1 WHERE SHOULD WE BUILD?

INVESTIGATION
1 CLASS SESSION

ACTIVITY OVERVIEW

NGSS CONNECTIONS

Students are introduced to the human impact on land and water use with a scenario that engages them in the issues in the context of a community’s building project. The activity elicits and builds on students’ ideas about the environmental impact of building on particular landforms. Students observe ways in which construction has changed the landscape as population has increased. When considering the impact of development, they apply the cross cutting concept of the influence of science, engineering, and technology on the natural world.

Review the unit overview and assessment chart for a summary of the NGSS taught and assessed in this activity and how the standards are woven together throughout the unit. Decide in advance which assessments you plan to emphasize.

NGSS CORRELATION

Performance Expectations

Working towards MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

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.

Science and Engineering Practices

Asking Questions and Defining Problems: Ask questions to identify and clarify evidence of an argument.
Crosscutting Concepts

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

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.

WHAT STUDENTS DO

Students examine photographs of undeveloped and developed hillsides, wetlands, and cliff top areas. The students then use their observations about changes that have happened to these areas to make a preliminary decision as to which site would be best for building a school and field. They identify which evidence would help them make a more informed decision and that they will consider over the course of the unit.

MATERIALS AND ADVANCE PREPARATION

For the teacher
1 visual aid of Student Sheet 1.1, “Observations Before and After Construction”

For the class
* 1 blank KWL table
* 1 chart paper (optional)

For each student
1 Student Sheet 1.1, “Observations Before and After Construction.”
1 Literacy Sheet, “Facilitating Group Interaction (optional)

TEACHING SUMMARY

GET STARTED
1. Text.

DO THE ACTIVITY
2. Text.
3. Text.

BUILD UNDERSTANDING
4. Text.
TEACHING STEPS

GET STARTED

1. Present the fictitious community of Boomtown.

   a. Introduce students to the need for a new school in the rapidly growing community.
      Explain that there are three possible sites being considered for construction as shown in the
      Student Book map—a hillside, a cliff near the ocean, and a wetland. Clarify that physical
      shapes of the land such as hillsides, cliffs, and marshes are called landforms.

   b. Review the term wetland.
      Students are likely to be able to identify hills and cliffs, but may be less familiar with wetlands.
      Describe a wetland as land saturated with water, such as a marsh or swamp. A marsh is a
      wetland area that is dominated by grasses, while a swamp is dominated by trees. Ask students
      to offer some local examples if there are any wetlands in your area. The marsh that is a
      potential building site in this unit, the Delta Marsh, is a marsh found at the mouth of a river.
      However, since deposition is not introduced until later in the unit, it is not necessary to explain
      the origin of the marshy area or the delta in the fictitious town of Boomtown at this time.

   c. (LITERACY) Elicit students’ ideas with a KWL chart.
      Introduce the usefulness of recording relevant evidence about the sites as the unit progresses to
      help make the decision on where to build in Boomtown. Use the chart paper or projector to
      create a KWL chart for the class that will be completed together as the unit progresses. As a
      class, begin filling in the first two columns of the KWL chart about what they know about
      what changes happen to the land when it is built on. At the end of the activity, revisit the chart
      and add to the last column together.

      The letters KWL refer to the three sections of the literacy strategy that asks, “What do I
      Know? What do I Want to Know? What did I Learn?” KWLs helps students to review what
      they already know, develop relevant questions, and process and apply the information that they
      encounter in the activities. Periodically in the unit, ask students to revisit the chart with ideas
      and questions generated from the activities. For more information on the KWL chart, see the
      Literacy section of Teacher Resources II, “Diverse Learners.”

DO THE ACTIVITY

2. If you have not previously done so, introduce the SEPUP model for collaborative work.

   a. Introduce SEPUP’s 4–2–1 model for collaborative work.
      Explain that many of the activities in this book utilize the SEPUP 4–2–1 cooperative learning
      model. Students work in groups of four or in pairs to share, discuss, compare, and revise their
      ideas and to conduct investigations and activities. In all cases, each individual student is
      responsible for contributing ideas, listening to others, recording and analyzing their results, and

1 SELTKW1
2 NGSPAQ3
monitoring their own learning.

b. Clarify which situations are appropriate for collaboration and which are appropriate for working independently.

In science, collaboration is essential to the development of new ideas and to a better understanding of scientific concepts. However, scientists must publish only their own work and must give others credit when they build on their ideas.

c. (LITERACY) Introduce strategies for effective group interaction.

Explain or model what productive group interactions (both agreement and constructive disagreement) look like and sound like. For more information about group work, including two optional student sheets to help support students’ interactions, see the section of Teacher Resources II, “Diverse Learners,” on Facilitating Group Interaction.34

3. Students make observations of three types of land areas before and after construction.


Explain that the photographs in the Student Book show examples of three kinds of locations being considered—hillsides, wetlands, and seaside cliffs—both before and after construction. Emphasize that these are not before and after photographs of Boomtown, since Boomtown is still in the process of deciding where to build. In fact, none of the photographs are of the same place nor are they taken from the exact same perspective. The photographs are simply intended to get students thinking about each kind of location before and after construction.


As students work together in pairs to observe the photographs, have them record their responses on Student Sheet 1.1, “Observations Before and After Construction.” Students should work in pairs to study the photographs, discuss their observations, and record their ideas. Then students meet in groups of four to further discuss their ideas and review their observations. Each student will then create a table and answer the questions at the end of the activity individually.

c. Share observations with the class.

When most groups have finished the Procedure, project Student Sheet 1.1, “Observations Before and After Construction,” on the board and compile student observations. Doing so provides a good opportunity to discuss the difference between scientific observations and inferences. “Observations” are what students can see directly in the photographs, while “inferences” are the conclusions they make based on what they see. For example, students may observe that the wetlands have been filled in and have less water. From this, they may infer that this has been bad for wildlife in the area. While this inference is a possibility, the only way to be certain would be to look at the actual situation and see if the wildlife has suffered as a result. This discussion anticipates the next two activities where students examine some indicators of human impact on the environment.

d. Discuss changes to land and water over a longer time.5

3 SESSGI1
4 SESSGI2
5 NGCC03
While students are thinking about what changes are likely to be caused by natural geological processes and what changes are likely to be caused by human activity, encourage them to think about changes in larger time frames. Brainstorm changes that could be observed over a few days or years and then challenge students to extend their thinking to consider changes in landforms that naturally occur over thousands or many thousands of years. Let students know they will further explore short- and long-term changes in this unit.

4. If you have not previously done so, introduce scientific evidence in science.

   a. Explain how scientists define and use evidence.

      Procedure step 5 provides an opportunity to introduce the definition of evidence provided in the Student Book. Explain that scientists collect information (data) with various tools and strategies, including observation and experimentation. Like scientists, students will use evidence to develop explanations, construct scientific arguments, and recommend solutions to problems. In this activity, students use observations to make a claim about the human impact of building in Boomtown.

   b. Distinguish evidence from opinion.

      Explain that evidence is information that supports a claim. In contrast, an opinion is the view someone takes about a certain issue based on his or her own judgment. An opinion might not be based on evidence. An informed opinion might be based on evidence; however, another person may have a different opinion based on the same evidence. To distinguish evidence from opinion in science it is helpful to determine if a statement describes information gathered through reliable and appropriate procedures and is likely to be reproducible. The question is: Could someone else gather similar information under similar circumstances? If the answer is yes, the statement is not opinion and is likely to be evidence.

   c. Discuss the sources, quality, and quantity of evidence.

      When evaluating evidence, scientists consider the source, quality, and quantity of the evidence available. Biased or insufficient evidence compromises the validity of scientific conclusions. Scientific conclusions should logically follow the evidence collected, and should not be overly generalized beyond the context of the investigation.

      The criteria for quality evidence may vary among the scientific disciplines. However, evidence is generally considered of higher quality if it is obtained through systematic investigation and is reproducible, meaning another investigation under the same set of circumstances would obtain similar data.

      Criteria for quantity also vary, but might include the sample size or number of trials in an experiment, the number of observations that support a conclusion, or the availability of multiple studies or multiple lines of evidence that lead to the same conclusion.

**BUILD UNDERSTANDING**

5. Reflect on the impact of building construction on the natural world.⁶

   a. Ask the class, “What are the positive and negative impacts of building the school?”⁷

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⁶ NGCCCO3
Let students brainstorm ideas about the impact of the construction has on the community and on the environment and record a list of their ideas on the board. On the positive side, human activities have often improved the quality of life, such as the widespread use of electricity. Provide examples of times when humans have altered the biosphere, damaging or destroying natural habitats or causing the extinction of a species such as the small fish that lived in the Mohave Desert called the Tecopa pupfish. In the mid 20th century, it was pushed to extinction by humans. Two springs were channeled together and the resulting habitat was unsuitable for the small fish.

b. Discuss how population growth takes a role in human impact on the environment.  
If students have not yet pointed this out, discuss the fact that the new school building needed as a result of population growth in Boomtown. Discuss the idea that as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth.

c. Ask students, “What ideas do you have about what should be required to build the school?”  
Brainstorm possible engineered strategies and technologies. Use this opening activity to allow students to consider possible design criteria and constraints for the building. Elicit student ideas about how requirements might influence the final design of the school. Point out that a building could minimize the environmental impact through thoughtful engineering and design.

6. If you have not previously done so, introduce the concept of trade-offs.

a. Introduce the idea that decisions about solutions to scientific and engineering problems often involve trade-offs.

This unit includes issues that relate to science and/or engineering and that may lead to decisions about the best solutions or designs for solving problems. One goal of this curriculum is to teach students that

- decisions about possible solutions often involve trade-offs.
- identifying trade-offs involves analyzing evidence.

Explain to students that in this unit they will make several decisions about where and how to build the school and fields. In this activity students use analysis item 3 to identify the trade-offs involved in the human impact of building the new school.

In a decision involving trade-offs something desirable is given up to gain another desirable outcome. Since many decisions involve trade-offs, students should understand that a perfect choice is often not possible. It is possible, however, to recognize and analyze the trade-offs associated with each decision.

b. Provide an example of trade-offs.

For example, when asked, “Paper or plastic?” at a store checkout counter, most shoppers make the choice quickly. But there are several trade-offs attached to choosing paper or plastic. A shopper who chooses paper over plastic may do so to avoid generating plastic waste. In requesting the paper bag, though, they are contributing to other environmental problems, such
as increased water and energy use, and the higher amounts of solid waste and CO₂ emissions associated with making paper bags. Neither choice is ideal, and both choices have a downside. Identifying the trade-offs helps clarify the reasoning that is being applied to make a decision.

c. Develop some examples of trade-offs in students’ lives.

To further explore trade-offs, brainstorm with the class a list of decisions they make every day that involve trade-offs. Choose one and talk through the associated trade-offs of deciding one way or another. This practice will familiarize students with ways of identifying and considering trade-offs in this and subsequent activities.

d. Identify some trade-offs of the Boomtown sites.¹⁰

Explain that in building on one site, such as the hillside, you gain some advantages, such as views of the town and safety from flooding, but you also give up or trade off other advantages, such as safety from landslides. Discuss any other potential trade-offs. Focus the discussion so that the land and water in the area since the main scientific ideas in the unit are geological processes and the relationship of these constructive and destructive forces to nutrient contamination due to run-off.

7. Introduce crosscutting concepts.

a. Explain that crosscutting concepts bridge disciplines of knowledge.

Explain that Crosscutting Concepts bridge disciplines, and can be a lens or touchstone through which students make sense of phenomena and deepen their understanding of disciplinary core ideas. Refer students to Appendix G, “Crosscutting Concepts,” and point out the symbols and definitions provided.

b. Give an example that makes sense for students.

Scientists investigate and try to explain how things work, and try to figure out what causes various events. Review the symbol for Cause and Effect in Appendix G, “Crosscutting Concepts,” which shows a simple diagram of cause and effect, where “A,” the cause, might or might not cause B, the effect, to happen. For example, in this activity X might have caused Y to happen. That is an example of a simple cause, but sometimes there are more complex causes, or chains of events that cause an effect.

b. Introduce the crosscutting concept of Cause and Effect.¹¹

In this unit, students use the crosscutting concepts of cause and effect to investigate the casual relationship between human activity and negative impacts on the environment. In this activity, the physical changes students observe in the photos establishes a relationship although they have not yet been formally introduced to correlation and casual relationship.

8. Consider the three building sites.

a. Review student site choices in analysis item 3.

As a class, review the map and the landforms. Students will analyze maps of Boomtown in

¹⁰ NGPEE33

¹¹ NGCCCE3
greater detail in the subsequent activities, so use this opportunity to support the introduction of the fictitious community of Boomtown and to connect the story to the landforms that students are observing. Use student responses to build on the idea that, while the students have gained some ideas about construction in different areas from the photographs, there is a lot more that they will need to know about Boomtown and the sites before making a final decision about where to build. Emphasize the importance of using evidence, or actual information about the sites, when weighing the relative advantages and disadvantages of the sites in order to make a decision.

b. (LITERACY) As a class, revisit the KWL chart.

To conclude the activity, revisit the KWL chart and fill in the last column. For example, students may have known animals and plants were impacted by building, but may have more questions about what it could do to the water. They may have learned that wetlands are sometimes filled to build houses. As an introductory activity, there maybe many more things students want to know at this point than they knew or have learned.

**SAMPLE RESPONSES TO ANALYSIS**

1. Explain how each of the following kind of places could be changed by the construction of buildings due to increased population:

   a. wetlands

   *The wetlands are changed because there is no longer any water in the area. The ground has become solid instead of marshy. There are no birds to be seen and the grasses and trees were replaced with species that are not originally from the area. There doesn’t appear to be anything that hasn’t been changed as a result of building at this site.*

   b. hillside

   *The hillside is changed because the trees were cut down and replaced with roads and houses. The earth surface has fewer peaks and valleys after building. The area outside of the immediate area does not seem to be changed.*

   c. cliff

   *The cliff is changed because of the house was built on the top of the cliff. The cliff seems to have crumbled more near the house, particularly right in front of it. The coastline seems to be less straight than it was and barriers have been added. The areas beyond the single house do not show any change.*

2. A **trade-off** is a desirable outcome given up to gain another desirable outcome. What are some of the trade-offs involving the human impacts of building a new school and fields?

   *One of the big trade-offs is that if we build the school, we give up the natural environment that was there. We are giving up the habitat for smaller animals in exchange for gaining an environment for humans.*

3. Examine the map of Boomtown below. Find each of the three sites being considered for the new school and fields:

   - Delta Wetlands
• Green Hill
• Seaside Cliff

Based on what you know so far, on which site do you think Boomtown should build the new school? Use the map and observations from this activity to form your opinion.

Student responses may vary. Look for answers that are based on the actual observations that students make of the photographs. One sample response is shown here:

_Boomtown should build homes on the wetlands, because the swampy areas are unattractive and that after construction the wetland is filled in with firm soil. It is worse to cut down the beautiful green areas on a hill. Plus it is better to build on a flat area because it is easier to access than on a hill._

4. Explain the questions you might have about the following, which could help the City Council decide where to build the new school.

Student responses may vary. One sample response is shown here:

a. animals in the area

_Could the birds seen in the photos become endangered or extinct due to the construction of the school?_

b. plants in the area

_Can plants also become endangered or extinct? How do plants contribute to the shape of the ground and habitat in the area?_

d. shape of the land

_Are some land shapes, such as a steep slope, harder or more expensive to build on?_

e. health of nearby water

_Could building affect the quality of the water?_

5. **Reflection:** Compare Boomtown to where you live. How is it similar or different?

Student responses may vary. One sample response is shown here:

_Boomtown is not similar to my town in that it is flat where we live and we are not near the ocean. We are similar in that there is a river and lake nearby. Also, our schools are overcrowded and some people want a new school._

**REVISIT THE GUIDING QUESTION**

What is the human impact of constructing buildings?

Some examples of the human impact due to building were shown in the photographs. Examples are less green space, fewer birds and animals, and changes to the land shape. Other impacts are yet to be explored in this unit.

**ACTIVITY RESOURCES**
KEY VOCABULARY

evidence
human impact
trade-offs
### Student Sheet 1.1

**Observations Before and After Construction**

< See IAES 2e trans. 24.1>

<table>
<thead>
<tr>
<th></th>
<th>Appearance Before Construction</th>
<th>Appearance After Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>cliff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hillside</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wetland</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sample Student Response

Student Sheet 1.1

Observations Before and After Construction

Sample Observations Before and After Construction

<table>
<thead>
<tr>
<th>Location</th>
<th>Appearance Before Construction</th>
<th>Appearance After Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>cliff</td>
<td>Sandy and rocky on the sides of the cliff. Some vegetation on the top. Small overhang at top. Looks unstable.</td>
<td>House on top of cliff. Sandy and rocky sides with more overhang than before. Less vegetation on top. Coastline is not as straight as before. Barriers built in front of shore</td>
</tr>
<tr>
<td>hillside</td>
<td>Covered with trees and grass. Hills have ridges and valleys.</td>
<td>Houses, roads, and cars. Less grass, fewer trees, and soil churned up in some places. Some areas are leveled.</td>
</tr>
<tr>
<td>wetland</td>
<td>Lots of water and birds. Full of grasses, reeds, and some trees. Land area looks swampy. No hills in the area. Some trees and grass.</td>
<td>No water visible. No birds visible. Lots of houses and concrete. Trees and grass are present, but different kinds than before.</td>
</tr>
</tbody>
</table>