adopted technology, assessment outline
C. Instructional Materials References
D. Scope and Sequence Map with Essential Standards outlined by Unit
E. References to key essential design and implementation documents

A comprehensive course of study and/or program is designed so that all students have access to the rigorous curriculum necessary to graduate high school demonstrating college and career readiness skills. Student-Centered learning provides opportunity for collaboration, communication, and a robust learning environment and provides opportunities for all students to meet the goals of the district’s Instructional Focus at the time of this writing: “All students communicate their thinking, ideas and understanding by effectively using oral, written and/or non-verbal expression.”

Key design considerations in the transition to the new California Next Generation Science Standards is a focus on changes in pedagogy. The NGSS instructional shifts guide classroom teaching and learning and form the foundation of curriculum and instructional design. Specific references to the key NGSS Instructional shifts are outlined within the 2015/2016 California Science framework document.

The curriculum document is aligned to the California Next Generation Science Standards: [http://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp](http://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp)
Earth Systems Course Description

The introductory course of Earth Systems is based on the Next Generation Science Standards for California Public Schools. Earth Science is designed to teach students to apply the laws, theories and principles of earth science to everyday phenomena. Earth Science consists of a group of sciences that deal with the Earth and its neighbors in space, including geology, oceanography, meteorology, and astronomy.

Course Requirements

<table>
<thead>
<tr>
<th>Course Length: Year Long</th>
<th>Grade Level: 9-12</th>
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<tbody>
<tr>
<td>UC/CSU Requirement: Meets UC/CSU “d” requirements</td>
<td>Graduation Requirement: Meets EUHSD Physical Science graduation requirement</td>
</tr>
<tr>
<td>Course Number (Semester A): 6080</td>
<td>Transcript Abbreviation (Semester A): EARTH SYSTEMS A P</td>
</tr>
<tr>
<td>Course Number (Semester B): 6081</td>
<td>Transcript Abbreviation (Semester B): EARTH SYSTEMS B P</td>
</tr>
<tr>
<td>Credits (Semester A): 5 Physical Science</td>
<td>Credits (Semester B): 5 Physical Science</td>
</tr>
<tr>
<td>Required Prerequisite/s: Completion or Concurrent Enrollment in Algebra 1 or Math 1 (Integrated)</td>
<td>Recommended Prerequisite/s: None</td>
</tr>
<tr>
<td>Board Approval Date (Curriculum): April 17, 2018</td>
<td>Board Approval Date (Materials):</td>
</tr>
<tr>
<td>Core Instructional Material/s: This course does not use a single textbook or resource but rather a set high quality Open Educational Resources (OERs); see the Supplemental Instructional Materials section next to this one for more detailed information.</td>
<td>Supplemental Instructional Material/s: A variety of supplemental instructional materials are used in this course and are identified in the Scope and Sequence and are also included in the detailed unit and lesson plans that are companions to this document. These supplemental instructional materials include the following: Humboldt State University's Open Educational Resources Library Oswego State University's Open Educational Resources Library</td>
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<tr>
<td>Technology Resource/s:</td>
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<tr>
<td>- Individual student computer</td>
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<tr>
<td>- Variety of classroom laboratory equipment (see specific units)</td>
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<td>Assessment/s:</td>
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<tr>
<td>- Each unit of instruction outlines key performance based tasks required in order to address specific CA NGSS skills.</td>
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<tr>
<td>- Specific unit plans will be developed and will contain key unit formative and summative NGSS aligned assessments.</td>
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<tr>
<td>- Assessment is ‘science’ and three-dimensional learning must be assessed three dimensionally. To assess our students, we plan and conduct investigations about student learning and then analyze and interpret data to develop models of what students are thinking. These models allow us to predict the effect of additional teaching that addresses patterns we notice in student understanding and misunderstanding. Assessment allows us to progressively improve our teaching practice, spiraling upward.</td>
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<tr>
<td>Meeting the Needs of ELs:</td>
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<tr>
<td>- Utilize the student information system to acquire the language levels of EUHSD English Learners.</td>
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<tr>
<td>- In 2012, the CA Department of Education adopted new language level proficiency descriptors and new EL state standards. Visit the following website to learn more about those new descriptors and corresponding standards: <a href="http://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf">http://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf</a></td>
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</table>

Credits (Semester A): 5 Physical Science

Credits (Semester B): 5 Physical Science

Required Prerequisite/s: Completion or Concurrent Enrollment in Algebra 1 or Math 1 (Integrated)

Recommended Prerequisite/s: None

Board Approval Date (Curriculum): April 17, 2018

Board Approval Date (Materials):
In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: http://www.cde.ca.gov/ci/rl/cf/documents/elaeldtwchapter11.pdf
The Scope and Sequence Guide is a California standards based document that delineates the standards based skills students are expected to know and do in order to meet College and Career Readiness expectations. Each unit of study in the Scope and Sequence document is designed to build upon the previous unit and/or prerequisite coursework in support of student mastery of specific standards based skills. The Scope and Sequence document provides the framework of understanding for key assignments, key assessments, and instructional resources and strategies that serve to assist students in meeting unit-learning objectives. The document will be updated annually with input from all stakeholders.

In coursework requiring reading and writing, the following standards are not specifically stated in any one unit of study, but are the result of implementation throughout the curriculum as students participate in reading, writing, and speaking/listening standards based activities.

- By the end of grade 11, students will read and comprehend literary nonfiction in the grades 11-CCR text completely and proficiently, with scaffolding as needed at the high range. (Reading Informational Text Standard 10)
- Students will write routinely over extending time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks and purposes. (Writing Standard 10)
- “To be college and career ready, students must have ample opportunities to take part in a variety of rich and structured conversations – as part of a whole class, in small groups, and with a partner – build around important content in various domains. They must be able to contribute appropriately to conversations, make comparisons and contrasts, and analyze and synthesize a multitude of ideas according to the standards of evidence appropriate to a particular discipline.” (Standards for ELA Anchor Standards for Speaking/Listening)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Semester</th>
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<td>2: Origins of Earth</td>
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<td>3: Plate Tectonics</td>
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<td>4: Natural Hazards</td>
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<tr>
<td>5: Human Impacts on Earth’s Systems</td>
<td>2</td>
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<tr>
<td>6: Designing Solutions to Human Impacts</td>
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Earth Systems Scope and Sequence
Unit 1 – Earth’s Place in the Universe
Length: 7 Weeks

Unit Description: Students investigate the origins of matter in the universe and the source of energy for Earth. Students explore evidence for how stars are the source of nearly all the chemical elements in our known universe that provide the necessary ingredients for Earth. Nuclear processes within stars (i.e., fusion) combine lighter elements into heavier elements. These elements make up our planet Earth and are the building blocks for all living and nonliving systems. Through a series of investigations, students discover how stars work and that their motion tells us about the origin of the Universe.

Focus Unit Standards:

Performance Expectations (PE):

**HS-ESS1-1:** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy in the form of radiation. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun’s core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun’s radiation varies due to sudden solar flares (“space weather”), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun’s nuclear fusion.]

**HS-ESS1-2:** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the Universe. [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]

**HS-ESS1-3:** Communicate scientific ideas about the way stars, over their life cycle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]

Key Learning Objectives:

**Students will be able to…**

- Use the periodic table and a model of atomic structure to explain the differences between atoms of the same element in terms of charge, mass, and sub particles.
- Identify and communicate the relationships between the life cycle of the stars, the production of elements, and the conservation of the number of protons plus neutrons in stars.
- Develop models to explain changes to atomic structure from fusion, fission, and radioactive decay, showing how energy is released in each.
- Construct a causal explanation for how different wavelengths of electromagnetic radiation are emitted from stars.
- Explain which pieces of valid and reliable evidences support particular components of the Big Bang Theory (i.e., composition of stars, H/He ratio, redshift, and cosmic background radiation).
- Use light as evidence to write an argument about the origin of the universe.

Essential Questions:

- What is light and where does it come from in our universe?
- What do the motion of stars tell us about the origin of the Universe and our planet?

Key Unit Assignments and Assessments:

- **1-1 Atomic Structure:** Students use computer simulations of atoms as a modeling tool to identify and describe the components of an atom and the relationships between subatomic particles. Students use data from the simulations to write an explanation about how the number and type of subatomic particles affects the identity, charge, mass, and nuclear stability for an atom. Students identify which testable scientific questions on Earth can be answered using evidence based on the nuclear stability for an atom.

- **1-2 Light and Matter:** Students observe different spectral tubes and organize the data to construct a claim about the relationship between the type of element and the absorption lines. Students will use this relationship to plan and conduct an investigation to determine the identity of an unknown element using a flame test. Students use data from the flame test to write an argument, supported by evidence and reasoning, about the identity of the unknown element. Last, students use combined information from relevant texts and their flame test data to explain how the phenomenon of photon emission is used by astronomers as evidence that stars produce elements through the process of nuclear fusion. Students do this by...
HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]

HS-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

**Disciplinary Core Ideas (DCI):**

- **ESS1.A:** The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- **ESS1.D:** Nuclear Fusion processes in the center of the sun release the energy ultimately reaches Earth as radiation.
- **ESS1.A:** The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and nonstellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
- **ESS1.A:** 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, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.
- **PS4.B:** Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

- What fuels stars and will they ever run out of that fuel?

annotating provided texts to create a model of the life cycle of our sun that includes information on how nuclear fusion changes over time.

- **1-3 Expanding Universe:** Students simulate the expansion of the universe and use data to explain the relationship between distance and time for galaxies in our universe. Students evaluate Einstein’s claim that the universe is static and use evidence from redshift to revise this claim.

- **1-4 Finding a new Earth:** Students use an HR diagram to explain how much longer we have until we lose our sun. Next, they make predictions about the future of stars and which ones will likely be the best element factories for future planets. Last, they are given 3 exoplanets with data on the star(s) in their solar system. Students use a Hertzsprung-Russell (HR) diagram to argue which planet is the most viable replacement for Earth.

- **1-5 Lab Safety:** Students will participate in lab safety training. Students will participate in a written lab safety test. Students must complete the test with at least 80% accuracy.

- **1-6 Portfolio/ Interactive Notebook:** Students will create a portfolio that will serve as storage of their lab reports, research projects (short and long term), and other key documents and learning experiences. Teachers may choose to utilize a print or digital notebook.
**ESS1.A:** The study of stars’ light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.

**PS3.A:** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

**PS2.B:** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformation of matter, as well the contact forces between material objects.

**PS1.C:** 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.

**PS4.B:** Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

**Scientific and Engineering Practices (SEP):**
- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

**Cross Cutting Concepts (CCC):**
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change
Earth Systems Scope and Sequence
Unit 2 – Origins of Earth
Length: 6 Weeks

Unit Description: Students explore and evaluate the bodies of evidence from light and orbiting bodies in our Solar System that allow us to explain the origins of Earth. They use these ideas to argue how gravity has affected the formation of our planet and continues to shape Earth’s systems. Students model how Earth’s systems have simultaneously co-evolved to shape our world today.

Focus Unit Standards:

**HS-ESS1-4:** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler’s laws of orbital motions should not deal with more than two bodies, nor involve calculus.]

**HS-PS2-1:** Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

**HS-ESS1-6:** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth’s oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

**HS-ESS2-7:** Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth’s surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the coevolution of Earth’s systems and life on Earth.]

Key Learning Objectives:

Students will be able to...

- Explain how Kepler’s three laws are used as mathematical representations that can predict the movement of orbiting bodies in our solar system.
- Construct an argument how gravity affects or controls the motion of the solar system.
- Given mathematical models, predict how orbits change due to gravitational effects from, or collisions with, other objects in the solar system.
- Explain how gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Use reasoning to connect the evidence (i.e., ancient Earth materials, meteorites, and other planetary surfaces) to construct the explanation of Earth’s formation and early history.
- Use evidence from absolute dating magnetic reversals to explain the formation of continents.
- Use multiple bodies of evidence to argue how Earth’s systems simultaneously co-evolved.
- Assess whether evidence is logically consistent with claims on how the ocean formed.
- Evaluate claims made about the age of the Earth and how it formed based on evidence from meteorites, other planets, and isotopes on Earth.

Essential Questions:

- Why do the planets move the way they do?
- What is the position of the sun in the solar system?

Key Unit Assignments and Assessments:

- **PT 2-1 Geocentrism vs Heliocentrism:** Students evaluate claims that the Earth is flat using evidence from observations of eclipses and orbital motion. Next, students use this evidence to evaluate the claim that the sun orbits the Earth. Last, students generate an infographic to explain to a broad audience what evidence is accessible to refute geocentric claims.

- **PT 2-2 Orbits:** Students use a computer simulation to observe properties of planetary motion that support Kepler’s Laws. Students change the location of the planet in relation to the sun while studying the path shape and gravitational and velocity vectors associated with orbiting motion. Students record their findings and compare it to real-world data and write an argument for whether or not the simulation is a valid tool for predicting orbital motion.

- **PT 2-3 Timeline of Earth:** Students construct a timeline of the history of Earth using evidence from relative and absolute data based ancient Earth materials, meteorites, and other planetary surfaces. Students use this timeline to evaluate the causal reasoning behind different arguments for the age of the Earth. Students present the age of the Earth they consider most valid based on the assembled evidence.
evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth’s other systems.]

**Disciplinary Core Ideas (DCI):**

- **ESS1.B:** Kepler’s laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.

- **PS2.B:** Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.

- **ESS1.C:** Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history.

- **ESS2.D:** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

- **ESS1.C:** Continental rocks which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.

- **PS2.A:** Newton’s second law accurately predicts changes in the motion of macroscopic objects.

**Scientific and Engineering Practices (SEP):**

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data

- What processes form a rocky planet?
- How do we know the age of Earth?
- How was our ocean formed?

- **PT 2-4 Co-Evolution of Earth’s Systems:** Students are presented with pictures of Earth (e.g., blue Earth, red Earth, and Gray Earth) that represent different shifts that occurred to the biosphere, geosphere, atmosphere, and hydrosphere. Students collect and evaluate evidence that they match to each picture of Earth. Students develop a model to explain one of the shifts between the different stages of Earth’s evolution.
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

**Cross Cutting Concepts (CCC):**
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change
Earth Systems Scope and Sequence
Unit 3 – Plate Tectonics
Length: 5 Weeks

**Unit Description:** In this unit, students investigate the bodies of evidence that allow us to explain what lies below our feet and how internal and surface processes shape landform features (e.g., valleys, volcanoes, and mountains) on our planet. Students design experiments to collect data that will allow us to predict what happens when these processes are disrupted. Additionally, they use various bodies of evidence to create timelines and models to explain what is happening in the state of California. Students use these models to argue what California will look like in 10 and 30 million years in the future.

**Unit Standards:**

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<th>Performance Expectations (PE):</th>
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| **HS-ESS 2-3:** Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth’s three-dimensional structure obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth’s layers from high-pressure laboratory experiments.]

| **HS-ESS1-5:** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).]

| **HS-ESS2-1:** Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and seafloor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as...]

**Learning Objectives:**

- Students will be able to...
  - Identify patterns in seismic data that explain the characteristics of layers of the Earth.
  - Conduct an experiment to investigate how energy moves throughout Earth’s layers to drive mantle convection.
  - Construct a model based on evidence of Earth’s interior to explain seafloor spreading by thermal convection.
  - Revise the model of continental drift with evidence on seafloor spreading and patterns in the ages of crustal rocks.
  - Use computational thinking to explain how the half-life of radioactive isotopes can be used to date rocks.
  - Use models to identify cause and effect relationships between components in Earth’s systems that increase or decrease changes to surface features on our planet.
  - Explain how relative (i.e., law of superposition and fossils) and absolute (i.e., radiometric) dating are used to identify changes to Earth’s surface over time.
  - Argue which pieces of evidences indicate the internal and surface processes (i.e., constructive and deconstructive forces) on the surface of our planet.
  - Synthesize the relevant evidence to explain the theory of plate tectonics and the land features.

**Unit Assignments and Assessments:**

- **PT 3-1 Thermal Convection:** Students design an experiment to investigate the variables that affect thermal convection. Using data from this investigation, students construct a model of thermal convection in a sphere and explain the causal link to seafloor spreading. Adding seismic data to this model, they explain the characteristics for Earth’s layers. Students use the model to write a hypothesis about what would happen if the heat source moved or went away on Earth. They test this hypothesis with their experimental setup and write an argument about how it would affect life on Earth.

- **PT 3-2 Date that rock!:** Students evaluate and revise the model of continental drift with evidence on seafloor spreading and patterns in the ages of crustal rocks. Using the Theory of Plate Tectonics, students are provided locations on the planet with specific surface features. They create a model to explain the creation of these surface features that uses evidence from relative and absolute dating. Students construct a temporal scale that shows the relative times over which the processes acted to produce the surface features. Last, they write an argument for the age of the crustal rocks at these locations based on their temporal scale, timeline from Unit 2, and the Theory of Plate Tectonics.

- **PT 3-3 Future California:** Students use computer simulations to construct a model of the constructive and deconstructive forces in California to predict what California will look like in 10 and 30 million years. Students identify a
Disciplinary Core Ideas (DCI):

ESS 2.A: Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

ESS 2.A: 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.

ESS 2.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. 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.

ESS 2.B: 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.

ESS 2.B: Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth’s crust.

ESS 2.C: The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s that develop as a result of movement at plate boundaries.

- Predict the ages of crustal rocks based on a specific location on the planet.
- Articulate the scientific principles on density that connect evidence to the claim that the Earth has layers and plate boundaries.
- Construct a model to illustrate the relationship between the formation of continental and ocean floor features and Earth’s internal and surface processes operating on different temporal scales.

**Essential Questions:**

- Why does the Earth look the way it does?
- How does the Earth’s surface move?
- How have the features of Earth transformed over geologic time?

Students generate ideas and write a research proposal about additional evidence needed to support their argument.
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.

ESS 2.E: The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it.

PS 1.C: 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.

PS 4.A: Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.

LS 4.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.

LS 4.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.

LS 4.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. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)
## Scientific and Engineering Practices (SEP):
- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

## Cross Cutting Concepts (CCC):
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change
Earth Systems Scope and Sequence
Unit 4 – Natural Hazards
Length: 7 Weeks

Unit Description: Students investigate how human populations have been impacted by natural hazards and the availability of natural resources. They research the risks posed by natural hazards within our own region and design solutions to mitigate the associated risks. Students design and conduct experiments to develop models of the physical and chemical processes that are affecting local watersheds and propose how to mitigate human impacts.

Unit Standards:

Performance Expectations (PE):

**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-PS4-1**: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth. [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]]

**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,]

Learning Objectives:

**Students will be able to…**

- Organize data on population statistics and describe whether there is a correlation with natural resource availability.
- Assess how well evidence supports claims that humans have been impacted by natural hazard occurrences.
- Explain the relationships among wave frequency, wavelength, and speed of waves in various media.
- Use the structure of water to explain its properties when solid, liquid, or a gas.
- Plan and conduct an investigation to collect data that explains factors that affect the dissolving process and recrystallization.
- Use a model to explain the relationship between atomic structure, molecular structure, polarity, and intermolecular forces.
- Plan and conduct an investigation to determine how intermolecular forces in solutions affect bulk properties, such as: melting point, boiling point, vapor pressure, and surface tension.
- Describe how the properties of water affect the presence of surface features on Earth through chemical (e.g., chemical weathering and recrystallization) and physical processes (e.g., stream transportation, erosion, and frost wedging).
- Design and conduct an investigation into the factors that affect erosion, which involve stream

Unit Assignments and Assessments:

- **PT 4-1 Floods**: Students investigate the “perfect storm” of climatic and weather events sent a record amount of water flooding through the Upper Mississippi River Drainage Basin. Climate models predict that as the global climate changes, it is likely that there will be larger and more frequent storms, which will lead to larger flood events like the flood of 1993. In this task, students use recurrence intervals from the Mississippi River to estimate the expected size and frequency of 100-year and 500-year floods for historical data (1943 to 1992) and an imaginary future scenario where large floods are more frequent (1943 to 2021). They compare the recurrence interval versus discharge on semi-log scatterplots and consider data from global climate models to make evidence based-claims about how changing climate in a warming world will influence river discharge and flood events. Last, students use FEMA flood maps to investigate similar risks in Escondido and write a proposal to the City about how to mitigate these risks.

- **PT 4-2 Earthquake**: Students investigate the risk of local Earthquakes and how building codes and additional planning measures mitigate the risk for harm to property and the lives of residents. Students are presented with a scenario that involves a 12 month outage from water aqueducts to San Diego County that are disrupted by a large earthquake on the San Andreas fault. Students research how we get
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).

**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. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]

**Disciplinary Core Ideas (DCI):**

- **ESS 3.A:** Resource availability has guided the development of society. 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.

- **PS 3.B:** Energy cannot be created or destroyed but it can be transported from one place to another and transferred between systems.

- **PS 4.A:** The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

- **ESS 3.B:** 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.

- **PT 4-3 Molecular Geometry:** Students pour a fine stream of water and place a charged balloon next to the stream. Students record observations that are used to generate scientific questions relevant to investigating the phenomenon. Next, students use 3 dimensional models of molecules to make a prediction about how using molecules different from water might impact the phenomenon. Using lewis structures, students draw a visual that explains the observations they record about different solutions and how they are affected by a charge. Last, students are asked to organize data on bulk properties (e.g., melting point, boiling point, vapor pressure, or surface tension) for different types of molecules and are asked to write explanations for the relationships they can infer between molecular geometry, polarity, strength of intermolecular forces, and the data.

- **PT 4-4 Stream Table:** Using stream tables, students plan and conduct an investigation into different factors that affect water based erosion in San Diego County watersheds. Through these experiments, students explore the various mechanical and chemical processes that contribute to the hydrologic and rock cycle. Students construct a model to explain the chemical and physical processes that impact erosion in our local watersheds and pose benefits and risks to human populations.
**Scientific and Engineering Practices (SEP):**
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**Cross Cutting Concepts (CCC):**
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# Earth Systems Scope and Sequence

## Unit 5 – Human Impacts on Earth’s Systems

**Length:** 5 Weeks

### Unit Description:
Students investigate how humans can and do affect local and global systems. Students begin by designing and conducting experiments to investigate the effects of sea level rise on local beach erosion. Using data from these experiments, students create proposals for local coastal governments to prepare for the next century of erosion. They complete their research into human impacts on Earth’s systems by modeling ocean acidification and exploring how the changes in the atmosphere are impacting marine organisms.

### Unit Standards:

#### Performance Expectations (PE):

- **HS-ESS2-6**: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: 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.]

- **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.]

#### HS-PS3-1:
Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.][Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]

### Learning Objectives:

Students will be able to…

- Develop a model that explains carbon cycling from one sphere to another and the relationships between components in the systems.
- Create model to identify and describe the components and mechanisms that affect the input, output, storage, and redistribution of energy on our planet and how this affects the climate.
- Use models and computational representations from Unit 2 to explain how changes in the tilt of Earth and the shape of its orbit around the sun have affected ice ages and the climate.
- Use computational representations to predict how climate is changed by different natural and anthropogenic activities, both locally and globally.
- Use geoscience data from global climate models to forecast current and future impacts to Earth systems.
- Analyze geoscience data and climate models to forecast the rate of ocean acidification.
- Evaluate technology-based solutions used to mitigate the impact of human activity.
- Model the relationships among Earth’s systems (hydrosphere, atmosphere, biosphere, and geosphere).
- Use geoscience data from global climate models to forecast current and future impacts to Earth systems.

### Unit Assignments and Assessments:

- **PT 5-1 Beach Erosion**: Students design and conduct experiments to investigate the effects of forecasted climate change on beach erosion in North County San Diego. Students construct models based on their research to explain how the cost is changing from dynamic surface processes. Using these models, students create forecasts for how the coast of San Diego County will change over the next 200 years. Students write proposals for local coastal governments to prepare for these changes and how to potentially mitigate them with technology based solutions.

- **PT 5-2 Ocean Acidification**: What is pH and how does carbon dioxide released from the burning of fossil fuels increase the acidity of the ocean? Students explore the answers to these questions in this two-part lab investigation. Students first model ocean acidification and conduct experiments with gases and solutions to revise this model. Next, students construct models to quantify the flow of energy in and out of Earth’s systems and the impact it has on climate. Last, students use data from our atmosphere and oceans to predict how pH levels will change over time.
| HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems. [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-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).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.] |
| 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. [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.] |

**Disciplinary Core Ideas (DCI):**

- **ESS 3.D:** The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space.

- **cryosphere, geosphere, and/or biosphere**

  - **regarding nitrogen and water.**
  - **Evaluate the role of the ocean as a buffer in the heat transfer.**
  - **Evaluate effects of human changes in local watersheds on the ocean and local water availability.**
  - **Analyze data to identify the effects of human activity (e.g., fossil fuel use) on Earth’s systems.**
  - **Use data to describe a particular unanticipated or unintended effect of a technology on Earth’s systems.**
  - **Explain a mechanism for the feedbacks between two of Earth’s systems and whether the feedback is positive or negative.**

**Essential Questions:**

- **How are humans impacting the carbon cycle?**
- **How is the planet affected by human activity?**
- **How have humans affected our local water supply?**
ESS 2.A: Earth’s systems being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

ESS 1.B: 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.

ESS 2.D: Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

ESS 2.D: 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 gasses added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.

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Earth Systems Scope and Sequence
Unit 6 – Designing Solutions to Human Impacts
Length: 6 Weeks

Unit Description: In this unit, students explore solutions to human impacts on Earth’s systems. Through the lens of our local watersheds in San Diego County, students design solutions to challenges faced by the use of the Colorado river basin. Next, students investigate technologies for clean water access and optimize how these tools are used for human populations. Using this water based context, they investigate the relationship between the management of natural resources, the sustainability of human populations, and biodiversity. Last, students propose solutions for challenges faced by human activities, such as the use of power plants for our electrical grid.

Unit Standards:

Performance Expectations (PE):

**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-ESS3-2**: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [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

Learning Objectives:

Students will be able to…
- Identify and design solutions to challenges faced by the use of the Colorado River basin.
- Evaluate the economics, environmental impacts, geopolitical costs, risks, and benefits with designed solutions to water use in San Diego County.
- Design and conduct an investigation into the efficiency and environmental impact of different power plants.
- Create a computational simulation to illustrate the relationships between the management of natural resources to supply these power plants and their impacts on human populations and biodiversity.
- Evaluate solutions to global challenges by taking into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.
- Computationally model whale populations to make recommendations on how to reduce the impact of human activities.

Essential Questions:
- How do we design and evaluate solutions to human impacts on Earth’s systems?

Unit Assignments and Assessments:

- **PT 6-1 Water in San Diego County**: Students investigate the challenges facing the Colorado River basin and how they affect water usage in San Diego County. Students identify and design solutions based on economic, environmental, geopolitical costs, risk, and benefits. Each solution is evaluated based on the reliability and validity of evidence. Students write an argument for how they would proceed with developing sustainable solutions for water usage in our county, particularly with the flow of the Escondido Creek.

- **PT 6-2 Recycled Water**: Students design and conduct an investigation into different water purification technologies to determine the possible refinements. Students describe and quantify the criteria and constraints for water purification and the tradeoffs with specific design decisions. Students write a proposal about how to refine a specific water purification technology to reduce the impact of human activities on natural systems, such as the Carlsbad and San Dieguito watersheds.

- **PT 6-3 Power Plants**: Students synthesize scientific information to evaluate the efficiency and environmental impact of different power...
Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.

**HS-LS4-6**: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

**HS-ETS1-1**: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

**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.

**HS-ETS1-4**: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Disciplinary Core Ideas (DCI):**

- **ESS 3.C**: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- **ESS 3.C**: Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
- **ESS 3.D**: Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.
- **LS 2.C**: Moreover, anthropogenic changes (induced by human activity) in the environment – including habitat destruction, pollution, introduction of invasive plants. They use this information to create a computational simulation to illustrate the relationships between the management of natural resources to supply these power plants and their impacts on human populations and biodiversity. Students must propose which of the nine currently available power plant designs are best to achieve this goal of reducing human and environmental impact. Students define the criteria and constraints for each proposed power plant and their effect on overall stability of and changes in natural systems; and cost, safety, and reliability.

- **PT 6–4 Whales**: Students explore the phenomenon of how anthropogenic sounds affect marine mammals, such as whales. They plan and conduct an investigation to count blue whales off the coast of Southern California with data from local researchers. Students use the counts of whales to present a recommendation to the Navy about how to mitigate the impact of vessels and training exercises. Last, students create a simulation to test a possible solution to reduce the impact of human activities on whale populations and the resulting biodiversity of that system.
species, overexploitation, and climate change – can disrupt an ecosystem and threaten the survival of some species.

ESS 3.C: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

ETS1.A: 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.

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.

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.

ETS1.B: Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

ETS1.C: 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.

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