From River to Tap

HOW DRINKING WATER IS TREATED

Respect Rule: Look, Listen, Learn, and Leave Alone (until instructed).

Overview

Students will tour a water treatment facility to learn the source of their drinking water and how the water is treated to make it safe for drinking. Students will also taste test water and construct a water delivery system.

Background

Water Treatment

The water that people drink every day has been treated to make sure it is safe. In the foothills, drinking water coming out of the faucet in the home may come from a private well or from a municipal source provided by a water agency. Water agencies get drinking water from two sources: ground water and surface water. The most common source is surface water—water flowing in rivers and collected in reservoirs. Private wells do not have the same regulation as water provided by a water agency. However, ground water that is pumped from a well is filtered through the ground, removing pollutants and harmful contaminants. Homeowners can check to make sure harmful microorganisms are not present in their well water. Chlorine may be added to kill microorganisms.

Water taken from rivers and lakes is treated at a water treatment facility. Chemical and biological pollutants must be removed. Treatment usually involves five different processes: aeration, coagulation, sedimentation, filtration, and disinfection. When water is pumped to a treatment facility, the first process might be aeration. This allows oxygen to enter the water, improving taste. In addition, certain pollutants break down or vaporize under aeration. The next process is coagulation. Chemicals such as alum are added to the water. Particles in the water cling to the alum. It is easier for these larger particles, called *floc*, to settle out of the water during the next phase, sedimentation. Water flows through a sedimentation basin, particles settle and the cleaner water is then sent on for filtration. The water flows through filters made of layers of sand and gravel, or membrane material. Filtration removes more pollutants, such as harmful bacteria. Most "conventional" water treatment facilities filter water through sand and gravel layers. However, in some plants where the source water is relatively clean, water passes through filters made of a very fine meshed material. For example, at the Buckhorn Treatment Plant in Amador County and the Copperopolis Treatment Plant in Calaveras, the water is filtered through long tubes containing membranes with very fine pores. The final step is disinfection. Chlorine or another chemical is added to kill any remaining contaminants and to make sure the water is free from germs as it travels from the treatment facility to homes. Disinfection may be the only treatment for water delivered from groundwater sources.

Before-the-Field-Trip Activity

Activity 1: The Earth's Water
Time: 45 minutes
Materials: Draw the Water Cycle Student Worksheet, world globe, *Bringing the Rain to Kapiti Plain* by Verna Aardema, glass, ice cube tray, salt shaker, 2-cup glass measuring cup, 1-teaspoon measuring spoon, ¼-teaspoon measuring spoon, water, paper for posters, art supplies for posters (may include crayons, scrap paper and paste, poster paint, etc.)

1. Show the globe to the class and ask why the earth is sometimes called the water planet. Ask how people depend on water, if there is enough, and what happens when there is not enough.
2. Read *Bringing the Rain to Kapiti Plain*. Discuss how people depend on water for a way of life.
3. Present "The Available Water Demonstration." It might sound something like this: The water in this measuring cup represents all the water on earth. Three percent of the water is fresh water (take out 1½ teaspoons

Objectives
Students will:
1. draw a diagram of the water treatment process; 2. draw a map that shows the source of their drinking water and how it is delivered to their community.

Grade Levels
5–8

Adult/Student Ratio
1 to 35 for in-class activities. At treatment facility, adult volunteers are required to achieve a ratio of 1 adult to 15 students

Where
Classroom and drinking water treatment facility. There are several possibilities. In Amador County, the Amador Water Agency's Buckhorn Treatment Plant is available for tours. In Calaveras County, tours are conducted at Calaveras County Water District's La Contenta facility. In Tuolumne County, tours are available through Tuolumne Utility District (TUD).

> **I care to live only to entice people to look at nature's loveliness. My own special self is nothing. [I want to be] like a flake of glass through which light passes.**
>
> —John Muir, *Listening to Nature,* by Joseph Cornell

and it in the glass). The other 97% is salt water which we can't use (shake some salt into the measuring cup and push it away). Two percent of the fresh water (take 1 teaspoon of water out of the glass) is frozen in the polar ice caps and in glaciers and is not available for us to use. (Put the teaspoon of water in the ice cube tray and push it away.) This leaves us less than 1% of the water on earth to use (hold up the glass with the remaining ½ teaspoon of water and then drink it), so we better make sure we take very good care of it."

4. Discuss ways each person can use water wisely. Have the students make posters to encourage wise use of water or have students label the water cycle drawing.
5. The water cycle cleanses water, but it is still the same water that was on earth millions of years ago. Students enjoy imagining where their recess drink of water was before they drank it. Explain that dinosaurs may have splashed in the water in the drinking fountain and expect to be greeted with groans of "Oh, gross!"

Field Trip Activities

Activity 1: Plant Tour
Time: 20 minutes
Materials: Conventional System Drinking Water Treatment Plant Student Worksheet, Conventional System Drinking Water Treatment Plant Answer Key, Membrane Filtration System Drinking Water Treatment Plant Student Worksheet, clipboards, pencils

1. A plant operator guides students through the treatment plant.
2. Students observe the stages of treatment from source water to treated water.
3. As students follow the path of water as it enters the treatment facility, they label their worksheets to show the five stages of conventional water treatment and/or the membrane filtration process.

Activity 2: Control Room Tour
Time: 20 minutes
Materials: None

1. A plant operator shows students how the treatment plant is electronically monitored to ensure proper water treatment.
2. Students view the computer schematics and learn how computers are used to monitor the treatment process.
3. Students watch a demonstration of several water chemistry tests performed routinely at the treatment plant to check water quality.

After-the-Field-Trip Activities

Activity 1: Water Connoisseurs—The Taste Test
Time: 20 minutes
Materials: Per class: 1 gallon distilled water, 1 gallon tap water, 1 gallon mineral water, 1 gallon private potable well water, 4 cups per student, 1 laminated chart to record voting

1. Put water into containers so that source cannot be identified.
2. Label cups and water 1–4.
3. Pour water for each student.
4. Have them work in groups to smell and taste water. Ask them to smell water. Do any smell better than others? Do they smell musty, metallic, and chlorine-like? Have them choose the best smelling and the worst smelling.
5. Record answers on a chart.
6. In groups, ask students to taste water. Does any water taste metallic, chlorine-like, fizzy, and musty?
7. Have them choose the best tasting and the worst tasting.
8. Reveal to the students which samples contain which type of water.
9. Discuss the sources of water in the community. Even though they are all safe to drink, students may prefer the taste of some water over another.
10. Discuss whether bottled water is necessarily safer than tap water. Do they like the taste of store-bought water better?

Activity 2: Drinking Water System Model
Time: 20 minutes
Materials: Community Water Supply System Model Teacher Worksheet, rocks, sticks, pinecones, pine needles, etc. at the site.

1. In small groups, students build models of their river system and the water delivery system. Students understand the connection between water in the rivers and water delivered to their homes.
2. Students need to construct a model that shows five components:
   - Drinking water source
   - A pumping station
   - A water delivery system
   - A water treatment facility
   - A community

Activity 3: Water Filtration
Time: 20 minutes
Materials: Water Filtration Unit Student Worksheet, *Water Filtration Kit* (STE Lending Library)

1. Have students build a water filtration unit.
2. In small groups, students work together to treat water using *Water Filtration Kit*.
3. Or students watch and participate selectively in a demonstration of the water treatment process.

Activity 4: My Drinking Water Map
Time: 40 minutes
Materials: Water Supply and Demand Student Worksheet, maps of Calaveras and Amador County Water Supply Maps provided in Appendix A, large white construction paper or plain white paper, pencils, crayons

1. Ask students to describe where their community's drinking water comes from. Does the water come from the river or from the ground? Some students may drink well water at home; however, water at their schools comes from a local river. What is the name of that river? How did the water get into the river?
2. Discuss precipitation and snow fall in the Sierra Nevada.
3. Start map with a picture of mountains, rain and/or snow. Label mountains Sierra Nevada. Draw and label the source of drinking water—the Mokelumne River, the Calaveras River, the Stanislaus River or ground water. Label the community. Trace in the water delivery system, including a pump station, a treatment plant, storage tanks, a distribution system of pipes, and houses.
4. Discuss where water goes after water is used in the house. Homes may be on septic systems or a sewage system. However, their school is on a sewage system. Water is delivered to another treatment facility, a wastewater treatment facility, cleaned, and then discharged to river, creek, or used for ittigation. This portion may be added as well to give students a clear picture that the water they use everyday is cycling through local waterways, and is part of the water cycle.

Activity 5: Assessment of Drinking Water Treatment
Time: 40 minutes
Materials: Assessment: From River to Tap Student Worksheet (Note: This assessment could be used instead of the mapping activity as a way to check students' understanding of the drinking water treatment process. Students could use the diagrams completed at the treatment plant as a study aid.)

1. Have students complete Assessment: From River to Tap Student Worksheet.
2. Discuss with students the answers.

Skills
Analyzing, evaluating, interpreting, organizing

Key Words
Aeration, Coagulation, Disinfection, Filtration, Sedimentation, Water cycle, Water

Source

Adapted with permission from

Drips and Drops, An Ace Consortium Integrated—Thematic Science Unit

The Water Cycle, California Department of Water Resources, Office of Water Education

The Water Sourcebooks, U. S. EPA Office of Drinking Water and Ground Water (online at http://www.epa.gov/safewater/kids/wsb)

Where Does Your Water Come From, June 1998. U. S. EPA Office of Water, Environmental Education. EPA 810-F-98-002

Resources

For the Teacher:

The Story of Drinking Water: Teacher's Guide, Intermediate Level, Grades 4, 5, 6, 2nd ed., American Water Works Association, Denver, Colorado, 1984.

Joanna Cole, *Magic School Bus at Waterworks*, Scholastic, 1986.

Water Works Lesson in *The Water Sourcebooks*, U. S. EPA Office of Drinking Water and Ground Water (online at http://www.epa.gov/safewater/kids/wsb)

For the Student:

Verna Aardema, *Bringing the Rain to Kapiti Plain.*

The Story of Drinking Water (student booklet), American Water Works Association, Denver, Colorado, 1984.

D. Smith, *If the World Were a Village*. The book presents the world as a global village and includes the topics of access to water, sanitation, and electricity.

Name Date

Assessment: From River to Tap

Student Worksheet

1. Name the source of our drinking water.

2. Describe how our drinking water gets from the river to our school.

3. Describe how water is treated at the water treatment plant.

4. How does filtration help clean the water?

5. Why is chlorine added to drinking water?

Name Date

Water Filtration Unit

Student Worksheet

1. Obtain a clean two-liter plastic beverage container with a cap for each group and one additional two-liter plastic container.

2. Cut each bottle in half. Tape the rim of each half with masking tape to protect students from the sharp edges. The bottom part of the bottle will be used as a catch basin for water. The top section of the bottle will act as a filter.

3. Poke several holes in the cap.

4. Discuss why most well water is clean enough to drink.

5. Screw the cap on the bottle and place one tablespoon of clean gravel in the neck of the filter to keep the soil from clogging the holes in the cap.

6. Place two cups of soil in the filter.

7. Place the filter in the catch basin.

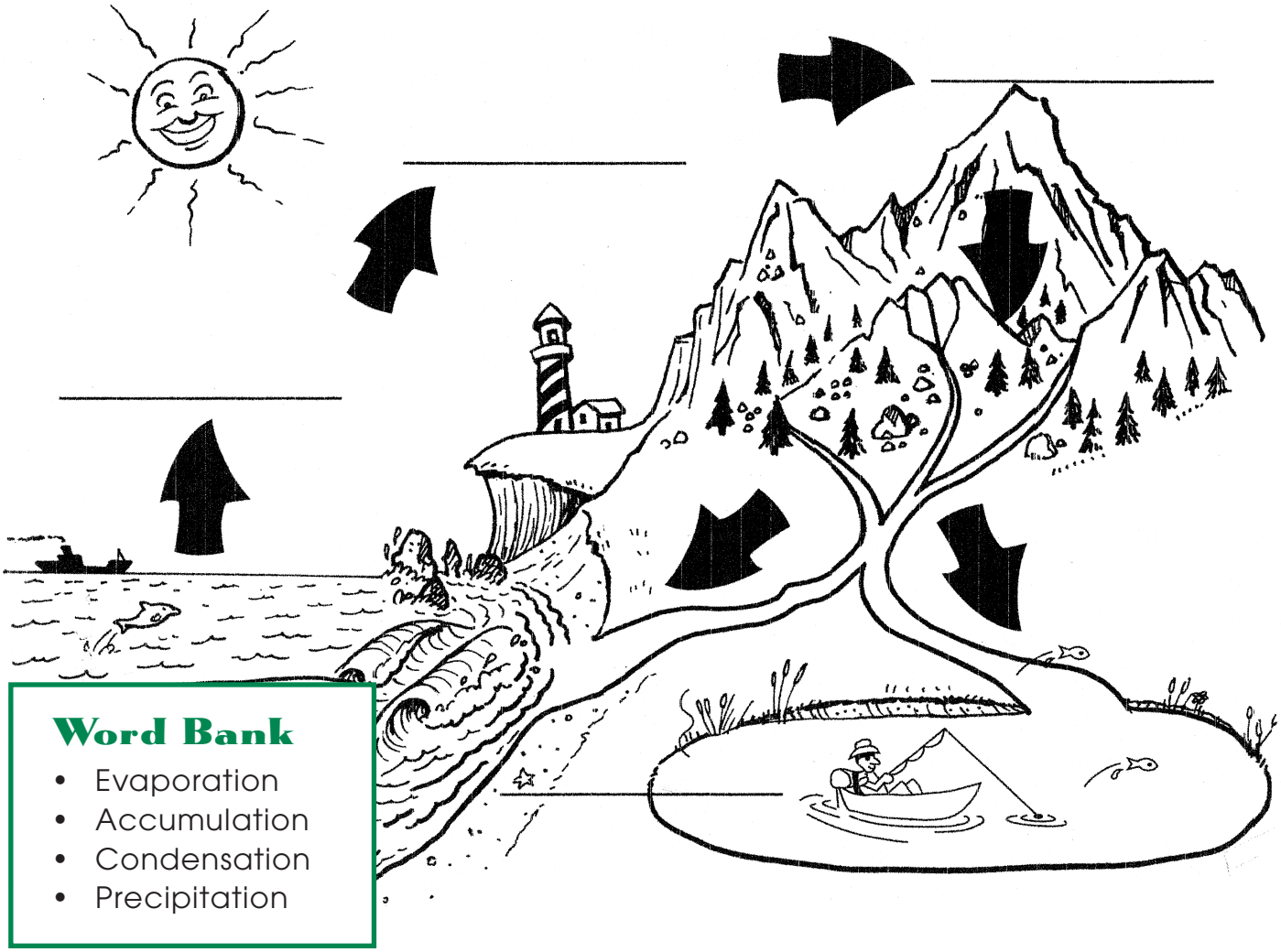
8. Provide two cups of dirty water and pour this water slowly on top of the soil and at the same time start the stopwatch.

9. Hold filters above the catch basin to deep the cap and neck of the bottle from touching the percolated water in the catch basin.

Name Date

Draw the Water Cycle

Student Worksheet



Word Bank

- Evaporation
- Accumulation
- Condensation
- Precipitation

Source:
California Department of Water Resources

Name Date

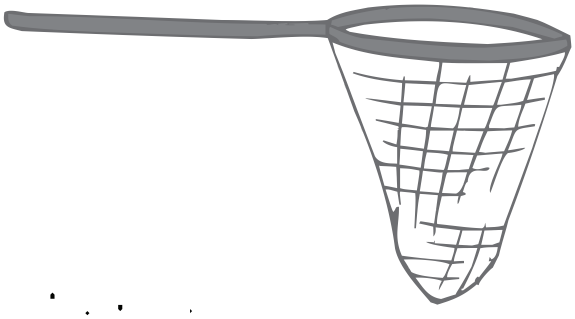
Membrane Filtration System

Drinking Water Treatment Plant

Student Worksheet

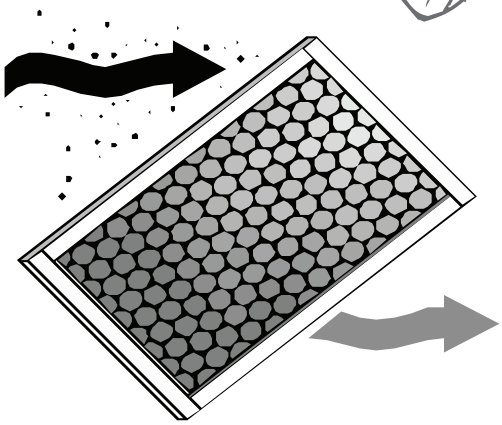
Source Water:

_____ River



Step 1: Remove large particles

_____



Step 2: Flow through fine mesh

_____

Step 3: Kill germs
Chemical to kill germs:

_____

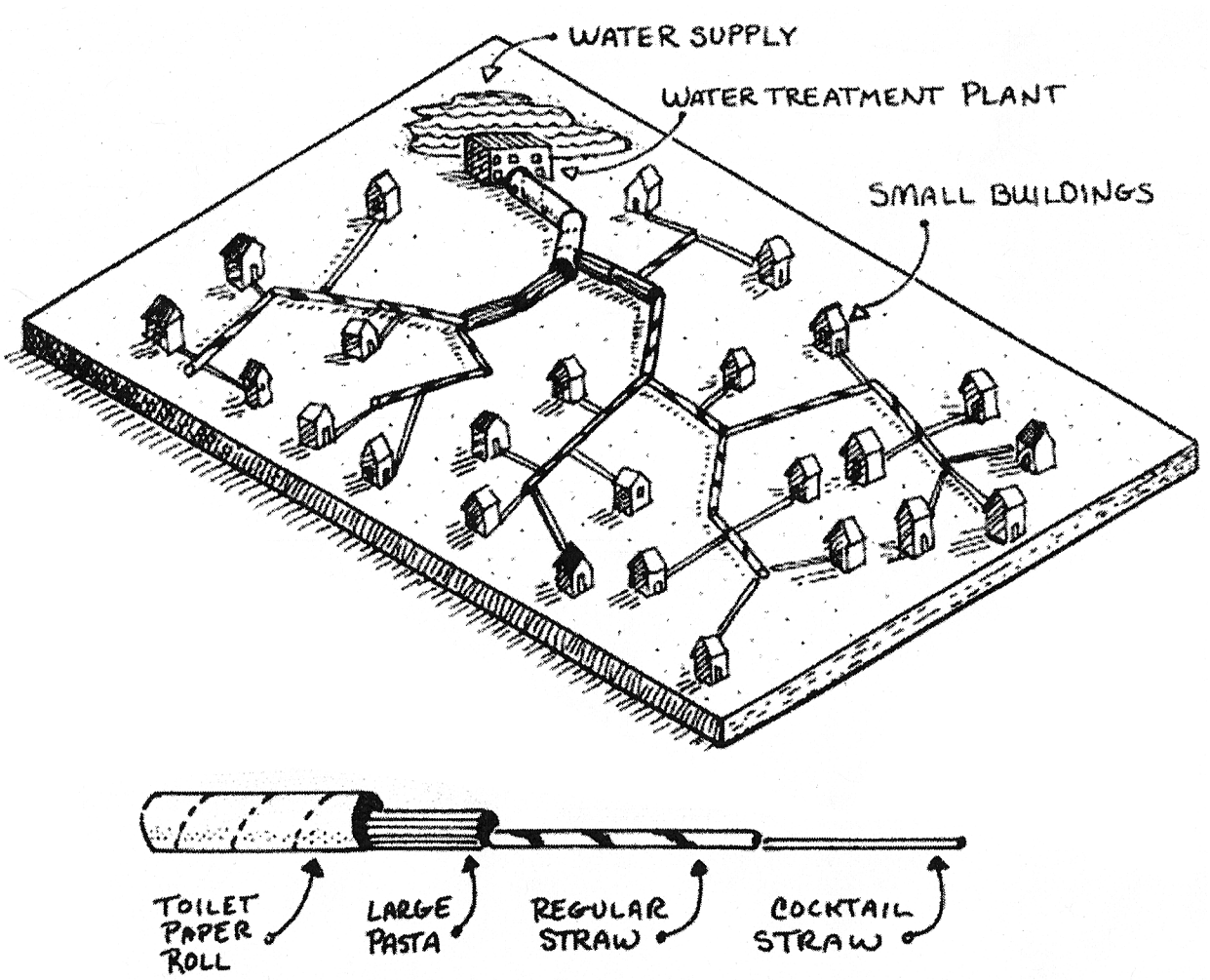
Chemical to neutralize water:

_____

Word Bank: Chlorine, Disinfection, Lime, Strainer, Membrane Filtration, Mokelumne, Stanislaus

Community Water Supply System Model

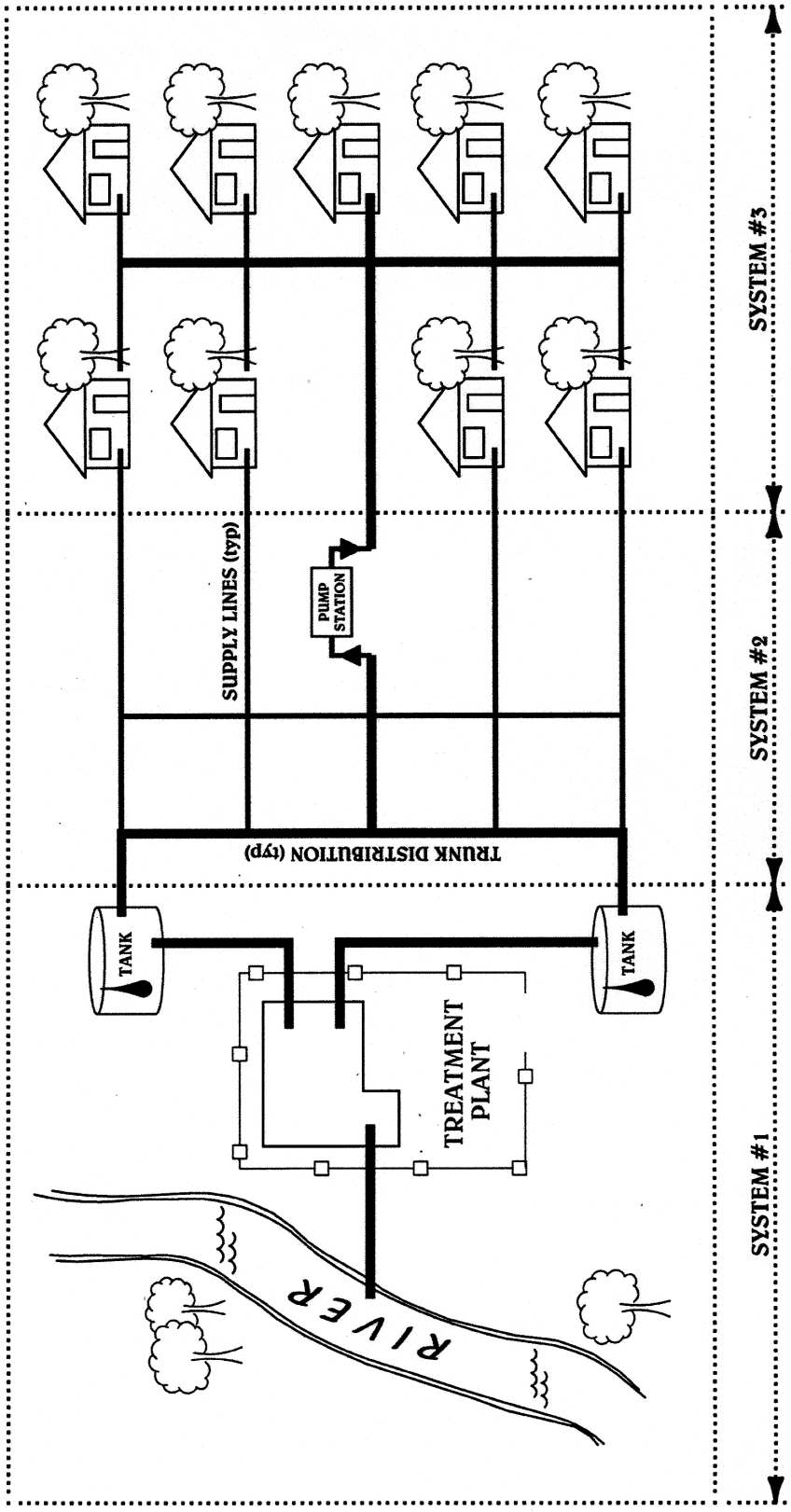
Teacher Demonstration



Name Date

Water Supply and Demand

Student Worksheet

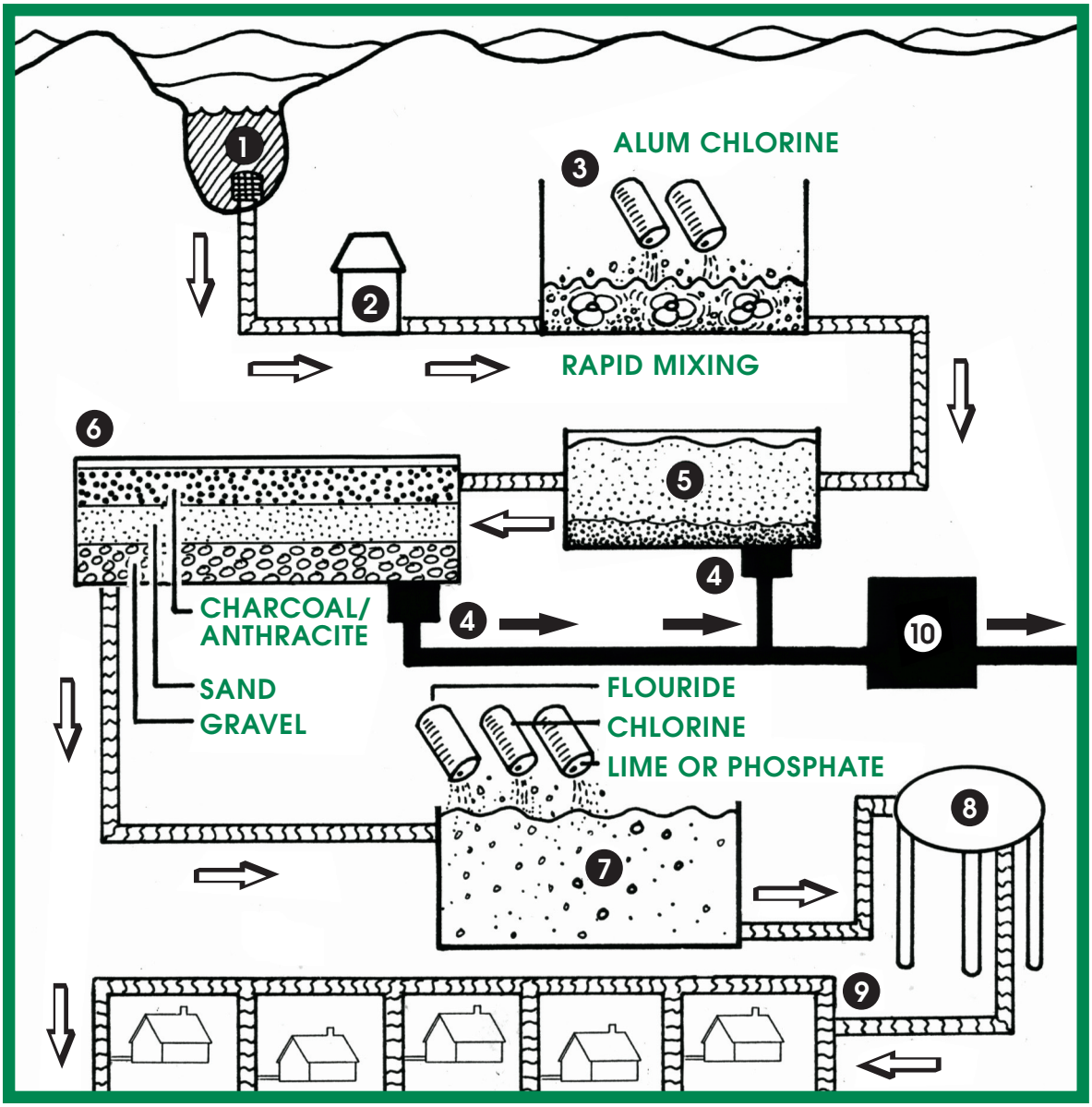


Name _____ Date _____

Conventional System Drinking Water Treatment Plant Student Worksheet

10 Stages of Drinking Water Treatment:

1. Source of Water: _____
2. Pump Station: _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. STORAGE
9. DISTRIBUTION
10. SOLIDS HANDLING



From The Water Sourcebooks, US EPA Office of Drinking Water and Ground Water.

Word Bank

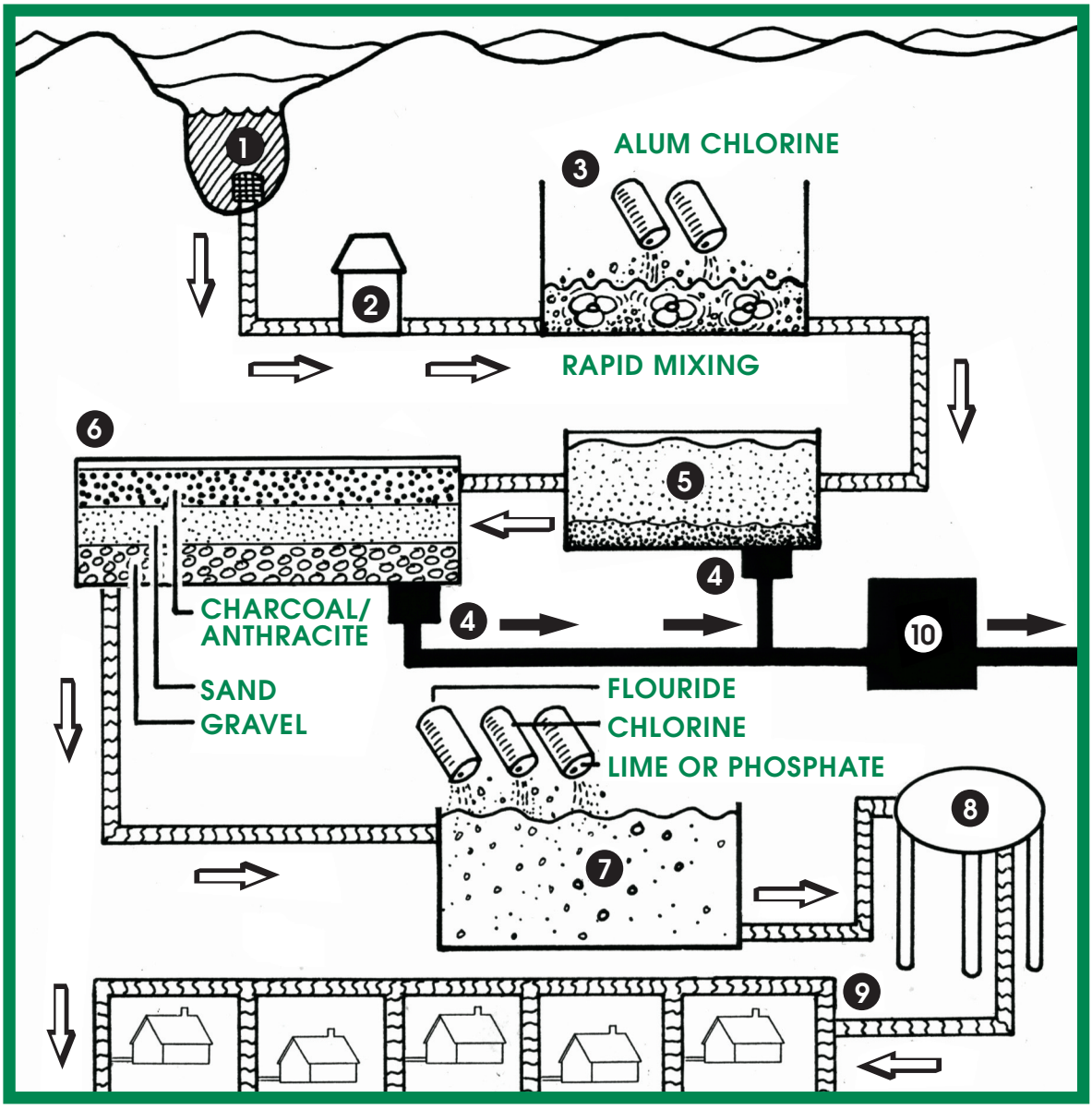
Filtration
Sedimentation
Calaveras River
Well
Aeration
Mokelumne River
Storage
Disinfection
Stanislaus River
Coagulation

Conventional System Drinking Water Treatment Plant

Answer Key

10 Stages of Drinking Water Treatment:

1. **MOKELUMNE, STANISLAUS, CALAVERAS, or TUOLUMNE**
2. **PUMP STATION**
3. **AERATION / DISINFECTION**
4. **COAGULATION SOLIDS COLLECTION**
5. **SEDIMENTATION**
6. **FILTRATION**
7. **DISINFECTION**
8. **STORAGE**
9. **DISTRIBUTION**
10. **SOLIDS HANDLING**



From The Water Sourcebooks, US EPA Office of Drinking Water and Ground Water.

Name Date

Settle Down!

Student Worksheet

Find out how sediment forms and deposits. You will observe what happens when different sized particles are settled in water. You can create a model sedimentation tank to see how sludge and effluent are separated.

Materials: 3 cups of dirt, 1 cup of sand, 1 cup of pebbles, 2–5 small rocks (1 inch in diameter), 1 gallon of tap water, Salad oil, Turkey baster, Eye dropper, 4 clear plastic cups, numbered #1 to #4, Small aquarium, Bucket

Procedure

1. Mix the dirt and water in a bucket. Fill the baster with the mixture from the bucket and put it into cup #1. Record your observations.
2. Put the sand, pebbles and rocks into the bucket. Fill the cup marked #2 from the bucket and record your observations.
3. Pour salad oil into the bucket. Fill the baster from the middle of the mixture in the bucket and place its contents into cup #3. Take a baster full from the top of the bucket and put it in cup #4. Observe cups #3 and #4.
4. Without mixing the contents of the bucket, pour the remainder of the mixture into the aquarium. What happens after an hour? Five hours? One day? One week?

1. What was different about each sample taken? _____

_____

2. What did you notice about the samples in each cup? How would you remove the oil from the mixtures in #3 or #4? _____

_____

3. Can you remove the dirt from the bottom of the aquarium without mixing it with the liquid on top? _____

_____

4. How are your observations similar to what happens in ponds and streams in nature? _____

_____

For the Teacher:

Activity From Newton's Apple, a production of KTCA Twin Cities Public Television. Made possible by a grant from 3M (duplication for educational use encouraged).

Educational materials developed with the National Science Teachers Association.