

Title: Water Works

Source: The Water Sourcebook Series, U.S. Environmental Protection Agency

Subject(s): Science, Social Studies, Language Arts

Grade(s): 3-5

Objectives: Students will be able to demonstrate the process that water treatment plants use to purify water by conducting their own water purification demonstration. Students will then creatively describe the water treatment process by writing a story.

Summary: After reviewing key terms and the basic steps involved in the water treatment process, students will divide into teams and each perform one step in the water treatment process. At the end of the activity students will compare and record observations about the treated and untreated water. A question sheet and word search are provided as follow-up activities. As an extension activity, students can write a story or draw cartoons about what happens to fictional characters as they go through the water treatment process.

Modification: Instead of making a trip to the local water treatment plant, students can view a fun presentation of the water treatment process online at Fairfax Water's website at [http://www.fcwa.org/education/the\\_plant/index.html](http://www.fcwa.org/education/the_plant/index.html).

You may also choose to take a virtual tour of the Blue Plains Advanced Wastewater Treatment Plant online at [http://www.dewasa.com/about/model\\_flash.cfm](http://www.dewasa.com/about/model_flash.cfm).

Standards: S3CS4. S5CS4. S4CS4. Students will use ideas of system, model, change, and scale in exploring scientific and technological matters.

S3L2. Students will recognize the effects of pollution and humans on the environment.

S4E3. Students will differentiate between the states of water and how they relate to the water cycle and weather.

SS3E1. The student will describe the four types of productive resources.

ELA3R2. The student acquires and uses grade-level words to communicate effectively.

ELA4R3. ELA5R3. The student understands and acquires new vocabulary and uses it correctly in reading and writing.

# WATER WORKS

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## OBJECTIVES

The student will do the following:

1. Demonstrate the process that water treatment plants use to purify water for drinking by conducting a water purification experiment.
2. Describe what happens in the water treatment process by writing a story.

## BACKGROUND INFORMATION

Water treatment is the process of cleaning water and making it safe for people to drink. Because water is a good solvent it picks up all kinds of contaminants. In nature, water is not always clean and safe enough for people to drink.

Our drinking water comes from both surface and groundwater. Water in lakes, rivers, and swamps contains impurities that may make it look and smell bad. Water that looks clean may contain harmful chemicals or bacteria and other organisms that can cause disease.

In the past, waterborne diseases were a major public health concern but today these diseases are no longer a health threat in the United States because of the improved water treatment. Technicians working in drinking water facility laboratories make thousands of tests each year to insure that our drinking water supply is free of disease-causing bacteria. These test results are reported to the state and local governments.

It takes the efforts of both federal and state governments as well as local water supply systems to keep our drinking water safe and in good supply. The Safe Drinking Water Act and its amendments set the standards for public drinking water. The Environmental Protection Agency administers these standards.

Water treatment plants clean and maintain the quality of drinking water by taking it through the following processes: (1) aeration, (2) coagulation, (3) sedimentation, (4) filtration, and (5) disinfection (see definitions in "Terms" below).

### Terms

**aeration:** to expose to circulating air; adds oxygen to the water and allows gases trapped in the water to escape; the first step in water treatment.

### **SUBJECTS:**

Science, Social Studies, Language Arts

### **TIME:**

120 minutes

### **MATERIALS:**

1 gallon (4 L) jug of water  
2 1/2 cups (600 mL) soil or mud  
acetate sheet  
four 2-liter plastic bottles  
funnel  
scissors  
2 tablespoons (30 mL) of alum  
2 tablespoons (30 mL) of bleach  
2 cups (500 mL) fine sand  
2 cups (500 mL) coarse sand  
1 cup (250 mL) fine gravel  
1 cup (250 mL) coarse gravel  
1 cup (250 mL) activated charcoal  
cotton for plug  
tap water  
a tablespoon  
clock  
student sheets (included)  
tape recorder with tape (optional)  
camera with film (optional)  
teacher sheet (included)

**coagulation:** the process by which dirt and other suspended solid particles are chemically “stuck together” so they can be removed from the water; the second step in water treatment.

**disinfection:** the use of chemicals and/or other means to kill potentially harmful microorganisms in the water; the fifth step in water treatment.

**filtration:** the process of passing a liquid or gas through a porous article or mass (paper, membrane, sand, etc.) to separate out matter in suspension; the fourth step in water treatment.

**groundwater:** water that infiltrates into the earth and is stored in usable amounts in the soil and rock below the earth’s surface; water within the zone of saturation.

**sedimentation:** the process that occurs when gravity pulls particles to the bottom of the tank; the third step in water treatment.

**sludge:** solid matter that settles to the bottom of septic tanks or wastewater treatment plant sedimentation tanks; must be disposed of by bacterial digestion or other methods or pumped out for land disposal or incineration.

**surface water:** precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration, and is stored in streams, lakes, wetlands, reservoirs, and oceans.

**water treatment:** a method of cleaning water for a specific purpose, such as drinking.

## ADVANCE PREPARATION

- A. Make a copy of the diagram of a water treatment plant and water treatment word search puzzle for each student. You may use the diagram of a water treatment plant as a transparency.
- B. Gather materials for demonstration of water treatment process.
- C. Prepare “dirty water”; add approximately 2 1/2 cups (600 mL) of soil or mud to 1 gallon (4 L) of water.
- D. Cut one 2-liter bottle in half, cut the bottom from another bottle, and cut the top from a third bottle.
- E. Alum can be found at the grocery store in the spices section. It is commonly used for making pickles.
- F. NOTE: You may want to construct the filter before beginning the activity or may choose to let a team of students prepare it. To prepare the filter use the bottle with its bottom cut off to construct the filter. Turn the bottle upside down. Loosely put a cotton plug in the neck of the bottle. Pour the fine sand over the cotton plug followed by activated charcoal, coarse sand, fine gravel, and coarse gravel. Clean the filter by slowly and carefully pouring through 1-2 gallons (4-8 L) of clean tap water.

## PROCEDURE

## I. Setting the stage

A. Ask the students the following questions.

1. How many of you used water in some way today?
2. How did you use water? (shower, brush teeth, flush toilet, prepare meal)
3. Where does your water come from?
4. How can you be sure your water is safe to drink?

B. Discuss the water treatment plant and what it does.

1. Hand out the diagram of a water treatment plant.
2. Discuss the process that takes place during each step. Use the definitions given to explain each step:
  - a. Aeration – Vigorously stirring up water to add air to it and drive out other gases that might be dissolved in it; similar to “whipping” it with a mixer (as in cooking).
  - b. Coagulation – Adding chemicals to make dirt and other particles clump together.
  - c. Sedimentation – Letting the clumps settle out (they’re heavier than water, so they sink to the bottom).
  - d. Filtration – Pouring the water through a filtering system that has lots of layers of materials that trap things that did not settle out (including things too small to see).
  - e. Disinfection – Adding chlorine to kill germs that might make people sick (similar to swimming pool methods).
3. Write the letters A, C, S, F, and D on the board. Review with the students the words they stand for. Write simple-to-remember phrases for each one, such as:
  - a. A = Add air
  - b. C = Create clumps
  - c. S = Soil settles out
  - d. F = Fine filters to trap tiny things
  - e. D = Die, germs, die!

Leave these on the board while the class builds the model.

## II. Activities

- A. Review the diagram of the water treatment plant. Discuss with the students, checking for understanding. Allow for questions and comments from the students.
- B. Divide the students into teams of four or five students. Each team will perform one step in the process. (Supervise closely.) Give Team I the materials and dirty water to start.
1. Team I should pour about 1.5 quarts (1.6 L) of “dirty water” into the uncut 2-liter bottle with the cap. (Use a funnel) Ask the students to describe the water.
  2. Have a student in Team I put the cap on the bottle and shake for 30 seconds. Continue the aeration process by pouring the water back and forth between two bottles 10 times. Ask the students what part of the water treatment process we have demonstrated. (aeration) Ask the students to describe any changes they observe.
  3. Team II should pour the aerated water into the 2-liter bottle with the top cut off. Add 2 tablespoons (30 mL) of alum to the water. Stir the mixture slowly for 5 minutes. Ask the students what process this group has demonstrated. (coagulation) Ask the students to predict what will happen.
  4. Team III should allow the water to stand undisturbed for 20 minutes. Ask the students to observe the water at 5 minute intervals and record their observations as to changes in the appearance of the water. (NOTE: Other groups may do the student sheet word search during this time frame or Team IV may construct the filter from the bottle with its bottom cut off. If you prefer to construct the filter model yourself, you may do it now if you'd like.) Ask the students what step this is? (sedimentation)
  5. Team IV should carefully, without disturbing the sediment, pour the top two-thirds of the water through the filter. Ask the students what step this is. (filtration) Have them quickly rest the filter model in the 2-liter bottle cut in half to collect the filtered water.
  6. After waiting until you have collected more than half of the water poured through the filter, add 2 tablespoons (30 mL) of bleach to the filtered water. The bleach represents the chlorination process. (CAUTION: Wear eye protection when handling bleach and quickly wash it off your skin if some should splash.) This is disinfection. Ask the students: “Did we recover the same amount of water we started with?” Measure approximately. Discuss that there is a certain loss of usable water in the water treatment process.
- C. Compare the treated and untreated water.
1. Ask the students whether treatment has changed the appearance and smell of the water. How has it changed?
  2. Explain to the students that this is a simulation of the process that a water treatment plant does; therefore, this water is not safe to drink.

### III. Follow-Up

A visit to the local water treatment plant is a valuable experience. If this is not possible, ask a representative from the water utility to visit the class.

- A. As you tour the plant, use your A, C, S, F, and D memory devices to review the terms with the

students.

- B. Assign each student a responsibility to perform during the trip or visit. Develop assignments and questions in advance. You may use the student sheet, "Water Works."
- C. Send the contact person at the water treatment plant a copy of the assigned questions before the visit so he/she will be prepared for the group.
- D. One student could also tape record the experience and another student could take photos for a visual record.

#### IV. Extensions

- A. Have the students write a story or draw cartoons about "Betty Bacterium," "Sediment Sam," or other fictional characters and describe what happens to these characters as they go through the water treatment process.
  - 1. Share the stories/cartoons with the class.
  - 2. Use as a bulletin board activity to reproduce the water treatment process.
- B. Ask the students to do the student sheet "Water Treatment Words" if you did not use it in the activity.

The answers to the word search are as follows:

a	g	b	f	o	n	i	f	g	r	o	u	n
r	g	r	v	u	t	s	i	d	a	o	n	i
d	i	c	o	a	g	u	l	a	t	i	o	n
s	e	n	f	u	n	t	t	r	a	t	s	
m	n	s	t	a	n	a	r	t	e	f	s	a
u	m	n	r	u	x	d	a	r	a	s	t	e
s	u	r	f	a	c	e	t	n	t	i	o	r
m	r	t	a	f	a	c	i	l	m	s	n	a
e	w	a	t	e	r	a	o	a	e	o	x	t
n	e	b	a	v	l	o	m	m	a	o	i	
b	a	c	t	e	r	i	a					
s	e	d	i	m	e	n	t	a	t	i	o	n
a	e	l	r	o	u	s	m	f	g	o	n	t

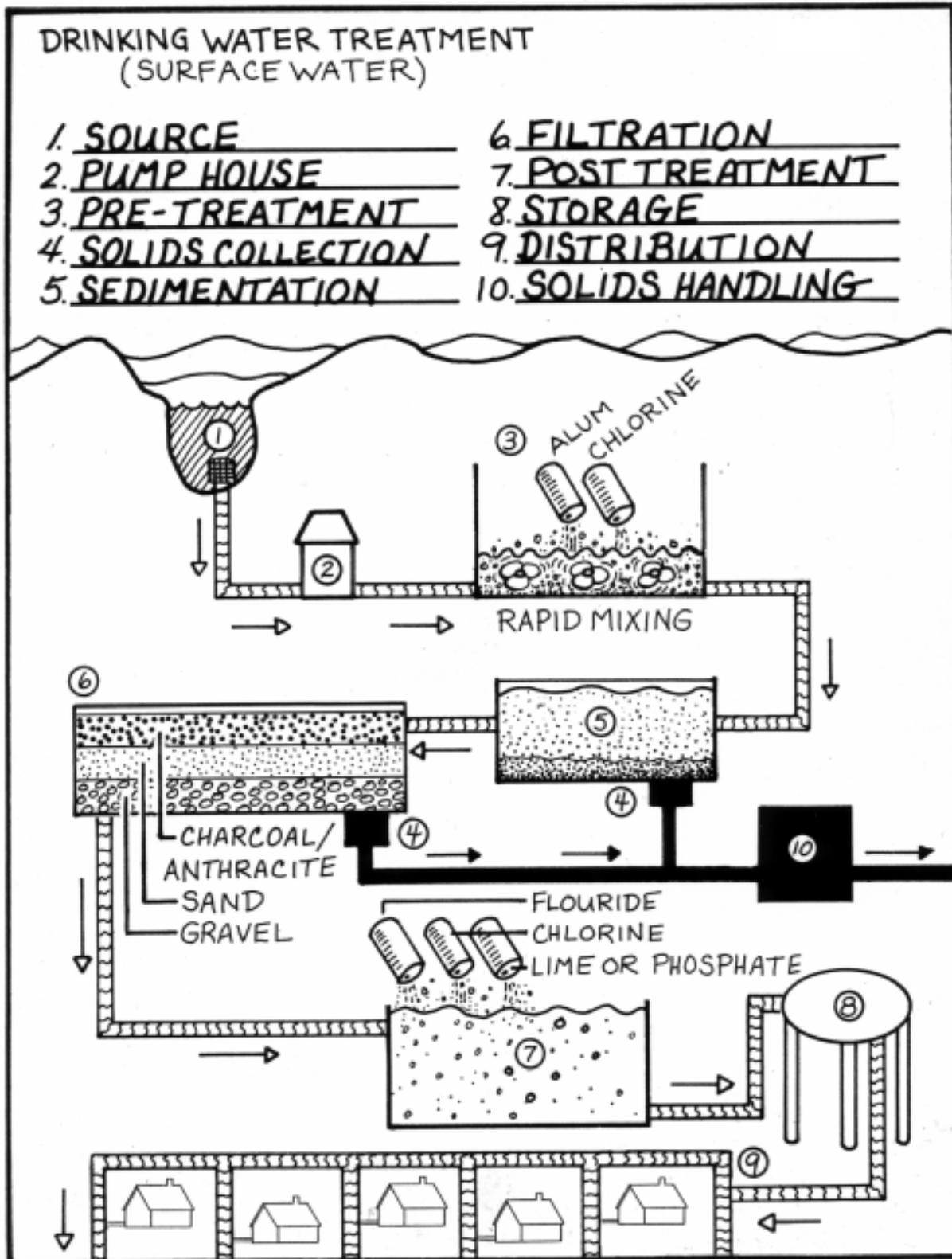
## RESOURCES

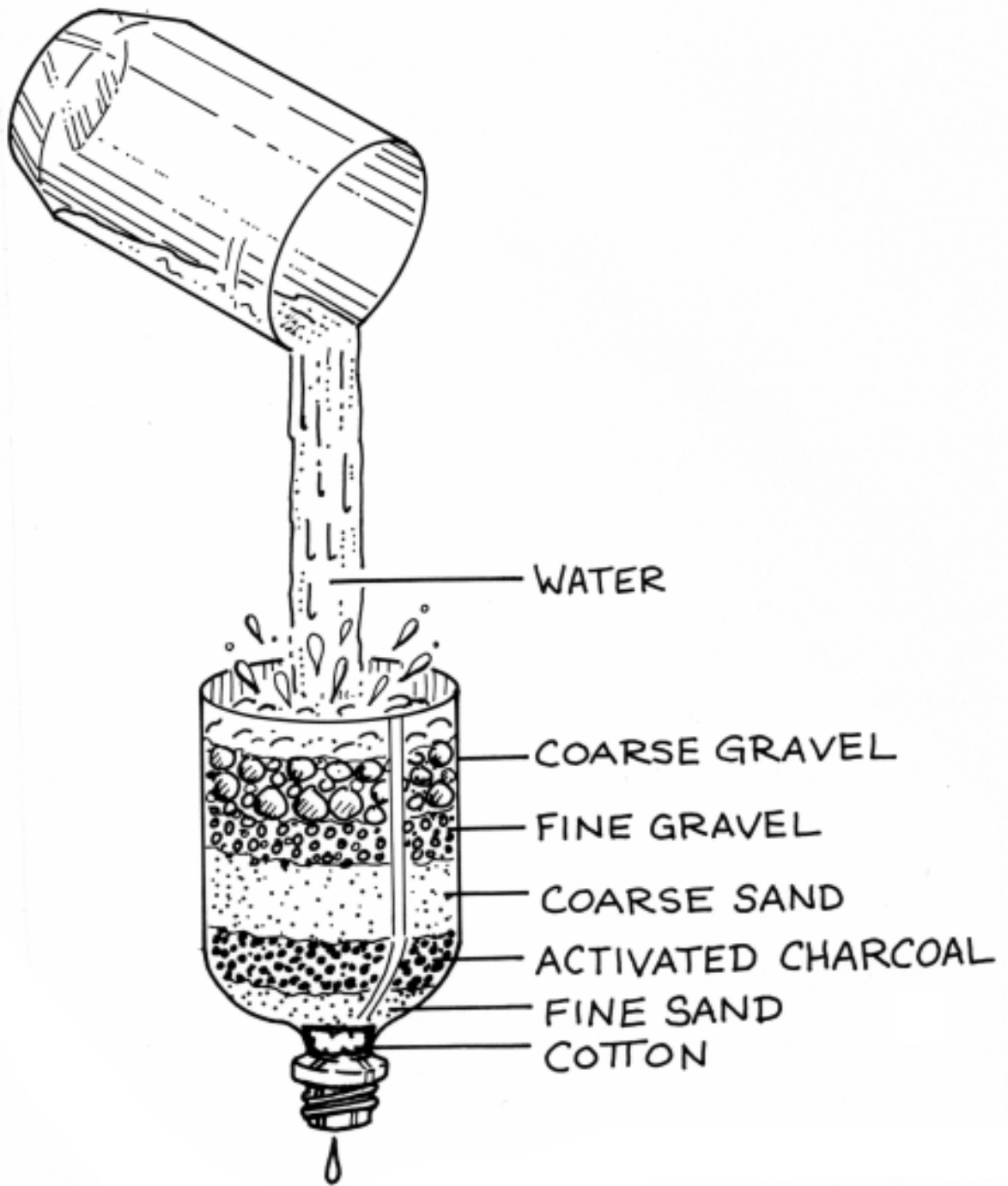
- "Science Demonstration Projects in Drinking Water: Grades K-12," U.S. Environmental Protection Agency, Washington, DC, 1990.
- "The Official Captain Hydro Water Conservation Workbook," East Bay Municipal Utility District, Oakland, California, 1982.
- "The Story of Drinking Water" (student booklet), American Water Works Association, Denver, Colorado, 1984.
- "The Story of Drinking Water: Teachers Guide, Intermediate Level, Grades 4, 5, 6," 2nd ed., American Water Works Association, Denver, Colorado, 1988.

Student Sheet

# DRINKING WATER TREATMENT PLANT

Student Sheet





Answer the following questions.

1. Where does our water come from?

2. How much clean water is produced each day?

3. How is the water tested?

4. What is used to destroy bacteria in the water?

5. What are the future plans for the water treatment system? As our community

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Can you find these words? Find the words, circle them, and check them off the list.

aeration  
coagulation  
filtration

water  
treatment  
sedimentation

surface  
ground

a g b f o n i f g r o u n  
r g r v u t s i d a o n i  
d i c o a g u l a t i o n  
s e n f u u n t t r a t s  
m n s t a n a r t e f s a  
u m n r u x d a r a s t e  
s u r f a c e t n t i o r  
m r t a f a c i l m s n a  
s w a t e r a o a e o x t  
n e b a v l o n m n a o i  
b a c t o n b a c t t e o  
s e d i m e n t a t i o n  
a e l r o u s m f g o n t