

# Phoenixville Area School District Understanding by Design (UbD) Science Template

Grade Level &/or HS Subject: **Environmental Science**

Unit Name: **Sculpting Earth's Surface**

Stage 1 Desired Results		
<b>Overarching NGSS &amp; PA Standards:</b>  <b>HS-ESS2-2</b> Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth Systems.  <b>HS-ESS2-5</b> Plan and conduct an investigation of the properties of water and its effects on Earth's materials and surface processes.  <b>HS-ESS2-7</b> Construct an argument	<i>Transfer</i>	
	<i>Students will be able to independently use their learning to...</i>	
	Ask questions and/or define problems Develop and/or use models Plan and/or carry out investigations Analyze and interpret data using computational thinking Obtain, evaluate, and communicate information (supported by evidence) Construct explanations and design solutions	
	<i>Meaning-Making</i>	
	<i>Students will understand that...</i>  Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures, and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that furthers reduces wetland extent.  Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).  Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increases weathering rates and	<b>ESSENTIAL QUESTIONS</b> <i>Students will keep considering...</i>  How and why is Earth constantly changing?  How do Earth's major systems interact?  How do the properties and movements of water shape Earth's surface and affect its systems?  How do living organisms alter Earth's processes and structures?

<p>based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.</p>	<p>allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.</p>	
<p><b>Which branch(es) of science apply:</b></p> <p><b>LS PS E&amp;S</b></p>	<p><b><i>Knowledge and Skills Acquisition</i></b></p>	
	<p style="text-align: center;"><b>UNDERSTANDINGS</b></p> <p><i>Students will know...</i></p> <p>ESS2A: Earth Materials and Systems -Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.</p> <p>ESS2.C: The Roles of Water in Earth's Surface Processes -The abundance of liquid water on Earth's surface and its unique combinations of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve, and transport materials, and lower the viscosities and melting points of rock.</p> <p>ESS2.D: Weather and Climate -The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.</p>	<p><i>Students will be skilled at...</i></p> <ul style="list-style-type: none"> <li>• Organizing data</li> <li>• Identifying relationships</li> <li>• Interpreting data</li> <li>• Making connections</li> <li>• Identifying the phenomenon to be investigated</li> <li>• Identifying the evidence to answer a question</li> <li>• Planning an investigation</li> <li>• Collecting data</li> <li>• Identifying scientific evidence</li> <li>• Evaluating and critiquing</li> <li>• Reasoning and synthesis</li> </ul>
	<p style="text-align: center;"><b>KEY VOCABULARY</b></p> <p>evaporation, infiltration, runoff, transpiration, evapotranspiration, drainage basin, dissolved load, suspended load, bed load, settling velocity, meanders, cut bank, point bars, oxbow lake, stream valley, floodplain, groundwater, water table, confined aquifer, unconfined aquifer</p>	
<p style="text-align: center;"><b>Stage 2 – Evidence</b></p>		
<p><b>Evaluative Criteria</b></p>	<p style="text-align: center;"><b><i>Assessment Evidence</i></b></p>	
<p>Project Rubrics Labs Quizzes Tests</p>	<p style="text-align: center;"><b>PERFORMANCE TASK(S):</b></p> <p>HS-ESS2-2</p> <ul style="list-style-type: none"> <li>• Students organize data that represent measurements of changes in hydrosphere, cryosphere, atmosphere, biosphere, or geosphere in response to a change in Earth's surface.</li> <li>• Students describe what each data set represents.</li> </ul>	<p>Differentiation Considerations:</p>

- Students use tools, technologies, and/or models to analyze the data and identify and describe relationships in the datasets, including:
  - The relationships between the changes in one system and changes in another (or within the same) Earth system.
  - Possible feedbacks, including one example of feedback to the climate.
- Students analyze data to identify effects of human activity and specific technologies on Earth's system if present.
- Students use the analyzed data to describe a mechanism for the feedback between two of Earth's systems and whether the feedback is positive or negative, increasing (destabilizing) or decreasing (stabilizing) the original changes.
- Students use the analyzed data to describe a particular unanticipated or unintended effect of a selected technology on Earth's systems if present.
- Students include a statement regarding how variation or uncertainty in the data (e.g., limitations, accuracy, any bias in the data resulting from a choice of sample, scale, instrumentation, etc.) may affect the interpretation of the data.

#### HS-ESS2-5

- Students develop an investigation plan and describe\* the data that will be collected and the evidence to be derived from the data, including:
  - Properties of water, including:
    - The heat capacity of water
    - The density of water in its solid and liquid states; and
    - The polar nature of the water molecule due to its molecular structure.
  - The effect of the properties of water on energy transfer that causes the patterns of temperature, the movement of air, and the movement and availability of water at Earth's surface.
  - Mechanical effects of water on Earth materials that can be used to infer the effect of water on Earth's surface processes. Examples can include:
    - Stream transportation and deposition using a stream table, which can be used to infer the ability of water to transport and deposit materials
    - Erosion using variations in soil moisture content, which can be used to infer the ability of water to prevent or facilitate movement of Earth materials; and
    - c) The expansion of water as it freezes, which can be used to infer the ability of water to break rocks into smaller pieces.
  - Chemical effects of water on Earth materials that can be used to infer the effect of water on Earth's surface processes. Examples can include:
    - The solubility of different materials in water, which can be used to infer chemical weathering and recrystallization

- The reaction of iron to rust in water, which can be used to infer the role of water in chemical weathering
  - Data illustrating that water lowers the melting temperature of most solids, which can be used to infer melt generation; and
  - Data illustrating that water decreases the viscosity of melted rock, affecting the movement of magma and volcanic eruptions.
- In their investigation plan, students describe\* how the data collected will be relevant to determining the effect of water on Earth materials and surface processes.
- In their investigation plan, students include a means to indicate or measure the predicted effect of water on Earth's materials or surface processes. Examples include:
  - The role of the heat capacity of water to affect the temperature, movement of air and movement of water at the Earth's surface
  - The role of flowing water to pick up, move and deposit sediment
  - The role of the polarity of water (through cohesion) to prevent or facilitate erosion
  - The role of the changing density of water (depending on physical state) to facilitate the breakdown of rock
  - The role of the polarity of water in facilitating the dissolution of Earth materials
  - Water as a component in chemical reactions that change Earth materials; and
  - The role of the polarity of water in changing the melting temperature and viscosity of rocks.
- In the plan, students state whether the investigation will be conducted individually or collaboratively.
- Students collect and record measurements or indications of the predicted effect of a property of water on Earth's materials or surface.
- Students evaluate the accuracy and precision of the collected data.
- Students evaluate whether the data can be used to infer the effect of water on processes in the natural world.
- If necessary, students refine the plan to produce more accurate and precise data.

#### HS-ESS2-7

- Students develop a claim, which includes the following idea: that there is simultaneous coevolution of Earth's systems and life on Earth. This claim is supported by generalizing from multiple sources of evidence.
- Students identify and describe\* evidence supporting the claim, including:
  - Scientific explanations about the composition of Earth's atmosphere shortly after its formation

	<ul style="list-style-type: none"> <li>○ Current atmospheric composition</li> <li>○ Evidence for the emergence of photosynthetic organisms</li> <li>○ Evidence for the effect of the presence of free oxygen on evolution and processes in other Earth systems</li> <li>○ In the context of the selected</li> <li>● Students evaluate the evidence and include the following in their evaluation <ul style="list-style-type: none"> <li>○ A statement regarding how variation or uncertainty in the data (e.g., limitations, low signal-to-noise ratio, collection bias, etc.) may affect the usefulness of the data as sources of evidence; and</li> <li>○ The ability of the data to be used to determine causal or correlational effects between changes in the biosphere and changes in Earth's other systems.</li> </ul> </li> <li>● Students use at least two examples to construct oral and written logical arguments. The examples: <ul style="list-style-type: none"> <li>○ Include that the evolution of photosynthetic organisms led to a drastic change in Earth's atmosphere and oceans in which the free oxygen produced caused worldwide deposition of iron oxide formations, increased weathering due to an oxidizing atmosphere and the evolution of animal life that depends on oxygen for respiration; and</li> <li>○ Identify causal links and feedback mechanisms between changes in the biosphere and changes in Earth's other systems.</li> </ul> </li> </ul>	
	<p style="text-align: center;">OTHER EVIDENCE:</p> <p>Optional</p> <ul style="list-style-type: none"> <li>● Labs <ul style="list-style-type: none"> <li>○ Stream Table Lab</li> <li>○ Properties of Water Lab</li> <li>○ Angle of Insolation Lab</li> <li>○ Greenhouse Gases Lab</li> </ul> </li> <li>● Unit Test <ul style="list-style-type: none"> <li>○ Running Water</li> <li>○ The Atmosphere</li> </ul> </li> </ul>	Differentiation Considerations: