4th Grade - Thematic Model - Bundle 3
Waves and Earth Features

This is the third bundle of the 4th Grade Thematic Model. Each bundle has connections to the other bundles in the course, as shown in the Course Flowchart.

Bundle 3 Question: This bundle is assembled to address the question "what evidence of patterns and systems do we see in erosion, waves, and Earth features?"

Summary

The bundle organizes performance expectations with a focus on helping students build understanding of waves, Earth features, and energy transfer. Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, but recognize that instruction is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

The idea that when waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach (PS4.A as in 4-PS4-1) could connect to the idea that a variety of hazards result from natural processes such as tsunamis, earthquakes, volcanic eruptions (ESS3.B as in 4-ESS3-2).

Both of these concepts can be connected to the idea that water—as well as ice, wind, living organisms, and gravity—breaks rocks, soils, and sediments into smaller particles and moves them around (ESS2.A as in 4-ESS2-1). This idea also connects to the concepts that energy is present whenever there are moving objects (PS3.B as in 4-PS3-3), and that living things affect the physical characteristics of their regions (ESS2.E as in 4-ESS2-1). This last idea connects to the concept that the energy and fuels that humans use are derived from natural sources and their use affects the environment in multiple ways (ESS3.A as in 4-ESS3-1).

The idea that most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans (ESS2.B as in 4-ESS2-2) also connects to the idea that a variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts (ESS3.B as in 4-ESS3-2).

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of developing and using models (4-PS4-1), planning and carrying out investigations (4-ESS2-1), analyzing and interpreting data (4-ESS2-2), constructing explanations and designing solutions (4-PS3-4 and 4-ESS3-2), and obtaining, evaluating, and communicating information (4-ESS3-1). Many other practice elements can be used in instruction.

Bundle Crosscutting Concepts

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the crosscutting concepts of Patterns (4-PS4-1 and 4-ESS2-2), Cause and Effect (4-ESS2-1, 4-ESS3-1, and 4-ESS3-2), and Energy and Matter (4-PS3-4). Many other crosscutting concepts elements can be used in instruction.

All instruction should be three-dimensional.

Performance Expectations	4-PS3-4 **Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.*] 4-PS4-1 **Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*] 4-ESS2-1 **Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.** [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [*Assessment Boundary: Assessment is limited to a single form of weathering or erosion.*] 4-ESS2-2 **Analyze and interpret data from maps to describe patterns of Earth's features.** [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.] 4-ESS3-1 **Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.** [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.] 4-ESS3-2 **Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*** [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [*Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.*]
Example Phenomena	Some parts of the country get a lot of earthquakes and other parts never have earthquakes. Wind turbines can generate electricity.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. Students could *define a simple design problem that can be solved through the development of a system* [that] ***transfers energy from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light***. 4-PS3-4 **Developing and Using Models** • Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Students could *collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regularly occurring events,* [such as the relationship between] ***locations*** [and] ***mountain ranges***. 4-ESS2-2

Additional Practices Building to the PEs (Continued)	**Planning and Carrying Out Investigations** • Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. Students could *test two different models of the same proposed process* [intended to] ***reduce the impact of a hazard resulting from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions)*** *to determine which* [model] *better meets criteria for success*. 4-ESS3-2 **Analyzing and Interpreting Data** • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Students could *represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships*, [such as the relationship between] ***rainfall*** [and the movement of] ***soils***. 4-ESS2-1 **Using Mathematical and Computational Thinking** • Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems. Students could *describe, measure, and graph quantities such as area, volume, weight, and time to address scientific questions* [related to] ***water and gravity breaking rocks, soils, and sediments into smaller particles and moving them around***. 4-ESS2-1 **Constructing Explanations and Designing Solutions** • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation. Students could *use evidence (e.g., measurements, observations, patterns) to support an explanation* [that] ***when waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach***. 4-PS4-1 **Engaging in Argument from Evidence** • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. Students could *make a claim about the merit of a solution* [that] ***"produces energy"*** [or] ***converts stored energy into a desired form for practical use*** *by citing relevant evidence about how it meets the criteria and constraints of the problem*. 4-PS3-4 **Obtaining, Evaluating and Communicating Information** • Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices. Students could *combine information* [about] ***the locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes*** *in written text with that contained in corresponding tables, diagrams, and/or charts to support scientific arguments*. 4-ESS2-2

Additional Crosscutting Concepts Building to the PEs	**Patterns** • Patterns of change can be used to make predictions. Students could describe that ***humans cannot eliminate the hazards [that] result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions) but can take steps to reduce their impacts,*** [including by using] *patterns of change to make predictions* [about the timing and location of hazards]. 4-ESS3-2 **Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. Students could *identify cause and effect relationships* [such as the relationship between] ***disturbing the surface*** [of] ***water*** [and production of] ***waves***; students could *use* [these relationships] *to explain change*. 4-PS4-1 **Energy and Matter** • Energy can be transferred in various ways and between objects. Students could describe how *energy can be transferred in various ways and between objects* [using the example of] ***water, ice, wind, living organisms, and gravity breaking rocks, soils, and sediments into smaller particles and moving them around***. 4-ESS2-1
Additional Connections to Nature of Science	**Science Investigations Use a Variety of Methods** • Science methods are determined by questions. Students could describe how the *science methods* [they used to investigate] ***water, ice, wind, living organisms, and gravity breaking rocks, soils, and sediments into smaller particles and moving them around*** [were] *determined by* [their] *questions*. 4-ESS2-1 **Science Addresses Questions about the Natural and Material World** • Science findings are limited to what can be answered with empirical evidence. Students could describe how *science [questions and investigations about]* ***energy and fuels that humans use*** *are limited to what can be answered with empirical evidence*. 4-ESS3-1

4-PS3-4 Energy

Students who demonstrate understanding can:

4-PS3-4. **Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Apply scientific ideas to solve design problems.

Disciplinary Core Ideas

PS3.B: Conservation of Energy and Energy Transfer

- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

PS3.D: Energy in Chemical Processes and Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.

ETS1.A: Defining Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.*(secondary)*

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects.

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Connections to Engineering, Technology, and Applications of Science

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

- Engineers improve existing technologies or develop new ones.

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Connections to Nature of Science

Science is a Human Endeavor

- Most scientists and engineers work in teams.
- Science affects everyday life.

Observable features of the student performance by the end of the grade:		
1	Using scientific knowledge to generate design solutions	
	a	Given a problem to solve, students collaboratively design a solution that converts energy from one form to another. In the design, students:
		i. Specify the initial and final forms of energy (e.g., electrical energy, motion, light).
		ii. Identify the device by which the energy will be transformed (e.g., a light bulb to convert electrical energy into light energy, a motor to convert electrical energy into energy of motion).
2	Describing* criteria and constraints, including quantification when appropriate	
	a	Students describe* the given criteria and constraints of the design, which include:
		i. Criteria:
		1. The initial and final forms of energy.
		2. Description* of how the solution functions to transfer energy from one form to another.

		ii. Constraints:
		1. The materials available for the construction of the device.
		2. Safety considerations.
3	Evaluating potential solutions	
	a	Students evaluate the proposed solution according to how well it meets the specified criteria and constraints of the problem.
4	Modifying the design solution	
	a	Students test the device and use the results of the test to address problems in the design or improve its functioning.

4-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

4-PS4-1. **Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

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Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns.

Disciplinary Core Ideas

PS4.A: Wave Properties

- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. *(Note: This grade band endpoint was moved from K–2.)*
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

Crosscutting Concepts

Patterns

- Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.

Observable features of the student performance by the end of the grade:		
1	Components of the model	
	a	Students develop a model (e.g., diagrams, analogies, examples, abstract representations, physical models) to make sense of a phenomenon that involves wave behavior. In the model, students identify the relevant components, including:
		i. Waves.
		ii. Wave amplitude.
		iii. Wavelength.
		iv. Motion of objects.
2	Relationships	
	a	Students identify and describe* the relevant relationships between components of the model, including:
		i. Waves can be described* in terms of patterns of repeating amplitude and wavelength (e.g., in a water wave there is a repeating pattern of water being higher and then lower than the baseline level of the water).
		ii. Waves can cause an object to move.
		iii. The motion of objects varies with the amplitude and wavelength of the wave carrying it.
3	Connections	
	a	Students use the model to describe*:
		i. The patterns in the relationships between a wave passing, the net motion of the wave, and the motion of an object caused by the wave as it passes.
		ii. How waves may be initiated (e.g., by disturbing surface water or shaking a rope or spring).
		iii. The repeating pattern produced as a wave is propagated.
	b	Students use the model to describe* that waves of the same type can vary in terms of amplitude and wavelength and describe* how this might affect the motion, caused by a wave, of an object.

	c	Students identify similarities and differences in patterns underlying waves and use these patterns to describe* simple relationships involving wave amplitude, wavelength, and the motion of an object (e.g., when the amplitude increases, the object moves more).

4-ESS2-1 Earth's Systems

Students who demonstrate understanding can:

4-ESS2-1. **Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.** [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [*Assessment Boundary: Assessment is limited to a single form of weathering or erosion.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

ESS2.E: Biogeology

- Living things affect the physical characteristics of their regions.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change.

Observable features of the student performance by the end of the grade:		
1	Identifying the phenomenon under investigation	
	a	From the given investigation plan, students identify the phenomenon under investigation, which includes the following idea: the effects of weathering or the rate of erosion of Earth's materials.
	b	From the given investigation plan, students identify the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon.
2	Identifying the evidence to address the purpose of the investigation	
	a	From the given investigation plan, students describe* the data to be collected that will serve as the basis for evidence.
	b	From the given investigation plan, students describe* the evidence needed, based on observations and/or measurements made during the investigation, including:
		i. The change in the relative steepness of slope of the area (e.g., no slope, slight slope, steep slope).
		ii. The kind of weathering or erosion to which the Earth material is exposed.
		iii. The change in the shape of Earth materials as the result of weathering or the rate of erosion by one of the following:
		1. Motion of water.
		2. Ice (including melting and freezing processes).
		3. Wind (speed and direction).
		4. Vegetation.
	c	Students describe* how the data to be collected will serve as evidence to address the purpose of the investigation, including to help identify cause and effect relationships between weathering or erosion, and Earth materials.
3	Planning the investigation	
	a	From the given investigation plan, students describe* how the data will be collected, including:
		i. The relative speed of the flow of air or water.
		ii. The number of cycles of freezing and thawing.
		iii. The number and types of plants growing in the Earth material.

		iv. The relative amount of soil or sediment transported by erosion.
		v. The number or size of rocks transported by erosion.
		vi. The breakdown of materials by weathering (e.g., ease of breaking before or after weathering, size/number of rocks broken down).
	b	Students describe* the controlled variables, including:
		i. Those variables that affect the movement of water (e.g., flow speed, volume, slope).
		ii. Those variables that affect the movement of air.
		iii. The water temperature and forms of matter (e.g., freezing, melting, room temperature).
		iv. The presence or absence of plants growing in or on the Earth material.
4	Collecting the data	
	a	Students make and record observations according to the given investigation plan to provide evidence for the effects of weathering or the rate of erosion on Earth materials (e.g., rocks, soils, and sediment).

4-ESS2-2 Earth's Systems

Students who demonstrate understanding can:

4-ESS2-2. **Analyze and interpret data from maps to describe patterns of Earth's features.** [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Analyze and interpret data to make sense of phenomena using logical reasoning.

Disciplinary Core Ideas

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.

Crosscutting Concepts

Patterns

- Patterns can be used as evidence to support an explanation.

Observable features of the student performance by the end of the grade:		
1	Organizing data	
	a	Students organize data using graphical displays (e.g., table, chart, graph) from maps of Earth's features (e.g., locations of mountains, continental boundaries, volcanoes, earthquakes, deep ocean trenches, ocean floor structures).
2	Identifying relationships	
	a	Students identify patterns in the location of Earth features, including the locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes. These relationships include:
		i. Volcanoes and earthquakes occur in bands that are often along the boundaries between continents and oceans.
		ii. Major mountain chains form inside continents or near their edges.
3	Interpreting data	
	a	Students use logical reasoning based on the organized data to make sense of and describe* a phenomenon. In their description*, students include that Earth features occur in patterns that reflect information about how they are formed or occur (e.g., mountain ranges tend to occur on the edges of continents or inside them, the Pacific Ocean is surrounded by a ring of volcanoes, all continents are surrounded by water [assume Europe and Asia are identified as Eurasia]).

4-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

4-ESS3-1. **Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.** [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.

- Obtain and combine information from books and other reliable media to explain phenomena.

Disciplinary Core Ideas

ESS3.A: Natural Resources

- Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change.

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Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering.

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

- Over time, people's needs and wants change, as do their demands for new and improved technologies.

Observable features of the student performance by the end of the grade:			
1	Obtaining information		
	a	Students gather information from books and other reliable media about energy resources and fossil fuels (e.g., fossil fuels, solar, wind, water, nuclear), including:	
		i.	How they are derived from natural sources (e.g., which natural resource they are derived from) [note: mechanisms should be limited to grade appropriate descriptions*, such as comparing the different ways energy resources are each derived from a natural resource).
		ii.	How they address human energy needs.
		iii.	The positive and negative environmental effects of using each energy resource.
2	Evaluating information		
	a	Students combine the obtained information to provide evidence about:	
		i.	The effects on the environment of using a given energy resource.
		ii.	Whether the energy resource is renewable.
		iii.	The role of technology, including new and improved technology, in improving or mediating the environmental effects of using a given resource.
3	Communicating information		
	a	Students use the information they obtained and combined to describe* the causal relationships between:	
		i.	Energy resources and the environmental effects of using that energy source.
		ii.	The role of technology in extracting and using an energy resource.

4-ESS3-2 Earth and Human Activity

Students who demonstrate understanding can:

4-ESS3-2. **Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*** [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [*Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Disciplinary Core Ideas

ESS3.B: Natural Hazards

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. *(Note: This Disciplinary Core Idea can also be found in 3.WC.)*

ETS1.B: Designing Solutions to Engineering Problems

- Testing a solution involves investigating how well it performs under a range of likely conditions.*(secondary)*

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change.

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Connections to Engineering, Technology, and Applications of Science

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

- Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.

Observable features of the student performance by the end of the grade:		
1	Using scientific knowledge to generate design solutions	
	a	Given a natural Earth process that can have a negative effect on humans (e.g., an earthquake, volcano, flood, landslide), students use scientific information about that Earth process and its effects to design at least two solutions that reduce its effect on humans.
	b	In their design solutions, students describe* and use cause and effect relationships between the Earth process and its observed effect.
2	Describing* criteria and constraints, including quantification when appropriate	
	a	Students describe* the given criteria for the design solutions, including using scientific information about the Earth process to describe* how well the design must alleviate the effect of the Earth process on humans.
	b	Students describe* the given constraints of the solution (e.g., cost, materials, time, relevant scientific information), including performance under a range of likely conditions.
3	Evaluating potential solutions	
	a	Students evaluate each design solution based on whether and how well it meets the each of the given criteria and constraints.
	b	Students compare the design solutions to each other based on how well each meets the given criteria and constraints.
	c	Students describe* the design solutions in terms of how each alters the effect of the Earth process on humans.