Lesson 1.1
Pre-Unit Assessment
Students’ Initial Explanations

In this lesson, students are introduced to the unit and to their role as water resource engineers engaging with a problem: the fictional city of East Ferris is facing a water shortage, and the mayor needs to know why. Students write initial explanations about why they think some areas get more rain than others and what factors may affect rainfall. Investigating how parts of the Earth system interact to explain why some places get more rain than others is central to this unit. The explanations students provide in this lesson serve as a Pre-Unit Assessment for formative purposes, designed to reveal students’ initial understanding of some of the unit’s core content, both unit-specific science concepts and the crosscutting concept of Systems and System Models, prior to instruction. As such, students’ explanations offer a baseline from which to measure growth of understanding over the course of the unit. These explanations can also provide the teacher with insight into students’ thinking as they begin this unit. This three-dimensional assessment will allow the teacher to draw connections to students’ experiences and to watch for preconceptions that might get in the way of students’ understanding. After writing their initial explanations, students learn about water availability on Earth through a hands-on activity with an inflatable globe and a set of graphs that show the global distribution of water. They discover that there is a limited amount of freshwater available for people to use. Finally, students review the unit’s reference book, Water Encyclopedia, which they will be using throughout the unit. The purpose of this lesson is to spark students’ interest in the problem of water shortages and to allow them to express their initial ideas about the unit content.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not.

Students learn:

- Reflecting on what you understand and don’t understand allows you to prepare for learning new things.
- An engineer is a person who uses science knowledge to design something in order to solve a problem.
- Almost all of Earth’s water is salt water in the ocean. The limited amount of freshwater is mostly in glaciers and groundwater.
- There is a limited amount of water available to people because people only use freshwater.
Water Distribution on Earth

Students are introduced to the unit’s reference book, then read and analyze graphs of global water distribution.

Instructional Guide

1. **Introduce *Water Encyclopedia***. Let students know that they will read a book to get a more precise idea of where water is on Earth. Hold up a copy of *Water Encyclopedia* and let students know that it is a reference book.

2. **Distribute books**. Distribute one copy of *Water Encyclopedia* to each pair of students.

3. **Let students explore the text**. Give pairs a couple minutes to look through the text and notice how it is organized and what sort of information it contains. Have a few students share what they noticed.

4. **Introduce the Partner Reading Guidelines**. Let students know that they will read a section of the book with a partner. Point out the Partner Reading Guidelines that you posted and read them aloud. Let students know that they can refer to the guidelines as they read.

5. **Locate information about water on Earth**.

   Let's figure out where we can find more information about where water is on Earth.

   Have students turn to the Table of Contents on page 3.

   Where could you look to find out more about where water is on Earth? [Page 30, “Places Where Water Exists on Earth”]

6. **Have pairs read pages 30–31 in *Water Encyclopedia***. Give pairs a few minutes to read, then ask students to share what they notice.
7. **Students analyze bar graphs.** Prompt students to look closely at each of the three graphs on pages 30–31. Encourage students to notice similarities and differences between the graphs.

8. **Project Water on Earth graph.** Explain that this is the same graph that is on page 30 of the book. Point out features of this graph, including the title ("Water on Earth"), axis labels ("Where the water is found" and "Amount (cubic kilometers)"), and bar labels ("The ocean (salt water)" and "Other locations (freshwater)").

![Image of Water on Earth bar graph]

What do you observe on this graph?

- Water on Earth is found in the ocean and other locations;
- Most of the water on Earth is found in the ocean and is salt water;
- A much smaller amount of water on Earth is found in other locations and is freshwater.

9. **Point out the amounts of salt water and freshwater.** Point out that the total amounts of salt water and freshwater shown in the graph are vastly different. Remind students how they learned that there was more water than land at Earth's surface during the globe activity, and that most of that water was salty ocean water.
10. **Project Freshwater on Earth graph.** Explain that this graph is zoomed in on the freshwater data from the previous graph. Point out that the amounts of water shown on this graph are much smaller than in the Water on Earth graph. Direct students’ attention to the bar labels in the graph.

![Freshwater on Earth graph](image)

*This graph shows where the freshwater on Earth is, including ice in glaciers and liquid water underground and at the surface. Freshwater also exists in plants and animals, as frozen ground ice, and as water vapor in the atmosphere.*

What do you observe on this graph?

[Most freshwater on Earth is found in glaciers, some is found in groundwater, and very little is found on the surface.]

11. **Discuss frozen freshwater.** Students may be surprised by how much freshwater is frozen. Explain that the bar labeled “glaciers” includes water contained in the polar ice caps, such as the humongous Antarctic ice sheet that covers Antarctica.

12. **Project Groundwater Diagram.** Have students examine the diagram, then ask volunteers to read the title, labels, and captions aloud. Emphasize that groundwater is *not* like a giant underground lake.
It might seem like there are big areas underground that are filled with water, but that is not usually the case.

Even though the ground and rock below us seem solid, there are tiny cracks in the rock and spaces between rock that water can seep into. When you add up all the water in those tiny spaces, it amounts to a lot of the water on Earth.

13. Project Surface Freshwater on Earth graph. Explain that this graph is zoomed in on the surface freshwater from the previous graph, and the amounts of water shown on this graph are much smaller than on the Freshwater on Earth graph.

What do you observe on this graph? [Most surface freshwater on Earth is found in lakes and only some is found in wetlands and rivers.]


**Places Where Water is Found on Earth**

- ocean
- rivers
- groundwater
- lakes
- glaciers
- wetlands
This is a list of most of the places where water exists on Earth. Use the graphs in the Water Encyclopedia to figure out how to order these from the least amount of water to the most.

Give students time to talk with their partners about how to put the places in order. After a few minutes, call on a volunteer to share.

How would you order these from the least amount of water to the most?
[Rivers, wetlands, lakes, groundwater, glaciers, ocean.]

15. Reflect on water distribution.

Where is most of the water on Earth?
[In the ocean.]

Where can most of Earth’s freshwater be found?
[In glaciers and groundwater.]

16. Introduce and post the first key concept. Let students know that throughout the unit, you are going to post statements of important science ideas. Read aloud the first key concept.

Almost all of Earth’s water is salt water in the ocean. The limited amount of freshwater is mostly in glaciers and groundwater.

Post the key concept on the wall under the Key Concept header.

17. Make a connection to human use of water.

Why does it matter to people that most of Earth’s water is salt water?
[People mostly use freshwater and there’s not very much freshwater available for them to use.]

18. Conclude the lesson. Let students know that they will read a book to learn more about water shortages in the next lesson.

Teacher Support

Rationale

Literacy Note: Partner Reading
Throughout this unit, we suggest that students read the books with a partner. This allows students time to apply and practice the reading strategies they’re learning, keeps them focused on the task at hand, and provides opportunities for them to assist each other with reading. Of course, you can use any effective reading procedures you’ve already established with your class. Before reading this first book in the unit, you may need to provide instruction on how to
read with a partner by using the Partner Reading Guidelines (provided in Digital Resources) or your own guidelines. Establishing procedures takes time at first, but will pay off in terms of student learning and management of the lessons. Over time, students gain practice working together and will need fewer reminders about reading together effectively.

**Instructional Suggestion**

**Literacy Note: Freshwater and Salt Water**
If your students are not familiar with the terms freshwater and salt water, you may want to have a brief discussion of the difference between the two, highlighting that the ocean has salt water and that people drink freshwater. You could also have them read the “Freshwater and Salt Water” section of Water Encyclopedia.

**Instructional Suggestion**

**Providing More Experience: Discussing Human Uses of Water**
To provide more experience for thinking about why the global distribution of water matters to people, you may have students brainstorm all the ways that they use water. You can record their ideas on the board. Then, once you have generated a significant list, you can have students identify which uses involve freshwater and which involve salt water. This will help them realize that the majority of human uses require freshwater, thereby emphasizing the problem of a limited amount of freshwater.

**Background**

**Science Note: Graphs in Water Encyclopedia**
The graphs in Water Encyclopedia include some simplifications to make them more accessible to fifth-grade students. In the Freshwater on Earth graph, the bar labeled glaciers includes water in ice caps and permanent snow as well. Ice caps are glacial, like glaciers, in the sense that they form and deform through the same processes. They form as snow accumulates, gets packed down by new layers of snow that form on top, and eventually turns into ice. They are deformed by the force of gravity, which causes them to move, down valleys or out across the sea. Permanent snow, on the other hand, is not as dense as the ice of glaciers and ice caps, and refers to snow that stays on mountain tops year round. Another simplification in the graph is that saline groundwater and saline lakes are not included in the salt water total of the Water on Earth graph, even though the volume of water in saline lakes and groundwater is about the same as the volume of water in freshwater lakes and groundwater. These simplifications do not have a significant effect on the main point of the graphs, which is that there is limited freshwater available for human use because the majority of Earth’s water is salt water in the ocean and most freshwater is frozen or underground.

**Instructional Suggestion**

**Going Further: Make a Groundwater Model**
This unit’s central problem is a water shortage in the fictional city of East Ferris. Later in this chapter, students will learn that East Ferris gets its freshwater from a groundwater reservoir. They explain that there is less water flowing into the reservoir than flowing out, which is the basis for their end-of-chapter explanations and essential to understanding the city’s water shortage. If you feel your students need more support in understanding groundwater, you may consider creating a model of groundwater. Fill a transparent plastic container partway with sand or small pebbles, then slowly pour water over the surface and allow students to observe the water trickling down and then filling up the pore spaces at the bottom of the container. Ask students to imagine that the bottom of the container represents a different rock type that does not allow water to sink in deeper. You might consider keeping this model in the classroom throughout the unit for added visual support, and returning to this model in Lesson 1.3 to provide a visual for what might happen if too much water is removed from a reservoir.
Background

Science Note: Aquifers
The area in which groundwater is located is called an aquifer. Aquifers are layers of permeable rock—that is, rock that has fractures or pores that allow groundwater to seep into it—or loose sediment. Groundwater can be found in many different types of rock, but the most common aquifers are porous sedimentary rock, like sandstone. Given their permeable nature, groundwater can move more easily through these types of rock. Though less common, aquifers can also be found in denser materials, such as igneous rock (like granite), as long as that rock contains fractures that water can seep into. In this unit, students will be introduced to multiple diagrammatic visuals of groundwater. Though sedimentary rock aquifers are more common, the aquifers in these diagrams resemble igneous rock to distinguish it from soil.

Assessment

Assessment Opportunities: Assessing Student Understanding of the Distribution of Water on Earth
This activity can be used to assess students’ understanding of the fact that most of Earth’s water is found in the ocean, and that most freshwater is found in glaciers or underground, with very little in streams, lakes, wetlands, and the atmosphere. If you would like to assess student understanding of these ideas, attend to their ordering of places where water is found on Earth in step 14 of this activity. Look for whether students can place the list in the proper order, from least amount of water to most [rivers, wetlands, lakes, groundwater, glaciers, ocean]. If students have trouble with these ideas, you might help them visualize the distribution of water on Earth using an additional visual model. For this model, fill a cup with water and have three additional empty cups on hand and label these “ocean,” “glaciers,” and “groundwater,” respectively.

• Hold up the cup of water and have students imagine that this is all the water on Earth. Ask students how much of this represents salt water in the ocean. [Most of it represents salt water in the ocean.] Pour most of the water into the cup labeled “ocean.”

• Hold up the cup again and explain that this is all the freshwater on Earth. Ask students how much of this represents frozen water in glaciers. Encourage them to refer to the graphs in Water Encyclopedia as necessary. [About two thirds of the water in the cup represents glaciers.] Pour about two thirds of the remaining water into the cup labeled “glaciers.”

• Hold up the cup again and ask students how much of this remaining water represents groundwater. [Almost all of it.] Pour almost all of the remaining water into the cup labeled “groundwater.”

• Hold up the cup one last time and explain that this represents all of the surface freshwater on Earth.

• Invite students to reflect on the model and share if/how it surprised them or changed their thinking about water on Earth.

Instructional Suggestion

Student Thinking: Scale, Proportion, and Quantity
The graphs in Water Encyclopedia provide an opportunity to discuss the crosscutting concept of Scale, Proportion, and Quantity with students. This crosscutting concept involves assessing the relative dimensions of that which you can observe about the natural and designed worlds and supports deeper understanding of objects, organisms, events, and phenomena. Point out that the volumes of water in the graph are described in standard units—cubic kilometers, which makes it possible to compare them. If students are unfamiliar with cubic kilometers, guide them to visualize one cubic kilometer. Students are likely familiar with the distance of one mile, for example from running a mile. Use this familiarity...
to have students visualize how long one kilometer is, about 0.6 miles. Or have students visualize the distance between two local landmarks that are one kilometer apart. Then have students imagine a cube with that distance as the length of each side. Explain that the volume of that cube is one cubic kilometer and point out that volumes of water in the graphs range from a little over 2,000 cubic kilometers (rivers) to more than 1,300,000,000 cubic kilometers (the ocean). If students have trouble visualizing how rivers, which may seem relatively flat, contain more than 2,000 cubic kilometers of water, point out that the volume of water is be distributed over a large area. It might be helpful to show students with blocks or clay how the volume of a cube can be the same as the volume of a very short, long rectangular prism, for example, by forming a cube with clay then stretching it out into an oblong shape. Also note how the scale of each graph is different. Prompt students to think about why this is the case. [The volumes of water are too different to show on graphs with the same scale. If the scale was the same all on three graphs, and matched that of the Freshwater on Earth graph, the bar for oceans would be too big to fit on the page. If the scale on all three graphs was the same as that of the Water on Earth graph, the bars for surface freshwater would be too small to see.]
Water Distribution on Earth

Students are introduced to the unit’s reference book, then read and analyze graphs of global water distribution.

Instructional Guide

1. Introduce Water Encyclopedia. Let students know that they will read a book to get a more precise idea of where water is on Earth. Hold up a copy of Water Encyclopedia and let students know that it is a reference book.

2. Distribute books. Distribute one copy of Water Encyclopedia to each pair of students.

3. Let students explore the text. Give pairs a couple minutes to look through the text and notice how it is organized and what sort of information it contains. Have a few students share what they noticed.

A reference book is a book that is read differently from some other informational books. Instead of reading reference books cover to cover, we use them to locate specific information about topics we wonder about. We will use Water Encyclopedia to find information about water throughout this unit.

4. Introduce the Partner Reading Guidelines. Let students know that they will read a section of the book with a partner. Point out the Partner Reading Guidelines that you posted and read them aloud. Let students know that they can refer to the guidelines as they read.

5. Locate information about water on Earth.

Have students turn to the Table of Contents on page 3.

¿Dónde podrían buscar para averiguar más acerca de en qué parte de la Tierra está el agua? [Página 30, "Lugares donde el agua existe en la Tierra"].

6. Have pairs read pages 30–31 in Water Encyclopedia. Give pairs a few minutes to read, then ask students to share what they notice.
7. Students analyze bar graphs. Prompt students to look closely at each of the three graphs on pages 30–31. Encourage students to notice similarities and differences between the graphs.

8. Project Water on Earth graph. Explain that this is the same graph that is on page 30 of the book. Point out features of this graph, including the title (“Water on Earth”), axis labels (“Where the water is found” and “Amount (cubic kilometers), and bar labels (“The ocean (salt water)” and “Other locations (freshwater)”].

9. Point out the amounts of salt water and freshwater. Point out that the total amounts of salt water and freshwater shown in the graph are vastly different. Remind students how they learned that there was more water than land at Earth’s surface during the globe activity, and that most of that water was salty ocean water.

¿Ustedes qué piensan que muestra esta gráfica?
[El agua sobre la Tierra se encuentra en el océano y otras ubicaciones; la mayor parte del agua sobre la Tierra se encuentra en el océano y es agua salada; una cantidad mucho más pequeña de agua sobre la Tierra se encuentra en otras ubicaciones y es agua dulce].
10. Project Freshwater on Earth graph. Explain that this graph is zoomed in on the freshwater data from the previous graph. Point out that the amounts of water shown on this graph are much smaller than in the Water on Earth graph. Direct students’ attention to the bar labels in the graph.

![Image of the Freshwater graph]

Esta gráfica muestra en dónde está el agua dulce en la Tierra, incluso el hielo en los glaciares y el agua líquida bajo la tierra y en la superficie. El agua dulce también existe en plantas y animales, en forma de hielo del suelo congelado y como vapor de agua en la atmósfera.

¿Ustedes qué piensan que muestra esta gráfica?  
[La mayor parte del agua dulce sobre la Tierra se encuentra en los glaciares, una parte se encuentra en el agua subterránea y muy poca se encuentra sobre la superficie].

11. Discuss frozen freshwater. Students may be surprised by how much freshwater is frozen. Explain that the bar labeled “glaciers” includes water contained in the polar ice caps, such as the humongous Antarctic ice sheet that covers Antarctica.

12. Project Groundwater Diagram. Have students examine the diagram, then ask volunteers to read the title, labels, and captions aloud. Emphasize that groundwater is not like a giant underground lake.

![Image of the Groundwater diagram]
Podría parecer que hay grandes áreas subterráneas que están llenas de agua, pero usualmente ese no es el caso.

Aunque el suelo y las rocas bajo nosotros parecen sólidos, hay grietas diminutas en la roca y espacios entre las rocas en donde se puede filtrar agua. Cuando suman toda el agua en esos lugares diminutos, llega a ser mucha agua sobre la Tierra.

13. **Project Surface Freshwater on Earth graph.** Explain that this graph is zoomed in on the surface freshwater from the previous graph, and the amounts of water shown on this graph are much smaller than on the Freshwater on Earth graph.

¿Ustedes qué piensan que muestra esta gráfica?
[La mayor parte del agua dulce sobre la Tierra se encuentra en los lagos y solo una parte se encuentra en humedales y ríos].

**Lugares donde se encuentra el agua sobre la Tierra**

- océano
- ríos
- agua subterránea
- lagos
- glaciares
- humedales

 esta es una lista de la mayoría de los lugares donde el agua existe sobre la Tierra. Usen las gráficas en la Enciclopedia del agua para averiguar cómo ordenar estos de la menor a la mayor cantidad de agua.

Give students time to talk with their partners about how to put the places in order. After a few minutes, call on a volunteer to share.

¿Cómo ordenarían estos de la menor a la mayor cantidad de agua?
[ Ríos, humedales, lagos, agua subterránea, glaciares, océano ].

15. Reflect on water distribution.

¿En qué parte de la Tierra está la mayor parte del agua?
[ En el océano ].

¿En qué parte de la Tierra se puede encontrar agua dulce?
[ En glaciares y agua subterránea ].

16. Introduce and post the first key concept. Let students know that throughout the unit, you are going to post statements of important science ideas. Read aloud the first key concept.

Casi toda el agua de la Tierra es agua salada en el océano. La cantidad limitada de agua dulce en su mayor parte está en glaciares y en agua subterránea.

Post the key concept on the wall under the Key Concept header.

17. Make a connection to human use of water.
18. Conclude the lesson. Let students know that they will read a book to learn more about water shortages in the next lesson.

Teacher Support

Rationale

Literacy Note: Partner Reading
Throughout this unit, we suggest that students read the books with a partner. This allows students time to apply and practice the reading strategies they're learning, keeps them focused on the task at hand, and provides opportunities for them to assist each other with reading. Of course, you can use any effective reading procedures you’ve already established with your class. Before reading this first book in the unit, you may need to provide instruction on how to read with a partner by using the Partner Reading Guidelines (provided in Digital Resources) or your own guidelines. Establishing procedures takes time at first, but will pay off in terms of student learning and management of the lessons. Over time, students gain practice working together and will need fewer reminders about reading together effectively.

Instructional Suggestion

Literacy Note: Freshwater and Salt Water
If your students are not familiar with the terms freshwater and salt water, you may want to have a brief discussion of the difference between the two, highlighting that the ocean has salt water and that people drink freshwater. You could also have them read the “Freshwater and Salt Water” section of Water Encyclopedia.

Instructional Suggestion

Providing More Experience: Discussing Human Uses of Water
To provide more experience for thinking about why the global distribution of water matters to people, you may have students brainstorm all the ways that they use water. You can record their ideas on the board. Then, once you have generated a significant list, you can have students identify which uses involve freshwater and which involve salt water. This will help them realize that the majority of human uses require freshwater, thereby emphasizing the problem of a limited amount of freshwater.

Background

Science Note: Graphs in Water Encyclopedia
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as the volume of water in freshwater lakes and groundwater. These simplifications do not have a significant effect on
the main point of the graphs, which is that there is limited freshwater available for human use because the majority of
Earth’s water is salt water in the ocean and most freshwater is frozen or underground.

Instructional Suggestion

Going Further: Make a Groundwater Model
This unit’s central problem is a water shortage in the fictional city of East Ferris. Later in this chapter, students will learn
that East Ferris gets its freshwater from a groundwater reservoir. They explain that there is less water flowing into the
reservoir than flowing out, which is the basis for their end-of-chapter explanations and essential to understanding the
city’s water shortage. If you feel your students need more support in understanding groundwater, you may consider
creating a model of groundwater. Fill a transparent plastic container partway with sand or small pebbles, then slowly
pour water over the surface and allow students to observe the water trickling down and then filling up the pore spaces
at the bottom of the container. Ask students to imagine that the bottom of the container represents a different rock
type that does not allow water to sink in deeper. You might consider keeping this model in the classroom throughout the
unit for added visual support, and returning to this model in Lesson 1.3 to provide a visual for what might happen if too
much water is removed from a reservoir.

Background

Science Note: Aquifers
The area in which groundwater is located is called an aquifer. Aquifers are layers of permeable rock—that is, rock that
has fractures or pores that allow groundwater to seep into it—or loose sediment. Groundwater can be found in many
different types of rock, but the most common aquifers are porous sedimentary rock, like sandstone. Given their
permeable nature, groundwater can move more easily through these types of rock. Though less common, aquifers can
also be found in denser materials, such as igneous rock (like granite), as long as that rock contains fractures that water
can seep into. In this unit, students will be introduced to multiple diagrammatic visuals of groundwater. Though
sedimentary rock aquifers are more common, the aquifers in these diagrams resemble igneous rock to distinguish it
from soil.

Assessment

Assessment Opportunities: Assessing Student Understanding of the Distribution of Water on Earth
This activity can be used to assess students’ understanding of the fact that most of Earth’s water is found in the ocean,
and that most freshwater is found in glaciers or underground, with very little in streams, lakes, wetlands, and the
atmosphere. If you would like to assess student understanding of these ideas, attend to their ordering of places where
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these ideas, you might help them visualize the distribution of water on Earth using an additional visual model. For this
model, fill a cup with water and have three additional empty cups on hand and label these “ocean,” “glaciers,” and
“groundwater,” respectively.

• Hold up the cup of water and have students imagine that this is all the water on Earth. Ask students how much of
  this represents salt water in the ocean. [Most of it represents salt water in the ocean.] Pour most of the water into
  the cup labeled “ocean.”
Instructional Suggestion

Student Thinking: Scale, Proportion, and Quantity

The graphs in *Water Encyclopedia* provide an opportunity to discuss the crosscutting concept of Scale, Proportion, and Quantity with students. This crosscutting concept involves assessing the relative dimensions of that which you can observe about the natural and designed worlds and supports deeper understanding of objects, organisms, events, and phenomena. Point out that the volumes of water in the graph are described in standard units—cubic kilometers, which makes it possible to compare them. If students are unfamiliar with cubic kilometers, guide them to visualize one cubic kilometer. Students are likely familiar with the distance of one mile, for example from running a mile. Use this familiarity to have students visualize how long one kilometer is, about 0.6 miles. Or have students visualize the distance between two local landmarks that are one kilometer apart. Then have students imagine a cube with that distance as the length of each side. Explain that the volume of that cube is one cubic kilometer and point out that volumes of water in the graphs range from a little over 2,000 cubic kilometers (rivers) to more than 1,300,000,000 cubic kilometers (the ocean). If students have trouble visualizing how rivers, which may seem relatively flat, contain more than 2,000 cubic kilometers of water, point out that the volume of water is be distributed over a large area. It might be helpful to show students with blocks or clay how the volume of a cube can be the same as the volume of a very short, long rectangular prism, for example, by forming a cube with clay then stretching it out into an oblong shape. Also note how the scale of each graph is different. Prompt students to think about why this is the case. [The volumes of water are too different to show on graphs with the same scale. If the scale was the same all on three graphs, and matched that of the Freshwater on Earth graph, the bar for oceans would be too big to fit on the page. If the scale on all three graphs was the same as that of the Water on Earth graph, the bars for surface freshwater would be too small to see.]