Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.

MS-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3-1. **Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.** [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

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 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Disciplinary Core Ideas

ESS3.A: Natural Resources

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Connections to Engineering, Technology, and Applications of Science

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

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

Observable features of the student performance by the end of the course:		
1	Articulating the explanation of phenomena	
	a	Students articulate a statement relating a given phenomenon to scientific ideas, including that past and current geoscience processes have caused the uneven distribution of the Earth's resources, including:
		i. That the uneven distributions of the Earth's mineral, energy, and groundwater resources are the results of past and current geologic processes.
		ii. That resources are typically limited and nonrenewable due to factors such as the long amounts of time required for some resources to form or the environment in which resources were created forming once or only rarely in the Earth's history.
	b	Students use evidence and reasoning to construct a scientific explanation of the phenomenon.
2	Identifying the scientific evidence to construct the explanation	
	a	Students identify and describe* the evidence necessary for constructing the explanation, including:
		i. Type and distribution of an example of each type of Earth resource: mineral, energy, and groundwater.
		ii. Evidence for the past and current geologic processes (e.g., volcanic activity, sedimentary processes) that have resulted in the formation of each of the given resources.
		iii. The ways in which the extraction of each type of resource by humans changes how much and where more of that resource can be found.

	b	Students use multiple valid and reliable sources of evidence.	
3	Reasoning		
	a	Students use reasoning to connect the evidence and support an explanation. Students describe* a chain of reasoning that includes:	
		i.	The Earth's resources are formed as a result of past and current geologic processes.
		ii.	The environment or conditions that formed the resources are specific to certain areas and/or times on Earth, thus identifying why those resources are found only in those specific places/periods.
		iii.	As resources as used, they are depleted from the sources until they can be replenished, mainly through geologic processes.
		iv.	Because many resources continue to be formed in the same ways that they were in the past, and because the amount of time required to form most of these resources (e.g., minerals, fossil fuels) is much longer than timescales of human lifetimes, these resources are limited to current and near-future generations. Some resources (e.g., groundwater) can be replenished on human timescales and are limited based on distribution.
		v.	The extraction and use of resources by humans decreases the amounts of these resources available in some locations and changes the overall distribution of these resources on Earth.

MS-ESS3-2 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3-2. **Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.** [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

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 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings.

Disciplinary Core Ideas

ESS3.B: Natural Hazards

- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.

Crosscutting Concepts

Patterns

- Graphs, charts, and images can be used to identify patterns in data.

Connections to Engineering, Technology, and Applications of Science

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

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Observable features of the student performance by the end of the course:		
1	Organizing data	
	a	Students organize given data that represent the type of natural hazard event and features associated with that type of event, including the location, magnitude, frequency, and any associated precursor event or geologic forces.
	b	Students organize data in a way that facilitates analysis and interpretation.
	c	Students describe* what each dataset represents.
2	Identifying relationships	
	a	Students analyze data to identify and describe* patterns in the datasets, including:
		i. The location of natural hazard events relative to geographic and/or geologic features.
		ii. Frequency of natural hazard events.
		iii. Severity of natural hazard events.
		iv. Types of damage caused by natural hazard events.

		v. Location or timing of features and phenomena (e.g., aftershocks, flash floods) associated with natural hazard events.
	b	Students describe* similarities and differences among identified patterns.
3	Interpreting data	
	a	Students use the analyzed data to describe*:
		i. Areas that are susceptible to the natural hazard events, including areas designated as at the greatest and least risk for severe events.
		ii. How frequently areas, including areas experiencing the highest and lowest frequency of events, are at risk.
		iii. What type of damage each area is at risk of during a given natural hazard event.
		iv. What features, if any, occur before a given natural hazard event that can be used to predict the occurrence of the natural hazard event and when and where they can be observed.
	b	Using patterns in the data, students make a forecast for the potential of a natural hazard event to affect an area in the future, including information on frequency and/or probability of event occurrence; how severe the event is likely to be; where the event is most likely to cause the most damage; and what events, if any, are likely to precede the event.
	c	Students give at least three examples of the technologies that engineers have developed to mitigate the effects of natural hazards (e.g., the design of buildings and bridges to resist earthquakes, warning sirens for tsunamis, storm shelters for tornados, levees along rivers to prevent flooding).

MS-ESS3-3 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3-3. **Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*** [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

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 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles to design an object, tool, process or system.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Crosscutting Concepts

Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

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Connections to Engineering, Technology, and Applications of Science

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

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Observable features of the student performance by the end of the course:		
1	Using scientific knowledge to generate design solutions	
	a	Given a problem related to human impact on the environment, students use scientific information and principles to generate a design solution that:
		i. Addresses the results of the particular human activity.
		ii. Incorporates technologies that can be used to monitor and minimize negative effects that human activities have on the environment.
	b	Students identify relationships between the human activity and the negative environmental impact based on scientific principles, and distinguish between causal and correlational relationships to facilitate the design of the solution.
2	Describing* criteria and constraints, including quantification when appropriate	
	a	Students define and quantify, when appropriate, criteria and constraints for the solution, including:
		i. Individual or societal needs and desires.
		ii. Constraints imposed by economic conditions (e.g., costs of building and maintaining the solution).
3	Evaluating potential solutions	
	a	Students describe* how well the solution meets the criteria and constraints, including monitoring or minimizing a human impact based on the causal relationships between relevant scientific principles

		about the processes that occur in, as well as among, Earth systems and the human impact on the environment.
	b	Students identify limitations of the use of technologies employed by the solution.

MS-ESS3-4 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3-4. **Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.** [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

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

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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Connections to Engineering, Technology, and Applications of Science

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

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

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Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Observable features of the student performance by the end of the course:		
1	Supported claims	
	a	Students make a claim, to be supported by evidence, to support or refute an explanation or model for a given phenomenon. Students include the following idea in their claim: that increases in the size of the human population and per-capita consumption of natural resources affect Earth systems.
2	Identifying scientific evidence	
	a	Students identify evidence to support the claim from the given materials, including:
		i. Changes in the size of human population(s) in a given region or ecosystem over a given timespan.

		ii.	Per-capita consumption of resources by humans in a given region or ecosystem over a given timespan.
		iii.	Changes in Earth systems in a given region or ecosystem over a given timespan.
		iv.	The ways engineered solutions have altered the effects of human activities on Earth's systems.
3	Evaluating and critiquing evidence		
	a	Students evaluate the evidence for its necessity and sufficiency for supporting the claim.	
	b	Students determine whether the evidence is sufficient to determine causal relationships between consumption of natural resources and the impact on Earth systems.	
	c	Students consider alternative interpretations of the evidence and describe* why the evidence supports the claim they are making, as opposed to any alternative claims.	
4	Reasoning and synthesis		
	a	Students use reasoning to connect the evidence and evaluation to the claim. In their arguments, students describe* a chain of reasoning that includes:	
		i.	Increases in the size of the human population or in the per-capita consumption of a given population cause increases in the consumption of natural resources.
		ii.	Natural resource consumption causes changes in Earth systems.
		iii.	Because human population growth affects natural resource consumption and natural resource consumption has an effect on Earth systems, changes in human populations have a causal role in changing Earth systems.
		iv.	Engineered solutions alter the effects of human populations on Earth systems by changing the rate of natural resource consumption or mitigating the effects of changes in Earth systems.

MS-ESS3-5 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3-5. **Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

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

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Ask questions to identify and clarify evidence of an argument.

Disciplinary Core Ideas

ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

Crosscutting Concepts

Stability and Change

- Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

Observable features of the student performance by the end of the course:			
1	Addressing phenomena of the natural world		
	a	Students examine a given claim and the given supporting evidence as a basis for formulating questions. Students ask questions that would identify and clarify the evidence, including:	
		i.	The relevant ways in which natural processes and/or human activities may have affected the patterns of change in global temperatures over the past century.
		ii.	The influence of natural processes and/or human activities on a gradual or sudden change in global temperatures in natural systems (e.g., glaciers and arctic ice, and plant and animal seasonal movements and life cycle activities).
		iii.	The influence of natural processes and/or human activities on changes in the concentration of carbon dioxide and other greenhouse gases in the atmosphere over the past century.
2	Identifying the scientific nature of the question		
	a	Students questions can be answered by examining evidence for:	
		i.	Patterns in data that connect natural processes and human activities to changes in global temperatures over the past century.
		ii.	Patterns in data that connect the changes in natural processes and/or human activities related to greenhouse gas production to changes in the concentrations of carbon dioxide and other greenhouse gases in the atmosphere.