9-12

WATER WORKS

OBJECTIVES

The student will do the following:

1. Describe the process that water treatment plants use to purify water for drinking.

2. Demonstrate how a water treatment plant works.

SUBJECTS:
Science (Physical, Earth, & Biology)

TIME:
2 class periods

MATERIALS:
student sheets
2-gallon (8 L) jug of water
5 cups (600 ml) soil or mud
acetate sheet
many 2-liter plastic bottles
funnels, scissors, stirring rods
alum, bleach, fine sand
coarse sand, fine gravel
coarse gravel
activated charcoal
cotton for plugs, tap water
tablespoons, clock
small piece of cheese cloth, rubber band

BACKGROUND INFORMATION

Our drinking water comes from both surface water 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.

Waterborne diseases have been and continue to be a major public health concern. Waterborne disease outbreaks, such as occurred in Milwaukee, WI in 1993 with 400,000 sick and over 100 deaths, give cause for continued vigilance in drinking water protection and treatment.

It takes the efforts of federal, state, and local governments, as well as local water suppliers, to keep our drinking water safe. The Safe Drinking Water Act and its amendments set the standards for public drinking water supplies. The Environmental Protection Agency is charged with ensuring that these standards are met. Technicians working in drinking water facility laboratories conduct thousands of tests each year to ensure that our drinking water supply is free of disease-causing bacteria and other pathogens. These test results are reported to state and local governments.

Drinking water treatment plants clean and maintain the quality of our water supplies through the following processes: (1) aeration, (2) coagulation/flocculation, (3) sedimentation, (4) filtration, and (5) disinfection. (See definitions in "Terms.")

Terms

aeration: exposing to circulating air; addition of oxygen to wastewater or water, as in first step of both activated sludge wastewater treatment process and drinking water treatment.

alum: aluminum salt (typically, aluminum sulfate) used as a flocculant

coagulant: a substance added to a mixture that will cause precipitates (flocs) to form; also called "flocculant"

coagulation: the process by which dirt and other small suspended solid particles are chemically bound, forming flocs using a coagulant (flocculant) so they can be removed from the water (the second step in drinking water treatment)

disinfection: the use of chemicals and/or other means to kill potentially harmful microorganisms in the water (the fifth step in drinking water treatment)

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

flocculant: a substance added to a mixture that will cause precipitates (flocs) to form; also called "coagulant"

flocs: lumpy or fluffy masses of particles agglomerated by a flocculant or coagulant

flocculation: physical process of growing of flocs from smaller flocs or particles

microbe: microorganism (microbiological organism)

microbiology: study of microorganisms, a large and diverse group of organisms that exists as single cells or cell clusters

sedimentation: the drinking water process of letting heavy particles in raw water settle out into holding ponds or basins before filtration

sludge: any solid, semisolid, or liquid waste that settles to the bottom of sedimentation tanks (in wastewater treatment plants or drinking water treatment plants) or septic tanks

waterborne diseases: diseases spread by contaminated water

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 or use as a transparency.

B. Gather materials for students to demonstrate the drinking water treatment process.

C. Prepare "dirty water"; add approximately 5 cups (600 ml) of soil or mud to 2 gallons (8 L) of water.

D. Alum (flocculant) can be found at the grocery store in the spices section. It is commonly used for making pickles.

PROCEDURE

I. Setting the stage

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

B. Hand out the diagram of a Water Treatment Plant and Data Form.

C. Discuss each step of water treatment. (An overhead transparency of the Student Sheet may be helpful.) Use the definitions given to explain each step.

II. Activity

A. Divide the students into working groups. Have each group perform the following steps and answer the following questions on the Student Sheet - Data Form:

1. Pour about 1.5 quarts (1.4 L) of "dirty water" into the uncut 2-liter bottle with the cap. (Use a funnel.) Describe the water.

2. Put the cap on the bottle and shake for 30 seconds. Continue the process by pouring the water back and forth between two bottles 10 times. What part of the treatment process does this represent?

3. Pour the aerated water into the 2-liter bottle with top cut off. Add 2 tablespoons (30 ml) of alum to the water. Stir the mixture slowly for 5 minutes. What process is occurring?

4. Allow the water to stand undisturbed for 20 minutes. Ask the students to observe the water at 5-minute intervals and record their observations. What process is occurring? (Note: some members of the group could be constructing the filter during this time according to the diagram on page 2-8 - see #5 below)

5. Cut the bottom from another 2-liter or 3-liter bottle. Construct the filter. Turn the bottle upside down. Loosely put a cotton plug in the neck of the bottle,

then cover the neck of the bottle with a piece of cheese cloth secured with a rubber band. 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 (4-8L) of clean tap water. Place the filter over the bottom part of the bottle. Without disturbing the sediment in the container with the alum, pour the top two-thirds of the water through the filter. What process is occurring?

6. After waiting until more than half of the water poured through the filter has been collected, add 2 tablespoons (30 ml) of bleach to the filtered water. What part of the treatment process does the addition of bleach represent?

B. Compare the treated and untreated water.

1. Record differences in appearance and odor.

2. Examine water with a microscope (both treated and untreated). Record observations.

C. Have students find out if there is any special treatment that is done to "smelly" water. (Note: Activated charcoal is often used.)

III. Follow-up

A. Have students write a report on how a water treatment plant purifies water. They must include all the steps.

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

RESOURCES

"Science Demonstration Projects in Drinking Water: Grades K-12," U.S. Environmental Protection Agency, Washington, D.C., 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.

Data Form

II. Activity

A. 2. Answer to question:

3. Answer to question:

4. Observations -----

Answer to question:

6. Answer to question:

B. 1. Differences in appearance and odor.

Treated Water	Untreated Water

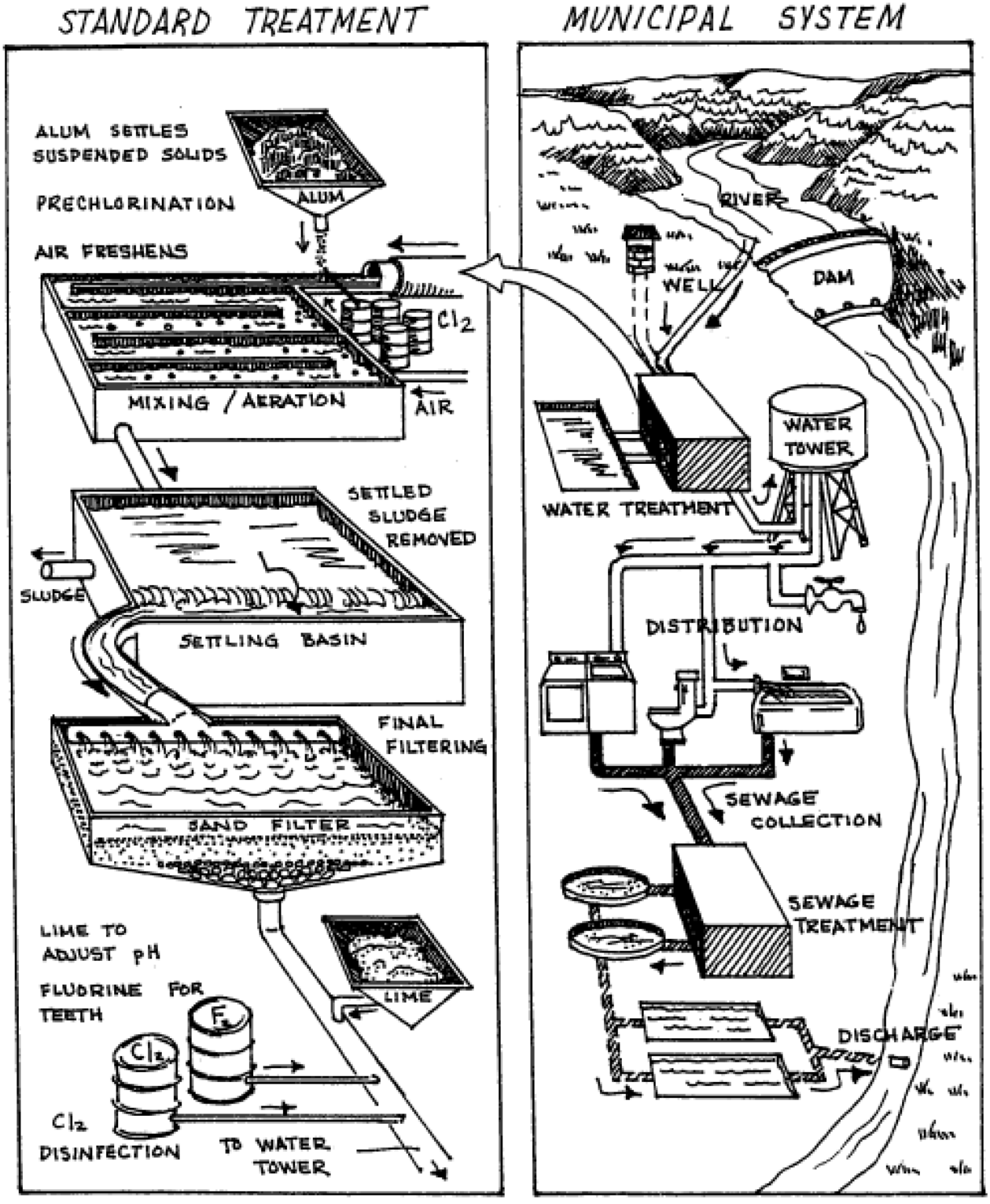
2. Microscope Observations

Treated Water	Untreated Water

III. Follow-up

Write a one-page report on how a water treatment plant purifies water for drinking.

TYPICAL MUNICIPAL WATER TREATMENT PLANT



FILTER MODEL