

Teacher Resources

Lesson #2: The Engineered System

Driving Question

#2 - Where does water come from and where does it go?

Learning Goal

Engineered System: Both surface water and groundwater systems provide water for humans. Surface water can be pumped directly from rivers and lakes. Groundwater can be pumped from aquifers via wells. The water is treated and piped to houses and businesses for use. Wastewater is cleaned and returned to the watershed.

Objectives

O6 - Explain how water cycles through the natural and engineered system.

Assessment

A5-6 - Develop a drawing to explain where the water you use in your house comes from, how water gets to your house, and where it goes when it leaves.

Lesson Purpose

The purpose of this lesson is to provide students with a context for all future lessons. This lesson provides students with a big picture of the groundwater system, the surface water system, and the engineered system. Details of all of these systems will be studied later in this unit. However, it is important for students to understand that these three systems fit together in the broad sense, so that when they study the smaller parts, they realize that all the parts of these systems are connected and help answer the driving questions.

This lesson also engages students in thinking about why they should care about where water comes from and where it goes. This lesson sets a purpose for the entire unit.

Lesson Overview

Activity Number	Label	Function	Description
2.1	Daily Journal Questions	<u>Elicit ideas, assess student thinking, preview new lesson</u>	Students respond in journals to daily question.
2.2	Why Do We Care Where Water Comes From?	<u>Engage/Establish Problem</u> This activity establishes a motivating purpose for the lesson and attempts to connect the content to student lives.	Students generate reasons why they should care about water and questions about where their water comes from and where it goes.
2.3	The Water Works	<u>Construct Understanding</u> This activity allows students to work in groups, build on each others' ideas, evaluate their own thinking, and develop understanding. It also allows students to model/represent the main ideas in a graphic form	Students work in groups to put cards together in order to show the path that water takes to and from their house

Activity Number	Label	Function	Description
2.4	Where Does it Come From & Where Does it Go?	<u>Construct Understanding/ Assess Ideas</u> This activity allows students to synthesize the learning that occurred during the group work and make it their own. It also provides an opportunity for teachers to assess individual student learning.	Students work individually to draw a picture that shows all of the parts of the engineered water system.
2.5 (optional)	Other Systems	<u>Application/ Construct Understanding</u> This activity allows students to compare engineered systems from different locations. It also connects lesson 2 back to lesson 1.	Students work in groups to put cards together to represent engineered water systems in different locations.
2.6	Closing Questions	<u>Summarize Learning</u> This activity provides students with opportunities to write about what they learned. It provides an additional formative assessment and includes group work self-assessments.	Students write about what they learned from today's lesson.

Preconceptions

Students likely know that water is treated before they drink it. They also likely know that wastewater is treated before it is released into a river. They may not understand the difference between drinking water treatment and wastewater treatment or that the facilities that perform the two treatments are different.

Common Preconception	Goal Conception	Addressing Activities	What to Emphasize
Water treatment is the same for drinking water and waste water.	The drinking water treatment process and waste water treatment processes are different. One is to make water drinkable and the other is to clean up waste water for release back into to environment	2.3 The Water Works	At this point it is not important for students to know what the differences between drinking water treatment and waste water treatment are. It is important that students understand that the two processes are different and happen in different and separate places.
		2.4 Where Does it Come From and Where Does it Go?	
		2.5 Other Systems	
The same water treatment facility treats drinking water and waste water	The drinking water treatment and waste water treatment processes are different and happen in different and separate facilities.	2.3 The Water Works	At this point it is not important for students to know what the differences between drinking water treatment and waste water treatment are. It is important that students understand that the two processes are different and happen in different and separate places.
		2.4 Where Does it Come From and Where Does it Go?	
		2.5 Other Systems	

Materials

Activity Number	Per Student	Per Group	Per Class
2.1	Journals		Journal questions posted on OHP or board
2.2	Lesson Packet #2		
2.3	Lesson Packet #2	Water Works Cards (1 set) Scissors (several pair)	2 sets of clue cards
2.4	Lesson Packet #2		
2.5	Lesson Packet #2	Water Works Cards - same as activity 2.3	
2.6	Lesson Packet #2		

Activity Descriptions

Activity 2.1: Daily Journal Questions (10 minutes)

Function/Rationale:

This activity

- 1) Allows the teacher time to take roll and complete administrative duties while students enter the room. Students should be expected to complete the journal activity everyday without prompting.
- 2) Elicits student ideas and previews the new lesson for the day.

Directions

- 1) Post journal questions on the overhead projector or chalk board. Suggested journal questions.
 - A) When you turn on the faucet, water comes out. Make a list that traces all the places water goes in order to get to your house. Start with the faucet and move backwards.
 - B) When water goes down the drain in your house, it has to go somewhere. Make a list that traces all the places the water goes once it leaves your house. Start with the drain and move forwards.
- 2) Students should respond individually in their journals to the daily journal questions.
- 3) Review the questions. Lead a short discussion asking for sample student responses.

Activity 2.2: Why Do We Care Where Water Comes From? (10 minutes)

Function/Rationale:

- 1) This activity sets the purpose for the unit and the current lesson. It engages students in thinking about why they should care about where water comes from.
- 2) This activity elicits student ideas about what is important to learn and what they are concerned about learning.
- 3) The individual-small group- whole class response pattern allows students to engage in individual thinking but also to learn from other students' responses.

Directions

- 1) Direct students to Activity 2.2 on their student page. Have students read the short passage either as a class, in groups, or individually.

From Student Pages:

During the summer of 2004, many people in Washington D.C., Lansing, MI, and other cities around the country learned that they have lead in their drinking water. Lead can be harmful to people, especially young children. Before 2004, most of these people, maybe even you, took for granted that the water that comes out of the tap was safe to drink. Now, people are asking questions about their water. This is just one example of why we should care about where our water comes from.

List two more reasons why we should care about where water comes from and where it goes. Think about water quality (is it safe to drink?) and water quantity (is there enough water?). You should also list any questions you have about your water.

Share your reasons and questions with the other people in your group.

- 2) Working individually, each student should write 2 reasons why we should care about where water comes from or questions about where water comes from and where it goes.
- 3) Have students briefly share their individual responses with the other students in their group.

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- 4) Lead a short class discussion, asking for sample student responses. Write some of the responses on the chalkboard or overhead projector.

Suggestions for Group Work

- 1) Remind students that in this activity, sharing ideas provides everyone with more opportunity to learn. Students are responsible for their own learning and making sure everyone in the group gets an opportunity to share and learn.
- 2) The student pages include spaces for each group member to record each other's ideas.

Activity 2.3: The Water Works (15 minutes)

Function/Rationale:

This activity

- 1) Allows students to co-construct their ideas in small groups.
- 2) Allows students to model/represent the main ideas in a graphic form.

Directions

- 1) Preview the activity 2.3 & 2.4 for the class. Give oral directions. Have students refer to the student packet at the same time. Place clue cards in the front of the room where all students can access them.
- 2) Have students cut apart one set of cards per small group (included at the end of the teacher packet - make one set for each group).
- 3) Have students lay the cards out on the table.
- 4) Working in groups, students should arrange the cards in an order that makes the most sense for how water to a house or apartment building and where it goes when it leaves in a typical urban/suburban system. Note: There are more cards than groups need.
- 5) If students need more information about a particular card, they can send one group member up to the front of the room to get a clue card. Clue cards should stay at the front of the room so that all students have access to them.
- 6) The order of the cards, for a typical urban/suburban system should be
 - A) Groundwater
 - B) Wells & Pumps
 - C) Water Conditioning/Treatment Plant
 - D) Water Supply Main
 - E) Water Pipes to House
 - F) Your Faucet
 - G) Your Drain
 - H) Your Sewer
 - I) Main Sewer
 - J) Wastewater Treatment Plant
 - K) River

Suggestions for Group Work

- 1) Remind students that they need to think about how they include everyone in the activity.
- 2) Each group should assign one person to be the Clue Card Collector. This will be one person who goes to the front of the room for clues and reports back to the group with the information learned. Only the Clue Card Collector may leave the group.

Activity 2.4: Where Does Water Come From & Where Does it Go? (15 minutes)

Function/Rationale:

This activity

- 1) Allows students to synthesize what they learned in the small group activity. Students must put the parts of the system together to show how they fit together.

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- 2) Requires students to internalize what they learned in the small group activity and make that learning their own.
- 3) Helps students take responsibility for their own learning.
- 4) Provides students with an opportunity to demonstrate their learning.

Directions

- 1) Lead a short class discussion that outlines the order of the cards for a typical urban/suburban water system. Clarify the function of the different stages as needed. Do not spend too much time on specifics or presenting "one right answer". This step is for clarification purposes only. The drawings students produce in step two will help you assess student understanding of the important concepts.
- 2) Have students work individually to create a drawing that shows the path that water takes to get to their house and where it goes when it leaves their house or apartment building. Students may refer to the cards on the table, but each student should draw his/her own drawing. Remind students to label their drawings.

Suggestions for Group Work

- 1) This is not a group activity. However, there may be some students in groups who will benefit from guidance or suggestions from other group members. Therefore, allow students to talk about their drawings, but insist that each person do their own work.

Activity 2.5: Other Systems (optional) (10-15 minutes)

Function/Rationale:

- 1) Provides options for students who finish activities 2.3 & 2.4 early.
- 2) Provides options for students who are not familiar with an urban/suburban system.

Directions

Have students put the cards in order for other systems. Suggestions include

- A) Rural system (groundwater, wells & pumps, pipes to house, home treatment system (maybe - not all homes have these systems), your faucet, your drain, your sewer, septic tank, ground)
- B) Africa (river or open hole well or community faucet, buckets, ground)

Activity 2.6: Lesson Closing

Function/Rationale:

This activity:

- 1) Encourages students to think about what they have learned.
- 2) Serves as a summary and closing for the lesson.

Directions

- 1) Students should work individually to answer the closing questions.

1. Write down one thing you learned today that you did not know before. (Saying "Nothing" is not an acceptable answer).
2. Write down one question that you still have or one thing that you would like to learn about where water comes from and where it goes. (Saying "Nothing" is not an acceptable answer).
3. Should we care where our water comes from? Why or why not?
4. Revise your answer to the journal question.
5. Grade your group work today. Circle the grade that your group deserves.

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- 2) If time permits, hold a short whole-class discussion, asking for sample student responses to the questions. Summarize the main points of the lesson. Ask for any questions.

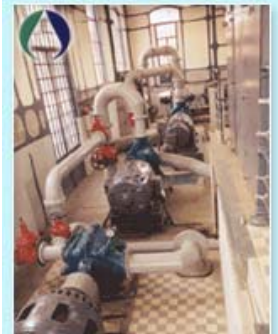
Suggestions for Group Work

- 1) Students should grade their group work.
- 2) If necessary, the teacher can offer suggestions for grades if the teacher feels students are not rating themselves accurately.

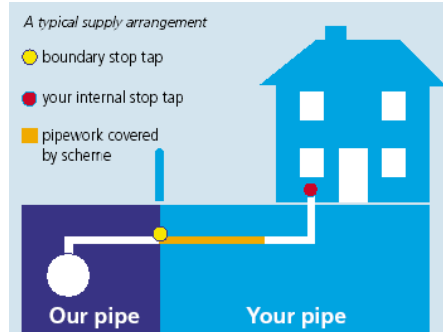
Water Works Cards (Page 1 of 3) - 1 set per group

Cut the cards apart.

Wells & Pumps



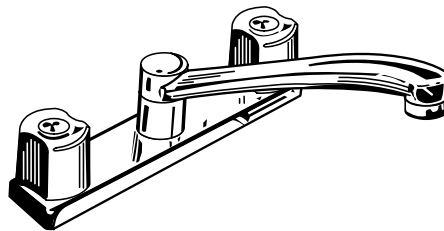
Water Pipes to House



Main Sewer



Your Faucet



The River



Water Supply Main



Water Works Cards (Page 2 of 3) - 1 set per group
Cut the cards apart.

Your Drain/Sewer Pipes



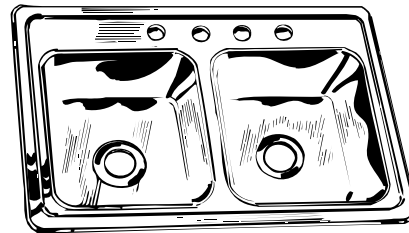
**Water Conditioning/
Treatment Plant**



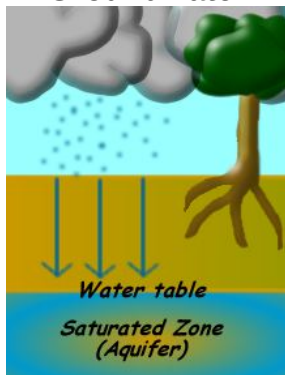
**Waste Water Treatment
Plant**



Your Drain



Groundwater



Water Tower Reservoir



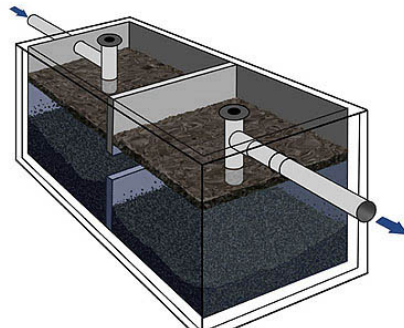
Water Works Cards (Page 3 of 3) - 1 set per group

Cut the cards apart.

Lake



Septic Tank



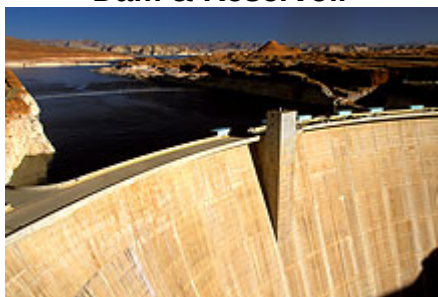
Home Treatment System



Buckets



Dam & Reservoir



Community Faucet or Pump



Clue Cards (page 1 of 2) - 2 sets per class

Wells & Pumps - Groundwater is taken out of the ground through holes drilled in the ground called wells. A pump is attached to the top of the well to pull the water out of the ground. For cities, these pumps can be quite large. Some houses can have their own wells and pumps.

Water Pipes to House - smaller diameter pipes bring the water from the water main into the house.

Main Sewer - This is the large city sewer that takes sewage to the waste water treatment plant.

Water Supply Main - These are large diameter pipes that distribute treated drinking water throughout the city.

Your Drain/Sewer Pipes - These pipes collect waste water from your house and connect to the main sewer

Water Conditioning/Treatment Plant -

Untreated (raw) water from the ground or river is piped to this facility where it is cleaned and tested to make sure it meets drinking water standards. In Lansing, water is softened and fluoride is added.

Waste Water Treatment Plant - Sewage is piped here through sewers. The sewage is removed from the water and the treated water is returned to the river.

Groundwater - Water that exists in small open spaces between rocks and in cracks in rocks underground.

Clue Cards (page 2 of 2) - 2 sets per class

Water Tower Reservoir -

Some towns and cities store their water in large tanks called reservoirs. Sometimes, these reservoirs are elevated so that the water flows downhill into people's homes & businesses.

Septic System -

Some houses are not connected to city sewers. These houses have home water treatment systems called septic tanks which are buried underground in the yard or area nearby the house.

Home Treatment Systems -

Some houses are not connected to a city water main. These houses usually have their own water treatment system to make the water drinkable.

Dam & Reservoir -

Some cities store their water supply behind dams in large, human-made lakes called reservoirs.

Community Faucet or Pump –

In some rural areas of Africa, there may be only one well for an entire village. People bring water jugs and buckets to the well to take water back to use in their houses.

Name: _____

Hour: _____

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Activity 2.2: Why Do We Care Where Water Comes From?

Purpose: People all over the world are concerned about having enough clean water to drink and enough water to grow their crops, manufacture their goods, and maintain the environment. Do you care about water?

Directions:

1. Read the paragraph below. You may read by yourself or with the people in your group.

During the summer of 2004, many people in Washington D.C., Lansing, MI, and other cities around the country learned that they have lead in their drinking water. Lead can be harmful to people, especially young children. Before 2004, most of these people, maybe even you, took for granted that the water that comes out of the tap was safe to drink. Now, people are asking questions about their water. This is just one example of why we should care about where our water comes from.

Make a short list of reasons why we should care about where water comes from and where it goes. Think about water quality (is it safe to drink?) and water quantity (is there enough water?). You should also list any questions you have about your water. Share your reasons and questions with the other people in your group.

2. Complete the left hand column in the chart below.
3. Share your reasons with the other people in your group.
4. Record some of the reasons other people in your group mentioned. Begin with ideas that were different from yours.

My reasons why we should care about where water comes from & where it goes.	Reasons listed by other members of my group
1	1
2	2
3	3

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Name: _____

Hour: _____

5. Write down three questions you have about water in the left hand column of the chart below.
6. Share your questions with your group.
7. Record some of the questions other people in your group mentioned. Begin with questions that were different from yours.

My questions about water	Questions listed by other members of my group
1	1
2	2
3	3

Name: _____

Hour: _____

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Activity 2.3: The Water Works

Purpose: Have you ever thought about how the water gets to your house and how it leaves when you are finished with it? Have you ever thought about where it comes from or where it goes? It takes lots of pipes, people, and pumps to get you your water.

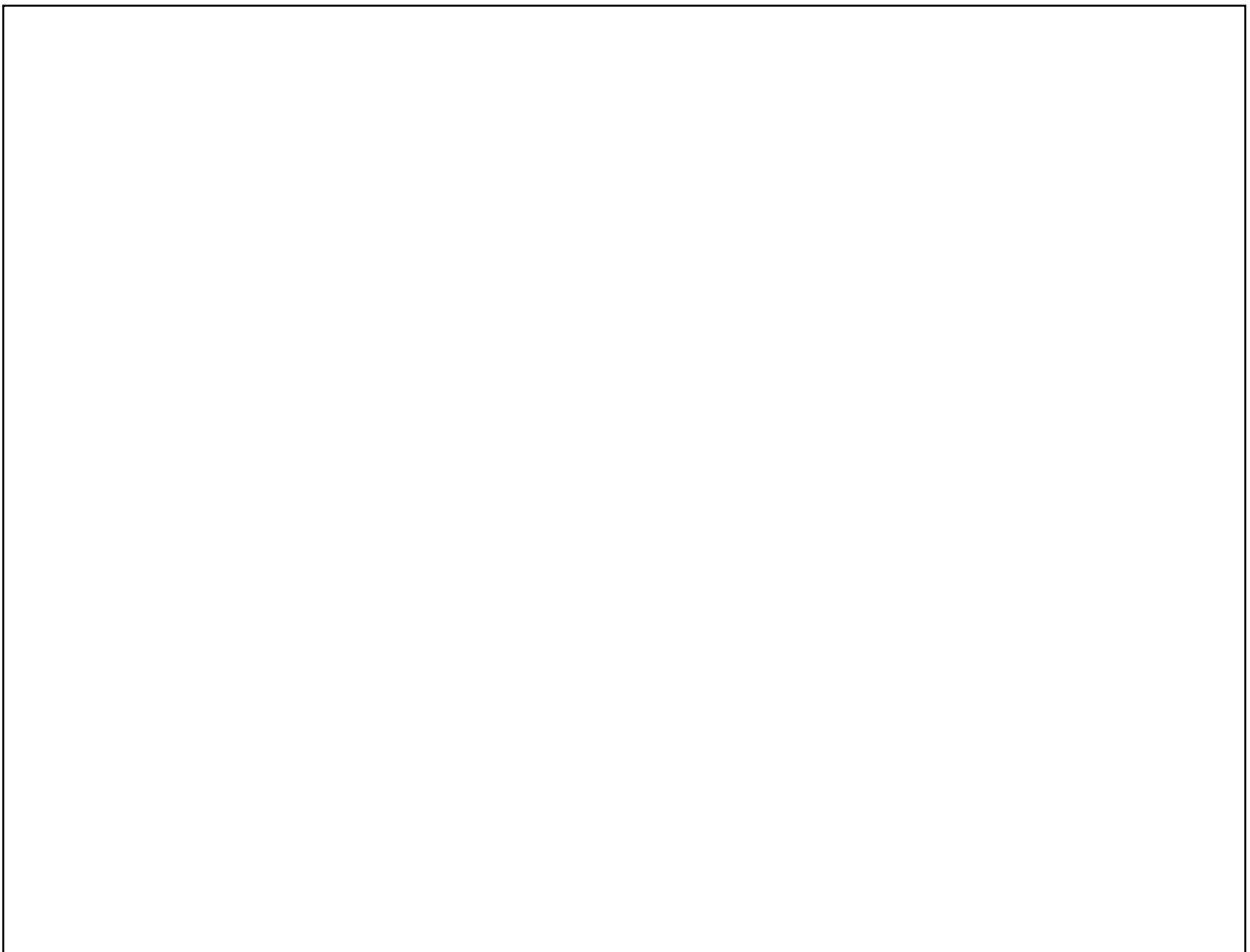
Directions

1. Cut out the cards on the next page. You only need to cut apart one set of cards for your group.
2. Working together with the other people in your group, lay the cards out on the table in an order that makes the most sense for getting water to your house and taking water away from your house.

Activity 2.4 Where Does it Come From & Where Does it Go?

1. Draw a picture that shows the path that water takes to get to a house and where it goes when it leaves a house or apartment building. Be sure to show where the water comes from and where it goes. You may refer to the cards that your group arranged on the table.
2. Be sure to label your drawing.

Draw your picture here:

A large empty rectangular box with a thin black border, intended for a student to draw a picture showing the path of water from its source to a house and then away from the house.

Name: _____

Hour: _____

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Activity 2.5: Other Systems

Purpose: Not all people get their water the same way. Depending on where you live, you may get your water in a different way. What are some other ways people get water to their houses and take it away when they are done with it?

Directions:

Now re-arrange the cards from the previous activity (2.3/2.4) for the following systems

A) A rural system in the United States: Not everyone lives where they are hooked up to a municipal water system. Many people, maybe even you, get their water from their own private well. Their waste water goes into a private, underground water tank called a septic tank. Here, solids sink into the tank where bacteria break it down. The water then drains out into the ground.

B) A rural system in Africa. In rural Africa, no one has access to municipal water treatment and waste water systems. People often have to walk long distances to get water. Remember the stories in lesson 1 if you need help.

