ALIGNMENT WITH THE THREE DIMENSIONS OF NGSS

UNIT 4.3: WHAT CAUSES LAND AND THINGS ON IT TO CHANGE? HOW CAN WE REDUCE THE IMPACTS ON HUMANS?

The following three tables explain how students engage in Science and Engineering Practices, use Crosscutting Concepts, and figure out Disciplinary Core Ideas in this unit's lessons. The codes used to identify each dimension's elements are described in the Teacher Handbook.

Developing and Using Science and Engineering Practices (by Lesson)

Practice	Lesson	How Students Engage In This Practice	Element of This Practice Used in This Lesson
Asking Questions and Defining Problems	1	Students identify that many natural hazards involve wind, water, and/or ground shaking, which they propose can cause land to change. Students use these initial ideas to ask questions about the possible causes of the land changes that they observed in Acadia National Park and brainstorm how those questions can be investigated.	Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (AQDP-E3)
Developing and Using Models	4	Students use a cloth sheet as a model that can be analogized to the characteristics of water waves. This is scaffolded as a whole class activity, as with the wave bin in Lesson 3, but in Lesson 5, students will individually develop models to describe wave characteristics.	Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. (MOD-E3)
Developing and Using Models	5	In Lesson 4, students used a bed sheet "parachute" as an analogy to better understand the characteristics of water waves. In this lesson, students will develop a model using abstract representations (drawings) to describe the patterns in waves and explain how those waves could have caused a ship to be wrecked on a beach, as well as how the wreckage was covered and uncovered over time.	Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. (MOD-E3)
Developing and Using Models	1	Students develop individual initial models and a Class Consensus Model to describe what caused the land changes in Acadia National Park. Since this is the first lesson of the unit, students develop these models with support from specific prompts, icons indicating possible causes, and multiple class discussions. Students will revise this model in future lessons as they figure out what causes land to change at different rates.	Develop and/or use models to describe and/or predict phenomena. (MOD-E4)
Developing and Using Models	7	Students use physical models of materials found at national park sites to test their predictions of which mechanisms of erosion caused the changes to the land they observed.	Develop and/or use models to describe and/or predict

			phenomena. (MOD-E4)
Developing and Using Models	9	In this lesson, students develop and revise a model to describe how an island like Hawai'i can form from repeated volcanic eruptions. Students' use of this element of Developing and Using Models supports their overall development of that practice in this unit.	Develop and/or use models to describe and/or predict phenomena. (MOD-E4)
Planning and Carrying Out Investigations	3	In this lesson, students will make observations of waves in various scenarios and use those observations as evidence when explaining how waves move things. Students will have additional opportunities to develop this practice in future lessons when they use observations as evidence for an explanation of several other land-changing-related phenomena.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)
Planning and Carrying Out Investigations	4	Students make observations of waves in water (represented by a cloth sheet) to serve as evidence for an explanation of wave formation in storms. This builds on the use of the wave bin from Lesson 3 and leads toward Lesson 5, in which students have to draw on experiences from all 3 lessons as they make observations of the impact of waves on a road.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)
Planning and Carrying Out Investigations	5	In Lesson 3, students used observations from their wave bin investigation to support their explanation that water waves do not cause forward motion to an object when it is in deep water, but the waves do move objects in the direction of the wave when they are close to the shore. In Lesson 4, students used observations from an investigation with the wave bins to support their explanation that water waves can vary in size due to changes in the wind. In this lesson, students will return to the wave bins and use the observations of water interacting with a model road to support their explanation that waves can remove land, cause a road to break, and result in road pieces sinking.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)
Planning and Carrying Out Investigations	6	Students make observations from images of national park sites to serve as evidence for an explanation of how land changes happened through weathering and erosion. This work builds on how students have made observations to produce data in prior lessons because they are observing different cases of land change, and their explanations are broadening beyond only water as a mechanism. In Lessons 3, 4, and 5, students made observations of physical models to produce data to support their explanations of waves causing changes to land. In this lesson, students are making observations of land that has changed in images from locations that were clearly not affected by waves. These data will serve as evidence to support their explanation of how erosion works by various mechanisms other than waves.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)

Planning and Carrying Out Investigations	7	Building on the investigations they did with wave bins in Lessons 3-5, students make observations and measurements to produce data to serve as the basis for evidence for their explanations of land changes in multiple national park sites. Their work with this practice in this lesson builds on that of prior lessons because they are working in smaller groups on investigations that they make sense of with less scaffolding before sharing takeaways with the class.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)
Planning and Carrying Out Investigations	8	In this lesson, students make observations of land changes in their communities and use them as additional evidence to explain the mechanisms causing land changes. Students also individually make observations before and after a major rainfall event. They use these observations to explain the effects of the heavy rainfall on the land. All previous experiences with this practice in this unit have been with partners, small groups, and the whole class. In this lesson, students have an opportunity to apply what they've figured out about making observations to produce data to use as evidence for their explanation individually.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)
Planning and Carrying Out Investigations	10	In this lesson, students are making observations to serve as evidence for their explanation of how the landscape of Hawai'i has changed over time. They will identify their observations as sources of evidence when explaining how plants are able to regrow on the island after volcanic eruptions. In previous lessons, students made observations that served as evidence, but now they are identifying the specific sources of evidence that support specific parts of their explanation.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (INV-E3)
Analyzing and Interpreting Data	2	Students analyze and interpret data to make sense of where natural hazards occur and what data are associated with them. Then, students use logical reasoning to figure out that strong storms occurred at the same time near Acadia when the damage occurred.	Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. (DATA-E2)
Analyzing and Interpreting Data	11	In this lesson, students will analyze and interpret data on maps in order to make sense of the locations of land and ocean floor features. They will use the data to determine patterns that can help predict where future volcanic eruptions may happen. Students work in this lesson with partners, small groups, and the whole class. Students will have additional opportunities to develop this practice in Lesson 12 when they analyze and interpret additional data presented through maps in order to determine the patterns that can help predict other natural hazards. They will do that work more independently, with less scaffolding.	Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. (DATA-E2)
Analyzing and Interpreting Data	12	Students analyze and interpret data from maps to make sense of where natural hazards are likely to occur using logical reasoning about patterns. This work builds on Lesson 11; students analyze and interpret maps in a heavily scaffolded fashion	Analyze and interpret data to make sense of phenomena, using logical reasoning,

		by asking students to do much of their analysis in pairs, using a variety of maps, and finally doing an individual analysis using a set of maps and location of choice.	mathematics, and/or computation. (DATA-E2)
Constructing Explanations and Designing Solutions	9	In this lesson, students work in groups to identify that rock layers can be used as evidence to support the explanation that multiple volcanic eruptions formed the island of Hawai'i. Students will also identify observations from a melted wax demonstration as evidence to support the explanation that the island formed from several events over time, rather than a single large event. In the next lesson, students will work in pairs and identify evidence that supports an explanation of how the landscape in Hawai'i has changed over time.	Identify the evidence that supports particular points in an explanation. (CEDS-E3)
Constructing Explanations and Designing Solutions	10	In this lesson, students identify that lava trees and tree molds serve as evidence to support an explanation that the landscape of Hawai'i has changed over time.	Identify the evidence that supports particular points in an explanation. (CEDS-E3)
Constructing Explanations and Designing Solutions	13	In this lesson, students generate multiple solutions to the problem of waves impacting Seawall Road through weathering and erosion. They also identify criteria and constraints for their solutions. In Lessons 14 and 15, students will narrow their solutions through initial analysis (in Lesson 14) and testing (Lesson 15) based on the criteria and constraints.	Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (CEDS-E5)
Constructing Explanations and Designing Solutions	14	Students generate and compare multiple solutions to the problem of protecting Seawall Road from weathering and erosion based on how well the solutions meet the developed criteria and constraints. Students will continue to compare solutions in Lesson 15 after building and testing their design solution.	Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (CEDS-E5)
Constructing Explanations and Designing Solutions	15	Students test and compare multiple solutions to the problem of protecting Seawall Road from weathering and erosion. They will compare solutions in more depth with their Collaborator Group, during the gallery tour, and during the Explore, as they individually collect qualitative data about how each design performed, and as a class, when they discuss how each of the designs met the criteria and constraints during the Consensus Discussion during the Synthesize. Students had the opportunity to generate solutions in Lessons 13 and 14, and that part of the element is not attended to in this lesson.	Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (CEDS-E5)
Constructing Explanations and Designing	16	In Lessons 13-15, students had the opportunity to work in small groups to generate, test, and compare solutions. In this lesson, students will individually compare and evaluate solutions that can help reduce the erosion of the dunes in	Generate and compare multiple solutions to a problem based on how well

Solutions		Indiana Dunes National Park. Students will compare 3 different solutions and determine how well they meet the criteria and constraints.	they meet the criteria and constraints of the design solution. (CEDS-E5)
Obtaining, Evaluating, and Communicating Information	7	Students read and make sense of a newspaper article in order to obtain scientific information about what we can figure out from fossils in rock layers and describe how that information is supported by evidence.	Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence. (INFO-E1)

Developing and Using Crosscutting Concepts (by Lesson)

Crosscutting Concept	Lesson	How Students Use This Crosscutting Concept	Element of This Concept Used in This Lesson
Patterns	2	Students use similarities and differences in the patterns of data that happen during various natural hazards to sort and classify the hazards by where they happen, when they happen, and what data are associated with the hazard. These patterns are used to figure out that storms, with large waves and high winds, occurred at the same time as the damage and changes to the road. This lesson will not explicitly support students in analyzing rates of change; they will investigate different rates of land-changing processes in Lessons 6 and 7.	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. (PAT-E1)
Patterns	4	Students use similarities and differences in patterns to sort and classify waves in 2 contexts: the cloth sheet model and their analysis of the Wind Investigation. This lesson builds on Lesson 2, in which students analyzed similarities and differences in patterns of different natural hazards. Here, they classify waves, a somewhat more abstract phenomenon. In this lesson, students will not analyze simple rates of change; they will do that in the context of other examples of land changing in Lessons 5 and 6.	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. (PAT-E1)
Patterns	5	In Lesson 2, students used patterns with their small groups to sort possible events that could have caused the change to the land in Acadia National Park. In Lesson 4, students used a parachute to classify wave patterns during a whole group activity. In this lesson, students will individually develop a model to explain how patterns of wave motion affected a shipwreck. At the end of this lesson, when students begin to investigate another instance of land changing in Acadia, they start to consider the rates of change at which erosion (not yet named) happens. They will use similarities and differences in patterns from other examples of erosion to analyze those rates of change in Lesson 6.	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. (PAT-E1)
Patterns	6	Students use similarities and differences between phenomena to determine relative rates of change for the phenomena. This builds on prior work in Lessons 2, 4, and 5, continuing the emphasis on rates introduced in Lesson 5. This emphasis is supported in part through the Timescale of Land Changes We Observe chart, which is carried forward to support thinking around rates and timescales in future lessons.	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. (PAT-E1)
Patterns	13	Students sort, classify, communicate, and analyze design products. This builds on students' work in Lesson Set 1, now requiring them to apply pattern thinking to a	Similarities and differences in patterns can be used to sort, classify, communicate

		designed product rather than natural phenomena. This lesson does not address rates of change, as this piece was addressed in Lesson Set 1.	and analyze simple rates of change for natural phenomena and designed products. (PAT-E1)
Patterns	11	In this lesson, students use patterns of change (emergence of ocean floor and land features around the world) to make predictions about which places are most likely to experience volcanic eruptions. Students will have additional opportunities to develop this crosscutting concept in Lesson 12 when they identify patterns of change to make predictions about which places are most at risk for certain natural hazards.	Patterns of change can be used to make predictions. (PAT-E2)
Patterns	12	Students use patterns of change (emergence of natural hazards around the world) to make predictions about which places are most at risk from them. This builds on Lesson 11 by providing students many more patterns to make sense of and giving students the opportunity to apply these patterns individually in the exit ticket.	Patterns of change can be used to make predictions. (PAT-E2)
Patterns	1	Students generate a list of natural processes that they think may have caused the changes to the land and roads in Acadia National Park. As students generate this list, they notice that many natural hazards involve wind, water, and/or ground shaking. Students use these patterns to support an initial explanation about the possible cause of the changes to the land. Students' work in this lesson is directly supported by icons that help them identify those patterns of causes and scaffolded by working with partners, groups, and as a whole class. In future lessons, students will use patterns as evidence to support an explanation in different contexts and with less teacher support.	Patterns can be used as evidence to support an explanation. (PAT-E3)
Patterns	6	Students identify patterns in images and data from national park sites to use as evidence to support an explanation of how different physical features were formed through erosion. Students previously leveraged this element in Lesson 1 when they developed initial explanations of the anchoring phenomenon based on photographs, but here they will draw on texts, and in Lesson 7, on experiments, for evidence.	Patterns can be used as evidence to support an explanation. (PAT-E3)
Patterns	7	In this lesson, students identify patterns of fossils that can be used as evidence to support an explanation that the landscape has changed over time.	Patterns can be used as evidence to support an explanation. (PAT-E3)
Patterns	9	Students observe melted wax solidifying into a repeatable pattern of layers. Students will also read about and observe patterns of rock layers. Students use these patterns in the layering of materials to explain how the island of Hawai'i formed from multiple volcanic eruptions over time.	Patterns can be used as evidence to support an explanation. (PAT-E3)

Patterns	10	In this lesson, students will identify patterns in the location of tree molds and lava trees in order to support an explanation that the landscape of Hawai'i has changed over time.	Patterns can be used as evidence to support an explanation. (PAT-E3)
Cause and Effect	1	Students observe the land in Acadia National Park before and after an event that caused a change to the land and a road on it. Students use prior knowledge about ways that land can change to develop initial explanations about what caused the land to change. In future lessons, students test their ideas and adjust their explanations based on evidence to explain the changes they observed. In this lesson, students are supported in using this crosscutting concept with specific and direct prompts from the teacher, as well as class discussion and recording class ideas on charts. In later lessons, students will continue to identify and use cause-and-effect relationships to explain change in different contexts with less teacher support.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	3	Using wave bins, students test and identify that waves near the shore cause objects to move toward/onto the shore; they use this cause-and-effect relationship to explain the changes to Seawall Road (specifically the rocks being moved onto the road).	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	4	Students use cause-and-effect relationships to identify, test, and explain changes in waves. This builds on students' consideration of cause-and-effect relationships in the wave bin in Lesson 3 and prepares students to explain the full Seawall Road phenomenon in Lesson 5 and consider other phenomena, like the Tay shipwreck.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	5	In Lessons 3 and 4, students used the wave bins (models) to test how waves (cause) can make rocks move (effect). Students also test how increasing the force (cause) relates to the amplitude of the waves (effect). Students use these cause-and-effect relationships to explain how the land and things on it were changed. In this lesson, students use the wave bins to test how the waves (cause) can destroy a road (effect). Later in this lesson, students use cause-and-effect relationships to explain the changes to a shipwreck that is found on the beach over time. Students will continue to build their use of this crosscutting concept in future lessons when they work to develop explanations of how land and things on it can change due to causes that are not related to ocean waves.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	8	In this lesson, students consider the cause-and-effect relationship between mechanisms of erosion and the changes to land they cause in various communities, including their own. In Lessons 3-5, students determined the cause-and-effect relationship between the location and size of waves and the movement of objects in those waves, but now they are applying cause-and-effect relationships to another context: what causes changes to land in their communities.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)

Cause and Effect	10	In this lesson, students identify the cause-and-effect relationship between rainfall and plant growth and use this relationship to explain how plants in Hawai'i can regrow more quickly/more densely in some parts of the island than others after volcanic eruptions. In this lesson, students will not test these relationships. Students will have additional opportunities to develop this crosscutting concept by testing cause-and-effect relationships in Lesson 15.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	14	Students consider cause-and-effect relationships between design solutions and weathering and erosion-prevention techniques. In Lesson 14, students make predictions about the cause-and-effect relationship. They will test their solution to compare the effects of all groups' designs in Lesson 15.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	15	Students start to identify the effects of the design tests during the Collaborator Group and gallery tour as they observe all of the groups' results. The class will discuss the effects of each design they observed during the discussion in the Synthesize.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Cause and Effect	16	In previous lessons, students identified how wind and water can cause land to change. In this lesson, students will evaluate how well solutions can reduce the effects of wind on the dunes in Indiana Dunes National Park.	Cause and effect relationships are routinely identified, tested, and used to explain change. (CE-E1)
Scale, Proportion, and Quantity	5	In this lesson, students will begin to consider the relative time it could have taken for ocean waves to erode rock. Students will share initial ideas that some changes to the land could take long periods of time, which is different from the examples they have seen so far, in which the land changed in a very short amount of time.	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. (SPQ-E1)
Stability and Change	1	Students notice that changes to the land and road in Acadia can be measured in terms of differences over time, and they begin to raise questions about those changes occurring at different rates (many students will identify the changes to Acadia's land and road as fast changes, but some may not be convinced, and students may have questions about the rate of changes in the related phenomena they identify, as well). In this lesson, students' work with this element is scaffolded with specific teacher prompting. The class will continue to explore changes over time that happen at different rates as the unit goes on, and have more opportunities to use the concepts of stability and change in different contexts and with varied amounts of support.	Change is measured in terms of differences over time and may occur at different rates. (SC-E1)

Stability and Change	6	Students use the idea that change is measured in terms of differences over time and may occur at different rates when they create the Timescale of Land Changes We Observe chart, which they will add to in Lesson 7 and use as a reference in future lessons.	Some systems appear stable, but over long periods of time will eventually change. (SC-E2)
Stability and Change	7	Students use the idea that change is measured in terms of differences over time and may occur at different rates when they consider where their examples of land changing would fall along their Timescale of Land Changes We Observe chart (started in Lesson 6 and added to in this lesson).	Some systems appear stable, but over long periods of time will eventually change. (SC-E2)

Developing and Using Disciplinary Core Ideas (by Lesson)

Disciplinary Core Idea	Lesson	What Students Do to Figure Out This Idea	Element of This Idea Used in This Lesson
ETS1.B Developing Possible Solutions	13	In this lesson, students research problems related to weathering and erosion due to water, building on the research on Seawall Road from Lesson Set 1. They do not test solutions in this lesson, as they will do so in Lesson 15.	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (ETS1.B-E1) In PEs: 3-5-ETS1-2, secondary to 4-ESS3-2
ETS1.B Developing Possible Solutions	15	Students test how well their solutions perform under a range of likely conditions by generating different sizes of waves to test their designs. This is meant to simulate small, everyday waves and the large waves Seawall Road experienced during the coastal storm that damaged it.	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (ETS1.B-E1) In PEs: 3-5-ETS1-2, secondary to 4-ESS3-2
ETS1.B Developing Possible Solutions	16	In Lesson 15, students figured out that testing their solutions involves investigating how well they perform under a range of likely conditions by generating different sizes of waves to test their designs. In this lesson, students will read a book about scientists who investigate solutions to coastal erosion and observe several proposed solutions to the problem of erosion. Students will apply what they have figured out about testing and comparing solutions on an individual assessment about designing solutions to reduce erosion in Indiana Dunes National Park.	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (ETS1.B-E1) In PEs: 3-5-ETS1-2,

			secondary to 4-ESS3-2
ETS1.B Developing Possible Solutions	14	Students figure out that communicating with peers about proposed solutions to minimize erosion is an important part of the design process. This can lead to improved designs by working with a small group to compare how initial designs based on criteria and constraints, by doing a Gallery Tour to give and receive peer feedback, and by engaging in a discussion to further ask questions of peers.	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (ETS1.B-E3) In PE: 3-5-ETS1-2
ESS1.C The History of Planet Earth	7	Students figure out that patterns of rock formations reveal changes over time due to Earth forces when they investigate how erosion over time has changed the land at Guadalupe Mountains National Park. They also figure out that the presence and location of certain fossil types indicate the order in which rock layers were formed when they read and make sense of information obtained from a newspaper article.	Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (ESS1.C-E1) In PE: 4-ESS1-1
ESS1.C The History of Planet Earth	9	In this lesson, students figure out that rock formations reveal changes over time due to Earth forces, such as volcanic activity. They figure out that the island of Hawai'i formed from multiple volcanic eruptions over time. They observe rock formations and notice layers to determine that several events happened over time rather than a single large event that led to the formation of the island. Students will also use the rock layers to identify the relative order of events, from oldest to most recent. In the next lesson, students will continue to look at rock layers and explore how fossils can help to indicate the relative order of the layers.	Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (ESS1.C-E1) In PE: 4-ESS1-1

ESS1.C The History of Planet Earth	10	Students figure out that patterns in layers of volcanic rock and the things preserved on and in them reveal changes over time due to volcanic eruptions. They figure out that the presence of lava trees and tree molds provides evidence for changes to Hawai'i's landscape over time. Students had a previous opportunity to consider the locations of fossils and the evidence they provided about the order in which the layers were formed when they investigated Guadalupe Mountains National Park in Lesson 7.	Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (ESS1.C-E1) In PE: 4-ESS1-1
ESS2.A Earth Materials and Systems	1	In this first lesson of the unit, students begin to identify patterns in the natural hazards they propose as possible causes of the land changing in Acadia National Park. They begin to wonder if water, wind, and/or ground shaking could result in the changes they've noticed (e.g., rocks being moved, a road being broken up). Depending on the related phenomena students discuss, the class might also propose initial ideas about ice or living things breaking up or moving land. The questions students raise in this lesson will motivate their work to figure out these ideas as the unit goes on. In Lessons 6, 7, and 10, students will figure out more about how wind, water, ice, and living things can break rock into smaller pieces and move them around. This lesson will not likely raise initial ideas about rainfall affecting the type of living things found in a region, or how living things affect the characteristics of their regions. Students will work with those ideas in Lesson 10.	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.A-E2) In PE:4-ESS2-1
ESS2.A Earth Materials and Systems	5	In this lesson, students begin to explore how water can break rocks and move sediments around. This lesson will not support students in figuring out how ice, wind, living organisms, or gravity can break rocks and/or move them around; they will figure out these ideas in Lessons 6 and 7.	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.A-E2) In PE:4-ESS2-1

ESS2.A Earth Materials and Systems	6	Students build on what they figured out about Seawall Road in previous lessons when they investigate Thunder Hole in this lesson and figure out that the wind and waves that broke the road are able to make greater changes over longer periods of time. They use information about weathering and erosion mechanisms to identify other possibilities for how land is broken into smaller pieces and moved around, including rainfall, ice, living things, and gravity (not named). They observe patterns of evidence for these mechanisms at national park sites, and in Lesson 7, they will go on to gather more evidence to support these proposed mechanisms. This lesson will not address "Rainfall affects the types of living things found in a region," as this idea is addressed in Lesson 10.	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.A-E2) In PE:4-ESS2-1
ESS2.A Earth Materials and Systems	7	Students figure out that rainfall helps to shape land by exploring the effects of a heavy rainfall event in Guadalupe Mountains National Park. They will also figure out that water, ice, wind, and falling can break rocks, soils, and sediments into smaller pieces and move them around when they engage in investigations and discussions related to land change in various national parks. Students' work in this lesson builds on work they did in *Unit 2.1: How do wind and water change the shape of land and what can we do about it?*. In that unit, students identified that wind and water can move land, and now in this unit, students look for patterns in rates of these changes by investigating how different amounts of water, wind, or freeze/thaw cycles affect land differently. This lesson will not address how rainfall affects the types of living things found in a region, or how living things can be mechanisms of erosion. Students will explore these ideas in Lesson 10.	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.A-E2) In PE:4-ESS2-1
ESS2.A Earth Materials and Systems	8	Students figure out that land can be changed by water, ice, wind, living organisms, and/or gravity (not named) by making observations of land changing in their community and in a community in Montana, and using these observations as evidence of the effects of weathering and erosion. Students have previously figured out about land changes when specific examples of it were presented to them. In this lesson, they will need to observe an environment and identify the changes to the land and the mechanisms that they think caused those changes. This lesson will give students an initial opportunity to notice some changes made to land and things on it by living things, if they notice something like that in their community. They will not formally discuss living organisms as mechanisms of change until Lesson 10. This lesson will not address the ways that rainfall affects the types of living things found in a region; students will investigate this idea in Lesson 10.	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.A-E2) In PE:4-ESS2-1

ESS2.A Earth Materials and Systems	10	Students figure out that rainfall affects the amount of plants in an area by making observations of photos of areas of Hawai'i with varying amounts of plants, and comparing the locations of those photos to a rainfall data map in order to determine that the areas of the island with high amounts of rainfall are also the areas with many plants. They also figure out that plants can affect the physical characteristics of the island by breaking volcanic rock into smaller pieces, which allows for more plant growth. This lesson will not address how water, ice, wind, or gravity break land apart. Students figured out about these mechanisms of erosion in Lessons 6 and 7.	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.A-E2) In PE:4-ESS2-1
ESS2.B Plate Tectonics and Large-Scale System Interactions	9	In this lesson, students begin to figure out that maps can help locate the different land and water features of Earth when they use a variety of maps to help orient them to Hawai'i's location in relation to the continental US and to motivate questions about how the islands formed (surrounded by water). This lesson will not address how the locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns, or that most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans, and major mountain chains form inside continents or near their edges. Students will have opportunities to explore these patterns in Lessons 11 and 12.	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 of Earth. (ESS2.B-E1) In PE: 4-ESS2-2
ESS2.B Plate Tectonics and Large-Scale System Interactions	11	Students figure out by analyzing and interpreting data from maps that the locations of ocean floor structures, mountain ranges, and volcanoes occur in patterns. After analyzing the maps, students describe the patterns in the locations of Earth's features that they noticed. They use the patterns they noticed about the locations of volcanoes to predict and explain where volcanic eruptions are most likely to occur.	The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands

		This lesson will not address the locations of earthquakes. Students will continue analyzing and interpreting data in order to predict the locations of earthquakes by identifying patterns in their locations in Lesson 12.	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 of Earth. (ESS2.B-E1) In PE: 4-ESS2-2
ESS2.B Plate Tectonics and Large-Scale System Interactions	12	Students figure out that earthquakes occur in patterns by examining maps of earthquakes and other natural hazards and Earth features. In the Connect and the exit ticket, students reflect on how maps help locate land and water features of Earth. This lesson focuses students on the locations of earthquakes and how maps can help locate different land and water features of Earth. The rest of this DCI element was addressed in Lesson 11. However, students build on the patterns they noticed in Lesson 11.	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 of Earth. (ESS2.B-E1) In PE: 4-ESS2-2
ESS2.E Biogeology	6	Students obtain information about weathering and erosion mechanisms that indicate that plants and animals can affect the land. Students will continue to develop this idea in Lesson 10 when they figure out how land changes after a volcanic eruption.	Living things affect the physical characteristics of their regions. (ESS2.E-E1) In PE: 4-ESS2-1

ESS2.E Biogeology	10	Students figure out that living things affect the physical characteristics of their regions when they investigate how plants on Hawai'i are able to help break rock into smaller pieces, which allows for more plant growth.	Living things affect the physical characteristics of their regions. (ESS2.E-E1) In PE: 4-ESS2-1
ESS3.B Natural Hazards	1	In this first lesson, students use prior knowledge to identify natural hazards as a possible cause for the changes to the land in Acadia National Park. They draw upon their own experiences and prior learning from *Unit 3.2: Why do plants only grow well in certain places, and how can we protect them?*, if applicable. While this lesson will not directly engage students in identifying ways that humans can reduce the impacts of natural hazards, students may begin to ask questions about how humans can reduce these impacts. Questions from their own experiences and their observations of Acadia National Park motivate students to want to figure out more about natural hazards, and the ways humans can reduce their impacts in future lessons.	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (ESS3.B-E1) In PEs: 3-ESS3-1, 4-ESS3-2
ESS3.B Natural Hazards	2	Students investigate data about a variety of natural hazards to compare the data to what happened in Acadia. This develops the idea that there are a variety of natural hazards that happen in different places around the world, at different times of year, and include different mechanisms that can impact people and the land. This lesson will not address "Humans cannot eliminate natural hazards, but can take steps to reduce their impacts." It will be addressed in Lessons 13, 14, and 15; see the unit front matter for details.	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (ESS3.B-E1) In PEs: 3-ESS3-1, 4-ESS3-2
ESS3.B Natural Hazards	13	In this lesson, students read about a variety of solutions to protect from weathering and erosion due to water. Reflection on these solutions helps them figure out that humans can take steps to reduce the impact of natural hazards, even though they cannot eliminate them. This thinking builds on the idea, developed throughout the unit, that natural hazards result from natural processes. Students will further develop this element in Lesson 15, as they test and evaluate designs intended to reduce the impact of natural hazards.	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (ESS3.B-E1) In PEs: 3-ESS3-1, 4-ESS3-2
ESS3.B Natural Hazards	15	In previous lessons, students figured out that there are a variety of natural hazards that occur due to natural processes like wind and water. In this lesson, students will develop and evaluate solutions that can reduce the impacts of wind and/or water on the land and the things on it.	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can

			take steps to reduce their impacts. (ESS3.B-E1) In PEs: 3-ESS3-1, 4-ESS3-2
ESS3.B Natural Hazards	16	In previous lessons, students figured out that there is a variety of natural hazards that occur due to natural processes, like wind and water. In this lesson, students will develop and evaluate solutions that can reduce the impacts of wind and/or water on the land and things on it.	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (ESS3.B-E1) In PEs: 3-ESS3-1, 4-ESS3-2
PS4.A Wave Properties	3	Students will figure out that waves in deep water do not move things in the direction of the wave when they investigate how rocks move in their wave bins and when they watch videos of a fishing bobber and a seagull floating in deep water waves. They also figure out that waves near a shore can move things in the direction of the wave when they model the setup and conditions near Seawall Road in their wave bins. Students will begin to consider how waves are made when they discuss how to make waves in their wave bin, but they will continue to investigate this in Lesson 4 when they consider what created the waves in Acadia the day Seawall Road was damaged. This lesson will not address the idea that waves of the same type can differ in amplitude and wavelength; they will investigate that in Lesson 4.	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. (PS4.A-E1) In PE: 4-PS4-1
PS4.A Wave Properties	4	Students compare 2 potential causes of wave pattern formation in water to figure out that waves are typically made when wind disturbs the surface of water, such as during storms. This lesson will not address “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,” as this portion was addressed in Lesson 3. Students will go on to apply these ideas to the shipwreck phenomenon in Lesson 5.	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.

			(PS4.A-E1) In PE: 4-PS4-1
PS4.A Wave Properties	5	In Lesson 4, students figured out that waves can move objects forward and backward when they are near a beach, but when those objects are in deep water, they will move up and down as the wave passes. In this lesson, students will apply these ideas to the events of a shipwreck as they explain how the ship was wrecked, pushed onto a beach, and covered and uncovered by the waves moving sand on the beach. Students will continue to use ideas about waves and water as they explain how land changes in different time scales, such as at Thunder Hole in Lesson 6.	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. (PS4.A-E1) In PE: 4-PS4-1
PS4.A Wave Properties	4	Students figure out that waves differ in amplitude and wavelength by observing patterns formed in a cloth sheet when waves are generated. Students apply these ideas to a new context of a shipwreck in Lesson 5.	Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (PS4.A-E2) In PE: 4-PS4-1
PS4.A Wave Properties	5	In Lesson 4, students used the wave bins and a play parachute to figure out that waves can differ in their height and spacing. In this lesson, students will use what they figured out about wave height to explain how waves can destroy a road. Then, students will explain how height differs before and during a storm when they take an assessment to explain the events of a shipwreck.	Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (PS4.A-E2) In PE: 4-PS4-1

Building Toward English Language Arts Standards

In the OpenSciEd Elementary program, students use ELA/literacy to support them in making sense of their science work. Visit the Unit Overview for more information about the connections to these standards.

Texts intended for use in interactive read alouds are approximately two grade levels above the CCSS range for text complexity, and texts intended for scaffolded independent reading are within the CCSS text complexity range for that grade level.

We have noted in the table below the standards that are connected to lessons in two ways:

✱ = This standard is explicitly used and named in the lesson with specific support for teachers.

✔ = This standard is embedded in the work of the unit so frequently that it is not explicitly named in the lessons.

Reading: Informational Text	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
CCSS.ELA-LITERACY.RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.		✔			✱	✔	✔		✔	✔	✔	✔	✔	✔		✔
CCSS.ELA-LITERACY.RI.4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.		✱							✱	✱			✱			
CCSS-ELA-LITERACY.RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.		✔			✔	✔	✔		✔	✔	✔	✔	✔	✔		✔
CCSS-ELA-LITERACY.RI.4.4 Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.		✔			✔	✔	✔		✔	✔	✔	✔	✔	✔		✔
CCSS-ELA-LITERACY.RI.4.6 Compare and contrast a firsthand and secondhand account of the same event or topic; describe the differences in focus and the information provided.														✱		
CCSS-ELA-LITERACY.RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in	✱	✱						✱		✱						

charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.																
CCSS-ELA-LITERACY.RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.						*					*					

Writing	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
CCSS-ELA-LITERACY.W.4.2D Use precise language and domain-specific vocabulary to inform about or explain the topic.					*											*
CCSS-ELA-LITERACY.W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Speaking and Listening	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
CCSS-ELA-LITERACY.SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacherled) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CCSS-ELA-LITERACY.SL.4.1A Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CCSS-ELA-LITERACY.SL.4.1B Follow agreed-upon rules for discussions and carry out assigned roles.	*															
CCSS-ELA-LITERACY.SL.4.1C Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CCSS-ELA-LITERACY.SL.4.1D Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

CCSS-ELA-LITERACY.SL.4.2 Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.						*	*									
CCSS-ELA-LITERACY.SL.4.4 Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.												*	*			

Language	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
CCSS-ELA-LITERACY.L.4.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.						*										
CCSS-ELA-LITERACY.L.4.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 4 reading and content, choosing flexibly from a range of strategies.	✔	✔	*	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CCSS-ELA-LITERACY.L.4.4B Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word (e.g., telegraph, photograph, autograph).		*														
CCSS-ELA-LITERACY.L.4.5C Demonstrate understanding of words by relating them to their opposites (antonyms) and to words with similar but not identical meanings (synonyms).				*												
CCSS-ELA-LITERACY.L.4.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., wildlife, conservation, and endangered when discussing animal preservation).	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Building Toward Mathematics Standards

In the OpenSciEd Elementary program, students use mathematics to support them in making sense of their science work. We have noted in the table below the standards that are supported within lessons in this unit. You may find opportunities to expose students to more math standards than those we have noted in any given lesson, but we have provided this table as a starting point for your instructional planning.

✱ = This standard is explicitly used and named in the lesson with specific support for teachers.

Standards for Mathematical Practice	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
CCSS-MATH-Practice.MP2 Reason abstractly and quantitatively.		✱								✱						
CCSS-MATH-Practice.MP4 Model with mathematics.						✱										
CCSS-MATH-Practice.MP6 Attend to precision.		✱														

Number and Operations—Fractions	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
CCSS-MATH-4.NF.C.7 Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model.								✱								