LESSON 12

Dams: How Humans Change the Direction and Flow of Water

Overview and Objectives

Students have investigated how moving water affects land and, most recently, how natural land features affect the direction and flow of water. In this lesson, they explore ways that humans control flowing water. Students analyze, design, construct, and read about dams. By building dams in their stream tables and observing their effects, students begin to understand how humans can alter the direction and flow of water on land and control erosion and flooding.

- Students brainstorm why and how humans build dams.
- Students predict the effects of dams on the direction and flow of water in their stream tables.
- Students design and construct dams in their stream tables.
- Students test the effects of dams in their stream tables.
- Students read to learn more about dams.

Background

The average volume of water that flows in a stream determines the size of the stream channel. Some streams are small enough to step across, while others are hundreds of meters wide. If the volume of water in a stream remains constant, the channel changes very little. However, the volume of water in most streams changes continually. A severe storm may dramatically increase a stream's flow. This increased flow may cause the stream to overflow, or **flood,** its banks, eroding soil from some areas and depositing soil in other areas.

When rivers flood, they can damage property and crops. Homes, farms, livestock, and human lives may be lost. In the United States, the average annual cost of flood damage is more than $2 billion. About 100 Americans lose their lives to floods every year.

Small streams, particularly in the southwestern United States, are subject to **flash floods,** which are very sudden increases in runoff that may last from a few minutes to a few hours. The flooding of larger streams usually lasts from several hours to several days. A series of storms might keep a river above **flood stage** (the water level at which a river overflows its banks) for several weeks.

Levees are high ridges along the banks of streams that prevent or minimize flooding. When streams overflow their banks, the flow rate diminishes suddenly and heavier sediments are deposited along the stream bank. With repeated flooding, the deposits gradually grow higher until, after many episodes, a **natural levee** has been

created that protects the area behind the levee from flooding. **Artificial levees** are created by humans to provide some added protection from floods, but like natural levees, they may be overtopped and eroded by heavy flooding.

One way to reduce flooding is to build a **flood-control dam**—a barrier that controls the direction and flow of water. The main function of a flood-control dam is to hold the excess water from a storm until it can be safely and slowly released when water levels have fallen.

In this lesson, students design and construct a dam. Using their own design plans, groups select materials and decide how and where to build the dam. The purpose of the activity is to investigate how dams, like rocks and hills, can affect the direction and flow of water.

When the dam is completed, an artificial lake should form behind it. This lake acts as a **reservoir** for excess runoff. In a reservoir, stored water may be used to generate electricity **(hydroelectric power),** to supply drinking water to populated areas, or to irrigate farmland during dry periods. Some reservoirs are also used for recreational purposes, such as swimming and boating.

Because students may not always devise a method for releasing the water that accumulates behind their dams (for example, using a straw to narrow the stream channel), the water may spill over the dam. Discuss with your students why such an event might occur.

Materials

For each student

1 science notebook

For each group of four

1 copy of **Record Sheet 12-A: Building a Dam**
Stream table materials (as listed in Important Information on Materials, pgs. 7–10)
1 plastic cup with large hole (red dot), 270 ml (9 oz)
1 2-liter soda bottle, containing 1 liter (1 qt) of water
3 paper towels
15 craft sticks, 11 cm (4½ in)
20 toothpicks
1 cup of gravel, 270 ml (9 oz)
1 cup of sand, 270 ml (9 oz)
1 jumbo straw
Scissors
6 plastic centimeter cubes

For the class

8 resealable plastic bags, 30 × 38 cm (12 × 15 in)
2 rinse buckets, 3.8 liters (1 gal)
1 large absorbent pad, 58.4 × 91.4 cm (23 × 36 in)
1 sheet of newsprint
Assorted colored markers
Masking tape
Index cards
Cleanup supplies

Preparation

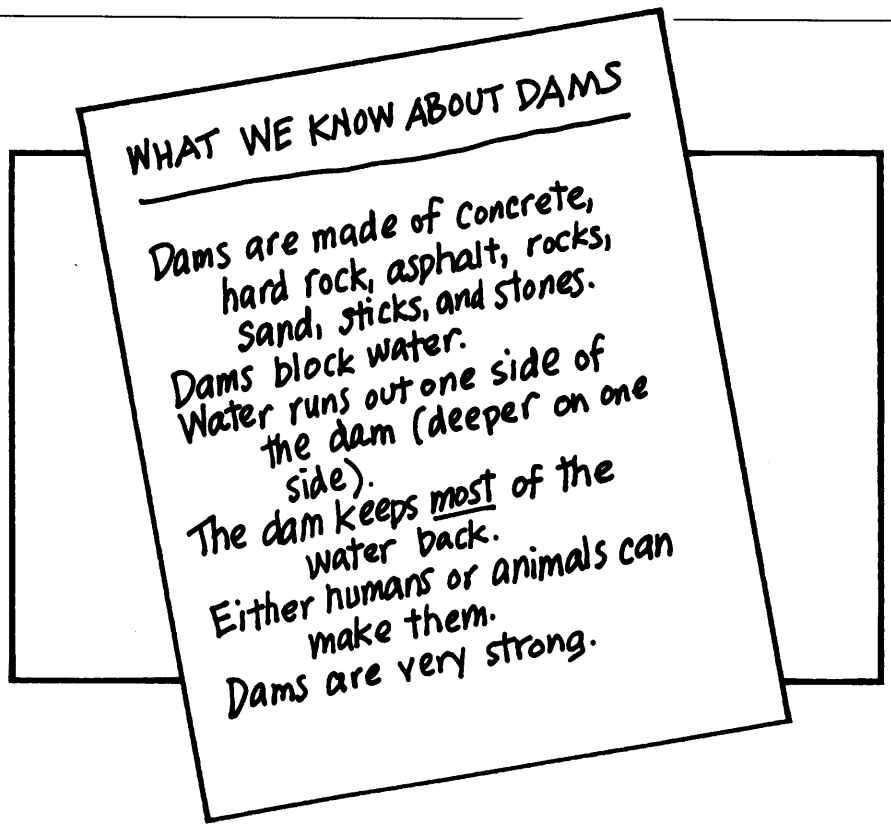
1. This is a long lesson. Preview it and decide if you will divide the lesson.
2. Preview the reading selection "Releasing a River" (pgs. 152–55 in this guide and pgs. 65–68 in the Student Activity Book). Decide when you will have students read it.
3. Label the newsprint "What We Know about Dams."
4. Make one copy of **Record Sheet 12-A: Building a Dam** for each group.
5. Fill the soda bottles with 1 liter (1 qt) of water.
6. Place each group's paper towels, craft sticks, toothpicks, straw, and plastic cubes in a resealable plastic bag for easy handling.
7. Fill one 270-ml (9-oz) cup with sand and one cup with gravel for each group.
8. Set up the distribution center or distribute materials to the permanent stream table stations around your classroom.
9. Set up a rinse station by placing two buckets of water, each half full, on an absorbent pad. Here, students can clean their hands, along with the plastic cubes and other reusable materials.
10. Check each group's stream table. The soil should be bulldozed as in previous lessons. If it is not, have groups mix and bulldoze the soil before the lesson begins.

Procedure

1. Ask students to identify features on the land other than rocks and hills that can affect the flow of water. Focus the discussion by asking students how humans control the flow of water. Have students brainstorm what they know about dams and flooding. Record their ideas on the newsprint.

Figure 12-1

Sample brainstorming list



2. Let students know that in today's lesson, each group will be modeling a design engineering team that has been asked to design a dam to help control flooding along the imaginary Gaveo River. Distribute and review **Record Sheet 12-A: Building a Dam.**

3. Ask each group to complete Steps 1 through 4 on the record sheet.

Management Tip: If you plan to divide the lesson into two sessions, this is a good stopping point.

4. After each group shares its plan with you individually, have them get their materials and begin to build and test a dam by following Step 5 on the record sheet. Let groups know they may include any or all of the materials provided when building their dams.
5. Allow groups to rotate around the room to view other completed dams. If possible, have one member from each group demonstrate their dam by pouring water through the cup.

Final Activities

1. Ask students to share their observations. Guide the discussion with questions such as the following:
   - How did your dam affect the direction and flow of water?
   - Did each dam produce the same results? Why or why not? (different materials, building methods, or placement of dams)
   - Did the placement of your dam protect your town from flooding? Why or why not?
   - Think about how the rocks and hills affected the direction and flow of water. In what ways were the results with the dam the same? In what ways were they different?
2. Help students analyze their design methods by asking them to think about the materials that worked well for their dam and those that did not and why. Encourage students to suggest what they might change if they were to design, build, and test their dams again.
3. Have students clean up. They should dismantle their dams; remove all plastic cubes, sticks, rocks, straws, and gravel from their stream tables; drain any extra water; and replace the rubber stoppers in the drain holes from inside the stream table. Ask students to rinse their plastic cubes and place them in their storage containers. They will use them again in Lessons 15 and 16. Only the soil should remain in the stream tables.
4. Assign the reading selection "Releasing a River" (pgs. 152–55 in this guide and pgs. 65–68 in the Student Activity Book). As partners read together, have one of them list in his or her notebook one benefit of dams (how dams are useful) and one drawback of dams (how dams are harmful and to whom). Have them compare these characteristics with those of their own dam.

Extensions

LANGUAGE ARTS

1. Imagine you are an animal that has established a home near a river. Suddenly the river is dammed and your environment floods. How will the dam affect you? What will you do?

SOCIAL STUDIES LANGUAGE ARTS

2. Have students research the Hoover Dam and the Aswan High Dam. Encourage students to debate the advantages and disadvantages of each dam.

SOCIAL STUDIES

3. Have students list places in the world that have suffered major droughts. How have dams helped in these catastrophes? List machines and inventions, such as the Archimedes' screw, that have helped people move water from flooded areas to areas where water is scarce.

ART SCIENCE

4. Encourage students to create labeled, detailed drawings of their dams. How did their constructed dam differ from their plan? Have students explore the role of engineers in designing and building dams.

Assessment

This assessment measures students' knowledge gained throughout the unit as it applies to dams. When you review the students' brainstorming sessions, discussions, investigation, and record sheets from this lesson, consider the following criteria:

- Could students brainstorm about dams and identify their basic characteristics?
- Did students make plausible predictions about the effects of a dam on the direction and flow of their streams?
- Could students state the effects their dams had on the direction and flow of water?
- Were students able to recognize the advantages and disadvantages of the materials they used to build their dams?
- Could students apply what they learned in this lesson to their understanding of the reading selection?

The design technology process used in this lesson requires that students work together to solve a problem. Use this lesson to assess students' abilities to work in a group, design a solution as a group, execute a design plan, and refine the design as needed.

Preparation for Lessons 13 and 14

A four-day break must occur between Lessons 13 and 14. Students will plant ryegrass and mustard seeds in their stream tables at the end of Lesson 13. Try to complete Lesson 13 on a Thursday. If the seeds are planted at the end of Lesson 13, the plants should be ready for Lesson 14 by the following Monday. Preview the lessons now and plan your schedule accordingly.

Reading Selection

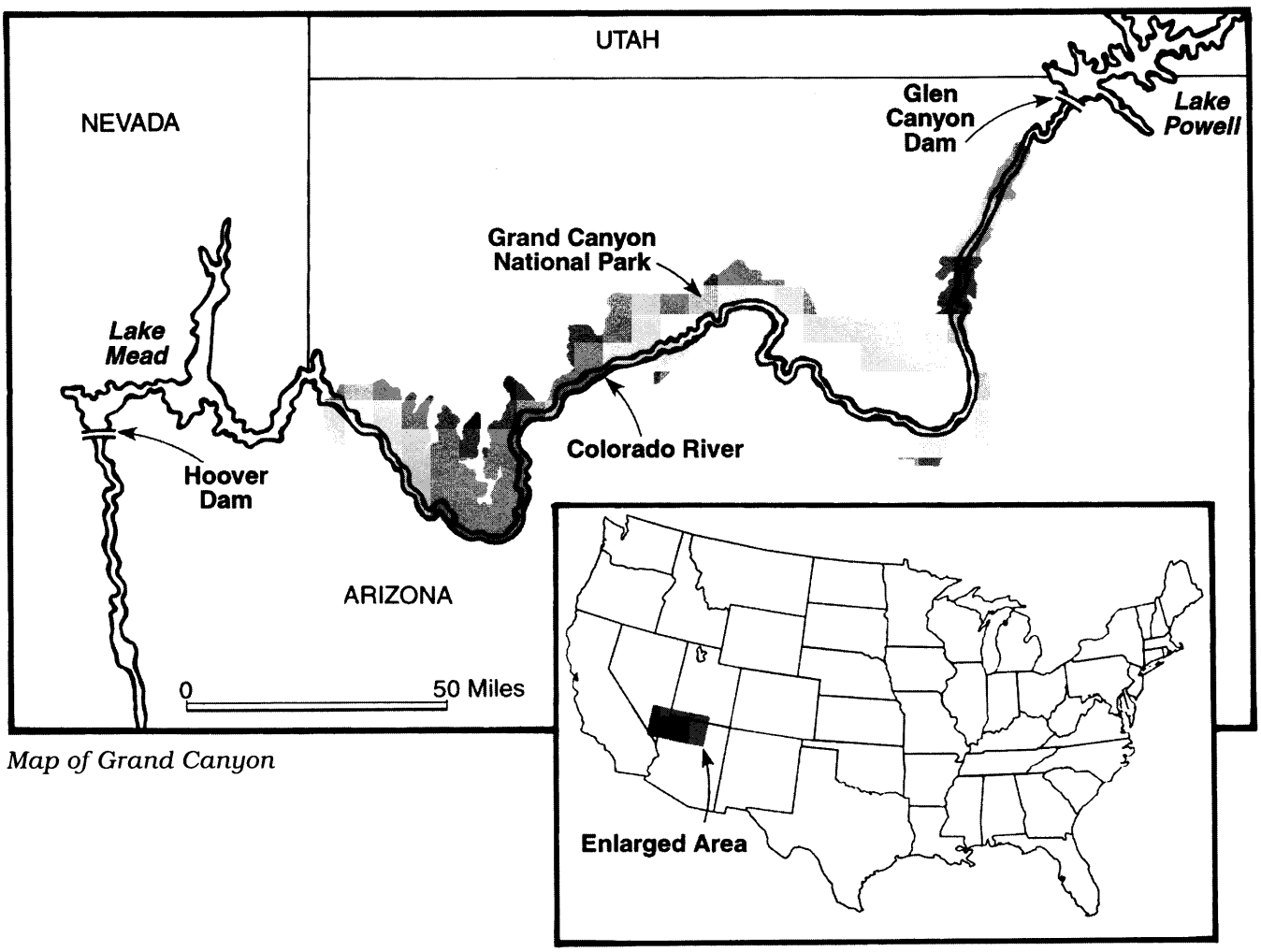
Releasing a River

It is March 26, 1996. A group of scientists stand at the base of the Glen Canyon Dam on the Colorado River. They are looking at the landscape shaped by the river. Earlier in the day, they canoed along the river observing its banks and the organisms—like ambersnails and the southwestern willow flycatcher—that live there.

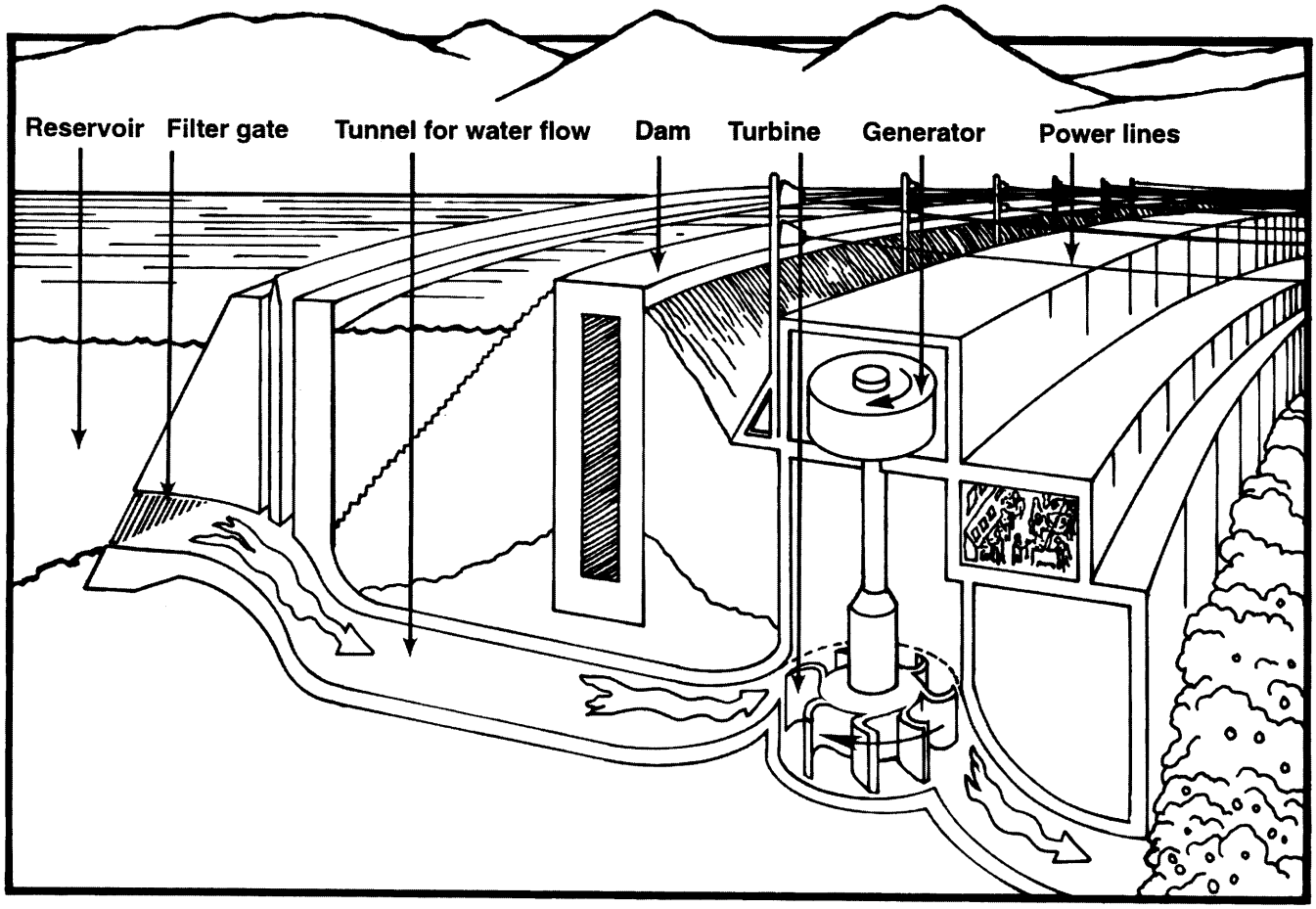
Millions of years ago, the Colorado River flowed across the Colorado Plateau. The land was high and flat then. Over the centuries, the Colorado River and its floods sculpted and shaped the land until a huge, deep canyon formed—the Grand Canyon.

A Lake Made by Humans

The scientists turn around to look at the massive concrete wall that holds back part of the Colorado River. Behind the dam is Lake Powell. It is the human-made lake, or **reservoir,** that formed when workers built the dam in 1963. Operators of the dam can control the flow of water that passes through the large pipes in the dam and into the canyon.



Map of Grand Canyon



Hydroelectricity

The water stored in the reservoir is used to make electricity. This **hydroelectricity** can provide power to homes and businesses. Just like a waterfall, water from the lake gushes through narrow openings inside the dam. The water hits the blades of **turbines,** or engines, and causes them to spin. These engines power the generators that make electricity.

Towns as far away as 250 miles receive water piped from reservoirs along the Colorado River. Towns can receive water from the reservoirs even during a drought. **Irrigation,** which brings water to farmland through drainage channels, provides farmers with water for growing crops.

People use the reservoir for recreation, too. Swimming, boating, and fishing are only a few of the fun things people enjoy doing on Lake Powell.

Swoosh! The Water Is Released

The dam was built to create electricity. But today, the scientists are going to open the dam. They will create a human-made spring flood.

Swoosh! The dam opens. A thunderous roar echoes through the canyon. More than 117 billion gallons of water blast out of the large tubes at the bottom of the dam. The scientists plan to leave the dam open for a week.

Why would anyone want to flood a canyon on purpose? Before 1963 when the dam was built, the river flooded every spring. The water eroded huge amounts of soil and deposited it along the river's banks. Beaches and sandbars formed when the floodwater pulled back. People on rafting or canoe trips could camp on the beaches. Fish could hide behind the sandbars in the warm, still water and lay their eggs. All along the river, the

ecosystem, or environment in which plants, animals, and their environment interact, depended on the floodwater.

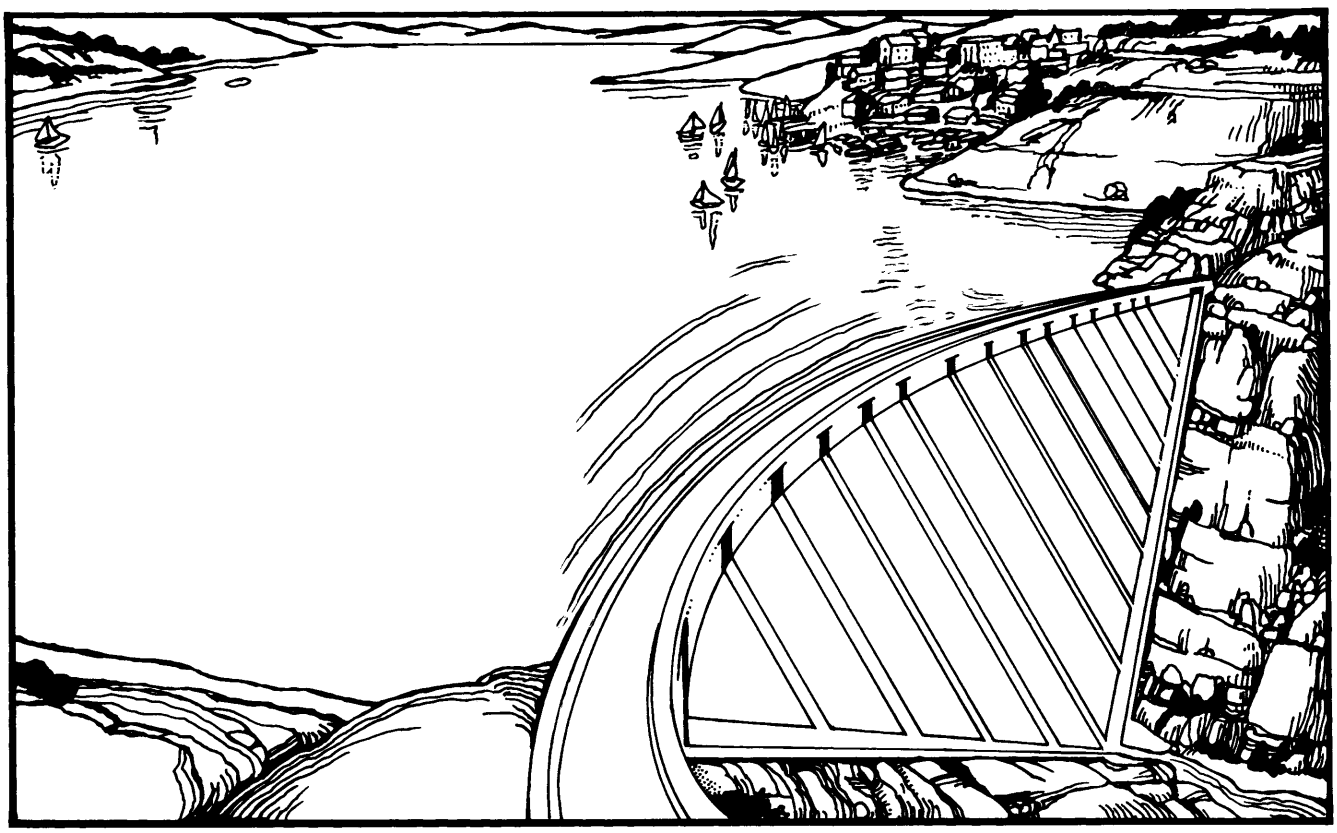
When scientists and engineers dammed the river, it no longer flooded each spring like it had for centuries. Across the country, scientists observed that dammed-up rivers were getting smaller. Trees sprouted in the middle of dry riverbeds. Some rivers, like the Colorado, no longer reached the sea. No wonder! Except during extremely high flood years, humans collect and use almost all the water in the entire Colorado River.

What were the scientists' goals for flooding the river? They wanted to restore the beaches along the river's banks. They also hoped the human-made flood would help bring back the natural habitat that plants and animals lost when the river was dammed.

Planning the Human-Made Flood

Scientists carefully planned each step of the flood. They tied transmitters to boulders to study how floods move sediment. They tagged endangered organisms. They even moved snails to higher ground before opening the dam.

And then there was the red water. To measure the speed of the flood, scientists who study water, or **hydrologists,** at the U.S. Geological Survey dyed the water red. They set up stations along the river below the dam. Each station transmitted data to satellites in the sky. Students, teachers, scientists, and others were asked on the World Wide Web to predict how long it would take the red floodwater to reach each station. Because of computers and satellites, people across the world could follow the flood as it happened!



Using a reservoir

USGS Gaging Stations	Predicted Arrival of Flood	Actual Arrival of Flood (estimated)
Lees Ferry	2 hours, 45 minutes	3 hours
Above Little Colorado River	14 hours, 16 minutes	13 hours
Above Grand Canyon	18 hours, 41 minutes	15 hours
Diamond Creek	40 hours, 39 minutes	37 hours

One person's predictions for the flood

More than a week later, the floodwater reached the Hoover Dam 300 miles away at the lower end of the Grand Canyon. What were the results of releasing the river? It will take a long time to tell how the flood affects plants and animals in the river habitat. But after the dam was closed and the flooding stopped, beaches could be seen along the river. Scientists are calling the flood a success. They might release the river every 10 years.

Humans have learned many ways to control the flow of water. Now they are realizing the effects. What do you think are the benefits of a dam? What are the disadvantages? Should humans release other dammed-up rivers? You might want to do some research to find out more about this topic.

Record Sheet 12-A

Names: _____

_____

Group: _____

Date: _____

Building a Dam

1. **Examine the Problem:** During heavy rains, the Gaveo River experiences flash floods. The Gaveo Town Council has asked your design engineering team to look into this problem. How would you solve the problem? List your ideas.

_____

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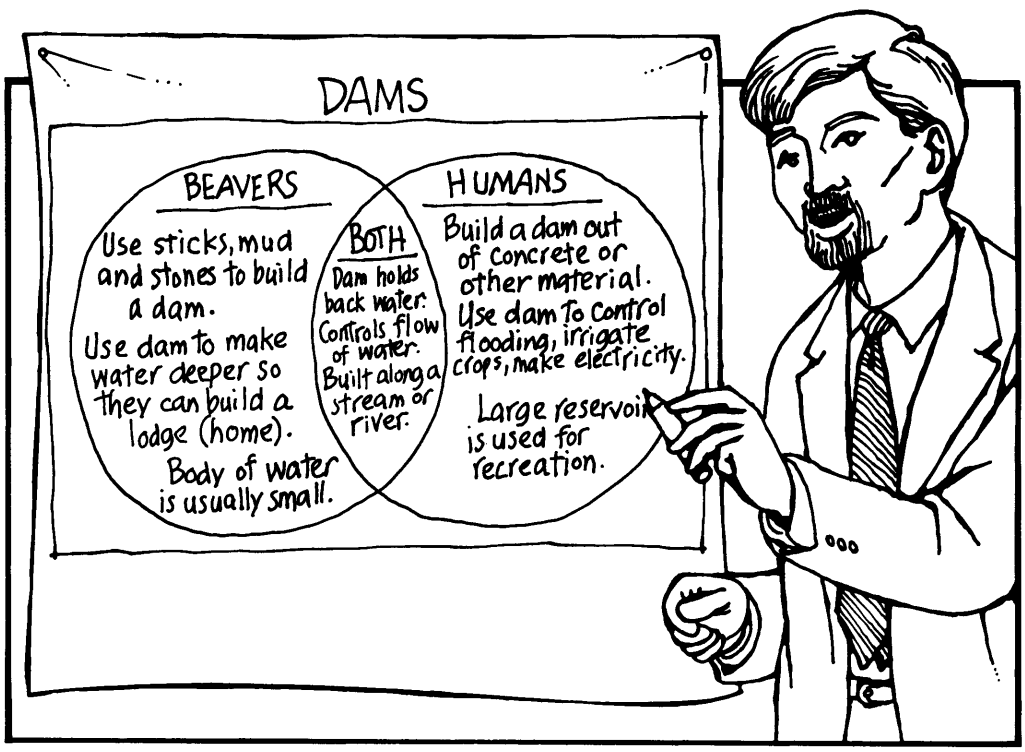
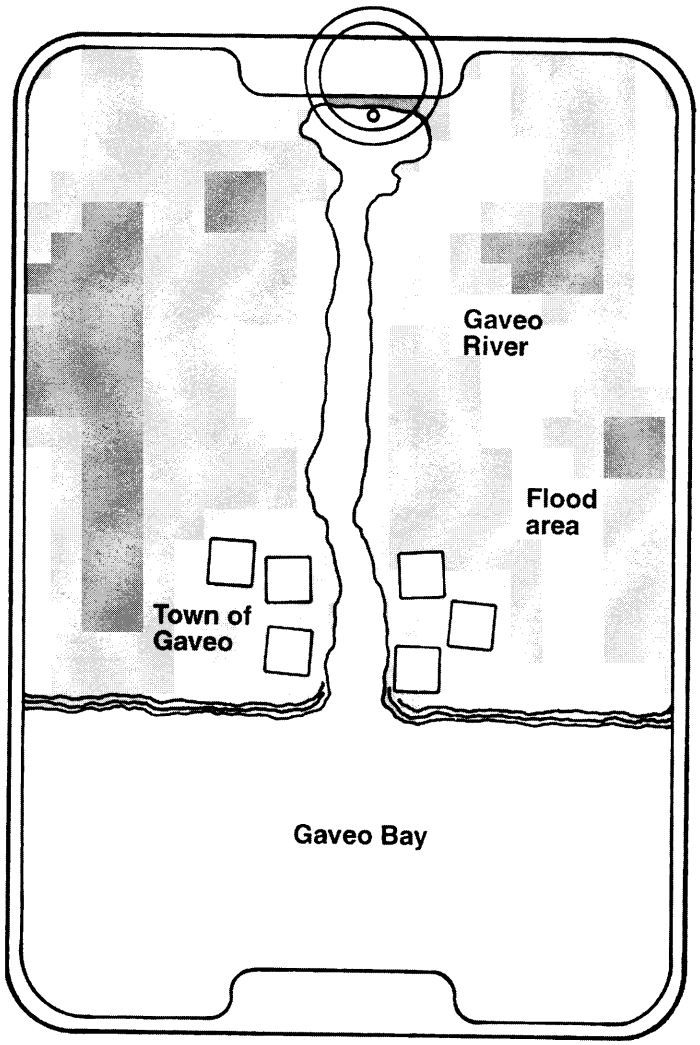
2. **Look at the Research:** A group of fourth-grade students has conducted research on how dams can be used to control the flow of water. Use their data, which appear on the Venn diagram below, as your starting point.



Record Sheet 12-A Name(s): _____

Building a Dam, *continued*

3. **Make a Plan:** Look at the map. Consider the location of the town of Gaveo. Where would you build your dam to protect the town from flooding? Draw your dam on the map.



Why would you choose this location?

_____

_____

_____

_____

4. **Make a Prediction:** What do you think will happen when the river floods after you build your dam? Use a blue crayon to show your prediction on the map.

Record Sheet 12-A Name(s): _____

Building a Dam, *continued*

5. Design, Build, and Test Your Dam:

- Set up your stream table as you have in other lessons.
- Use a spoon to carve the Gaveo River in your stream table. Use the illustration to help you.
- Look at the map. Place the plastic cubes in your stream table to represent the town of Gaveo. Make certain they are in the same place in your stream table as they are on the map.
- Build your dam.
- Test your dam by filling the stream source cup once. Change your dam, if you wish, and stop building when you are satisfied with your results. Record your observations in the space below.

_____

_____

_____