THE USED WATER MYSTERY

Objectives:
The student will be able to:

- The student will be able to demonstrate the process that water treatment plants use to purify water for drinking by conducting a water purification experiment.

Suggested Grade Level:
6-8

Subjects:
Science, Social Studies, Language Arts

Time:
Approximately 120 minutes

Materials:
- 1 gallon (4L) of water
- 2 ½ cups (600ml) of soil or mud
- acetate sheet
- four 2-liter plastic bottles
- funnel
- scissors
- 2 tablespoons (30mL) of bleach
- 2 tablespoons (30mL) of alum (can be purchased in grocery store in the spices section)
- 2 cups (500 mL) of fine sand
- 1 cup (250mL) fine gravel
- 1 cup (250mL) course gravel
- 1 cup (250mL) activated charcoal (can be found at most major pet stores in the aquarium section)

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 (EPA) 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

Note: The San Antonio Water System <u>currently</u> does not operate any drinking water treatment plants. Water is pumped from the Edwards Aquifer, sent to a tank where chorine and fluoride are added and then sent to the users. Water in the Edwards Aquifer exceeds all drinking water minimum requirements set out by the EPA.

- cotton for plug
- tap water
- a tablespoon
- clock
- student sheet (included)
- teacher sheet (included)

T E R M S

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.
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.

A D V A N C E P R E P A R A T I O N

A. Make a copy of the student sheet "Drinking Water Treatment Plant". You may use the diagram of a water treatment plant as a transparency.

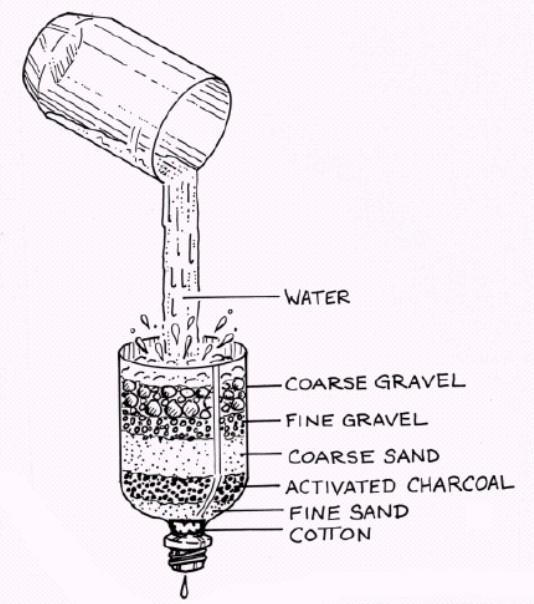
B. Gather materials for demonstration of water treatment process.

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. See the diagram below.



P R O C E D U R E

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 drinking water treatment plant and what it does *(remind students that SAWS currently does not operate a drinking water treatment plant).*

1. Hand out the diagram of a drinking 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. Activity

A. Review the diagram of the drinking 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: 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. Have the student look around their community for examples of water may get polluted during the course of a day or week. Ask them to brainstorm ways to reduce this pollution.

B. Look for ways in which nature cleans polluted water, i.e. the filtration process that occurs in aquifer water. Have students make a poster presentation about the ways 'mother nature' takes care of some pollution problems.

R E S O U R C E S

"Science Demonstration Projects in Drinking Water: Grades K-12," U.S. Environmental Protection Agency, Washington, DC, 1990.

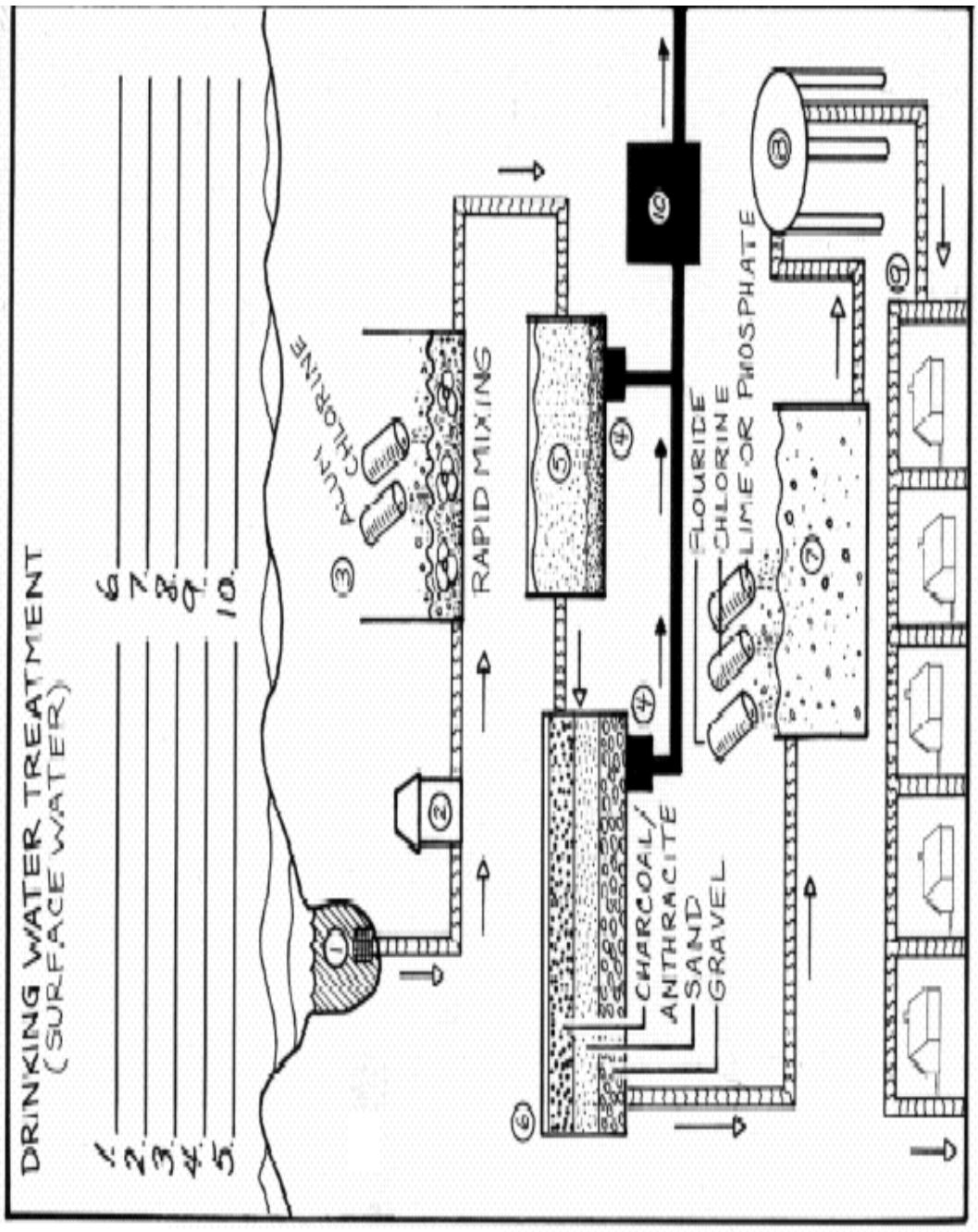
"The Official Captain Hydro Water Conservation Workbook," East Bay Municipal Utility District, Oakland, California, 1982.
"The Story of Drinking Water" (student booklet), American Water Works Association, Denver, Colorado, 1984.

"The Story of Drinking Water: Teachers Guide, Intermediate Level, Grades 4, 5, 6," 2nd ed., American Water Works Association, Denver, Colorado, 1988.

Thank you to the Environmental Protection Agency *Water Sourcebook* for this activity!

http://water.epa.gov/learn/kids/drinkingwater/wsb_index.cfm

STUDENT SHEET



TEACHER SHEET