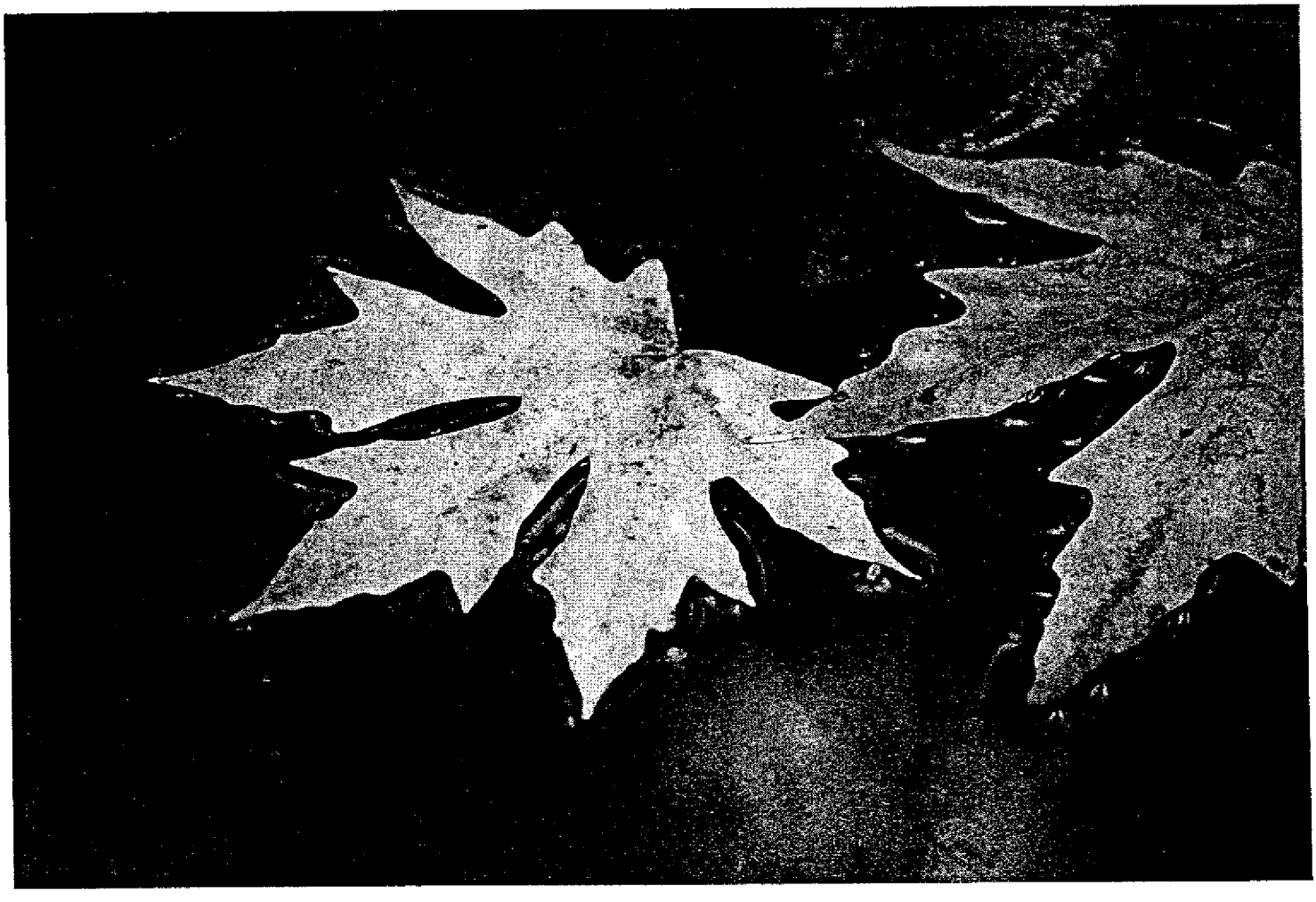
Sea Grant
Washington

ON-SITE SEWAGE SYSTEM EDUCATION CURRICULUM

A Workbook for Teachers, Students and Parents



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** Denotes a classroom or home activity*

On-Site Sewage Systems: the Basics

Our planet's water resources are finite. The water we drink today is the same water that Cleopatra drank in 70 BC.

That's because our planet's freshwater resources are recycled over and over again. These resources are also quite limited. One percent of Earth's water is available to human use. Two percent is frozen and the remainder is held as undrinkable saltwater in our oceans.

The demand for water constantly increases as the human population multiplies, but the amount of water for our use remains the same. So what's the best way for us to have ample amounts of usable water for the future? The answer's simple: we must keep our water supplies clean and conserve the water we already use in our homes, schools and businesses.

Every day, each person needs about two liters of water. However, most people use a lot more water than that. It's estimated that a family of four uses 900 liters (about 238 gallons) of water every day. Much of this water is being flushed down the drain and sent to our sewage treatment plants and on-site sewage systems.

In rural areas, homes are spread over great distances, making it difficult to link them to a single sewage treatment plant. Thus, most residences have their own on-site sewage systems. These systems can offer a high degree of wastewater treatment and, in some instances, produce a cleaner effluent quality than a big city's sewage treatment plant. Best of all, the effluent after treatment and disposal in the drainfield soils actually recharges underground aquifers, where it can be recycled for our use.

The key to effective performance of septic systems is regular care and feeding. By making proper operation and maintenance of our home septic systems part of our daily lives, we can ensure that our sewage is treated properly, removing contaminants and pathogens before the water is returned to the environment and recycled for our use.

This unit describes a number of activities to help students identify sources of water-borne waste — from soaps and detergents to household cleaners, hair care and hand lotions and the toilet paper we use. This unit will help them recognize products that should and should not go down the drain. Students will also be challenged to identify the various components of home on-site sewage systems and considerably larger sewage treatment facilities.

Although the curriculum is geared for the fourth grade classroom environment, the activities can be easily modified for use in middle and high school classrooms. The objectives identified in each activity are linked to specific Essential Academic Learning Requirements in Washington.

ACTIVITY: Septic Sense

OBJECTIVE: Identify the parts of a system, how the parts go together and how they depend on each other.

PURPOSE: The student will be able to identify the parts of an on-site sewage treatment and disposal system and how the various components function.

MATERIALS:

Septic Sense, Scents, Cents handout

On-Site Sewage Systems handout

Septic Sense Worksheet

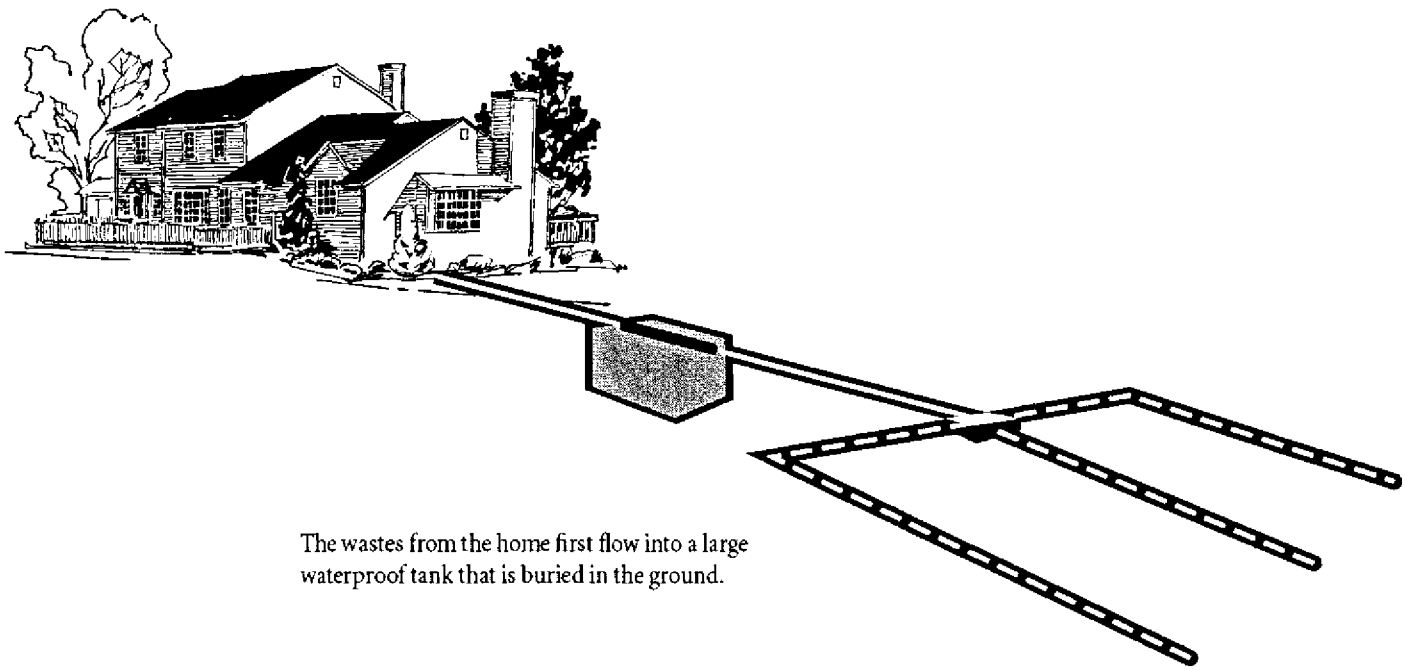
PROCEDURE: Have the students read the Septic Sense, Scents, Cents and On-Site Sewage System handouts that describe the different components of a typical on-site sewage system. The students will use this information to complete a worksheet, identifying and describing how these components function. These materials are also on the Washington Sea Grant Program Web site, *www.wsg.washington.edu*, under "Septic Sense."

EXTENSION: Divide the students into groups of 5 or 6. Assign a role for each student: toilet, tank, drainfield, waste, water and narrator. Have them act out the processes of an on-site sewage system in a short skit.

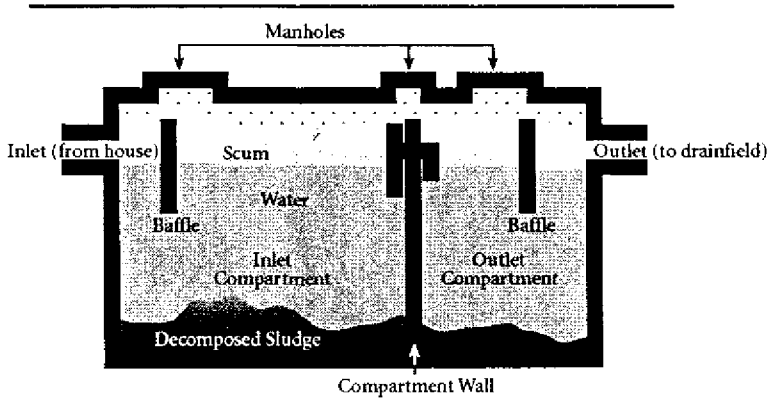
On-Site Sewage Systems

On average, a person in the U.S. contributes approximately 1.6 kg (3.5 lbs.) of phosphorus and 4.4 kg (9.9 lbs.) of nitrogen in wastes each year. In addition, this person uses from 190 L (50 gallons) to 1300 L (350 gallons) of water each day for drinking, cleaning and cooking, as well as flushing the toilet. How we deal with wastewater can have dramatic effects to our environment. Invented in 1896, the septic tank provided one way to safely and effectively store and treat human wastes.

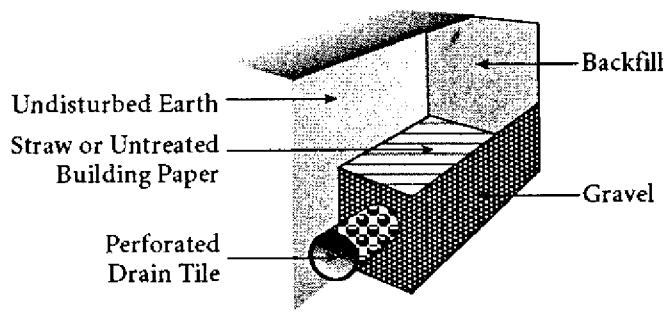
The modern on-site sewage system is made up of several parts that work to purify the wastewater from the home.



The wastes from the home first flow into a large waterproof tank that is buried in the ground.



The tank is connected through a distribution box to a series of long sections of perforated pipe that are also buried under the ground.

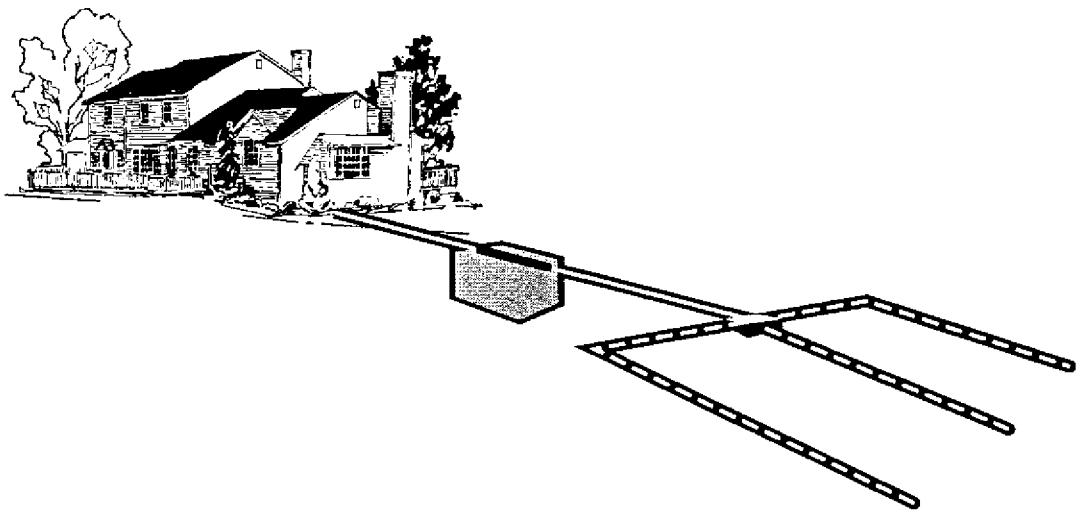


A typical septic tank is a buried watertight container made of concrete, fiberglass or polyethylene that is designed to pre-treat wastewater. It clarifies wastewater by holding the water long enough to allow the solids to settle out (sludge), be reduced by bacterial action or float to the surface (scum).

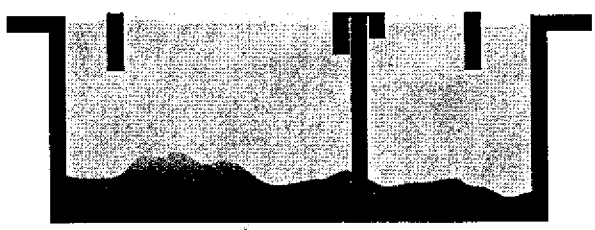
After the wastes have been held, separated and partially digested, the remaining liquid (called effluent) flows from the tank into the drainfield. The effluent still contains pollutants, but the filtering action of the soil and its microorganisms will break the pollutants down. The effluent entering the drainfield is absorbed by the soil. Some of the effluent will eventually reach underwater aquifers, some of it is absorbed by the roots of plants, and some of it evaporates into the air.

Septic Sense Worksheet

1. Label the parts of the on-site sewage system.



2. Label the cross-section of a septic tank.



3. Define these terms:

Effluent

Baffles

Biomat

Sludge Layer

Scum Layer

4. Describe what happens to the water that is washed down the drain and what happens to it in the on-site sewage treatment and disposal system.

5. List two ways to reduce the amount of water entering an on-site sewage system.

6. List the three main kinds of alternative on-site sewage systems.

ACTIVITY: Lotions and Potions

OBJECTIVE: Record and report observations, explanations and conclusions using oral, written and mathematical expression.

PURPOSE: To help students understand the way in which hair care products, soaps and lotions add to the scum and sludge layers of a septic tank.

MATERIALS:

- Shampoo
- Crème rinse
- Hair gels
- Lotions
- Liquid soaps
- Other gels and liquids used during a shower or bath.
- Small jars for comparisons of different products (e.g., shampoos) of the same variety
- Large jar

PROCEDURES: Collect the different types of products cited above. Have each student pick a different product they use during a shower or bath and put some of it into a small jar filled with water. Before they add the product to the jar, ask them to predict whether it will sink or float. Would rubbing the product between the student's hands (to make it foam) change whether it floated or sank? What happens to the products in the jar over time?

In front of the entire class, have students add the same quantity of each type of product into the large jar. How deep is the scum layer after the products have been added? How deep is the sludge layer? Now, have students add enough of each of the products to simulate the contributions of a four-person household. How much larger did the scum and sludge layers grow?

EXTENSION: Hold the large jar full of products for a week or two, periodically checking to see if the materials are changing from scum to sludge or vice versa.

COMMENTS: This activity is enjoyable and students have fun predicting if products will sink or float. It's also an excellent way to demonstrate how quickly things can accumulate, even though small quantities are used for each bath or shower.

ACTIVITY: Toilet Paper Savvy

OBJECTIVE: Use data to construct reasonable explanations.

PURPOSE: To help students better understand how toilet papers break down within the septic system. Toilet paper is made of non-soluble cellulose and lignin. Toilet papers that break down into fine fibers can easily travel into the drainfield, clogging soil spaces and preventing the drainfield from functioning. To prevent this from happening, toilet paper must remain in the septic tank until it is pumped out. The toilet paper usually accumulates in the septic tank's scum layer. Using less toilet paper will help slow the buildup of the scum layer.

MATERIALS:

Small jars with lids

Water

Different varieties of toilet paper with their packaging.

PROCEDURES: Have each student bring in a few squares of toilet paper and its packaging. Make a class chart on how many different brands of toilet paper the students use at home. Have students look at their toilet paper and predict what will happen to it when it enters the water. Will it break down into mush or hold its shape? Why do they think their sample will react that way? After reading the labels on the packages, have the entire class predict which brand will do the best. Have each student place a square of toilet paper in a small jar, then fill the jar with water. Rock the jar gently six or seven times to move the water around the tissue. Which varieties turned to mush and which held their shapes? Papers that stay intact will be less likely to travel out into the drainfield. Mushy ones can be easily transported into the drainfield, clogging soil spaces and causing the system to fail. Were any of the samples of toilet paper colored? How did they fare? How did the two-ply brands hold up, compared to the single-ply brands?

Leave the jars on the shelf in the classroom for a week and see if any of the tissues break down further. Check them again, one month later. Remember that toilet tissue should stay in the septic tank until it is next pumped.

Extension: If a microscope is available, look at a sample of toilet paper water under magnification. The tissue that has broken down quickly has large numbers of fibers floating around.

COMMENTS: A very interactive demonstration. It's best to have students each bring a few sheets of toilet paper with associated packaging from home for this experiment. This exercise is also a good way to demonstrate bar charts and introduce scientific theory.

ACTIVITY: Water Leaks are Water Sneaks

OBJECTIVE: Explain why similar investigations may not produce similar results.

PURPOSE: To teach students how much water a little leak can produce.

MATERIALS:

- Water Leaks are Water Sneaks Worksheet
- A medium-sized paper cup for each student
- A larger water container for each group
- A drip catcher for each group
- A measuring device

PROCEDURES: Ask the students if they know of any leaky or dripping faucets at school. Discuss locations and sizes of these leaks or drips. Explain that one way to get an idea of how much water can be lost through leaks is to make a model and measure the leaks over time. Explain that they will have a chance to make this model from a paper cup.

Pair students up and distribute paper cups, water containers and drip catchers. Using a sharp pencil demonstrate how to make a small hole in the center of the bottom of each paper cup. Have the students puncture their cups.

Demonstrate, by filling the cup with water (placing your finger on the hole) how to count the time it takes the cup to empty. Begin counting 1001, 1002, 1003, etc. Note: State that, to do class comparisons, all cups must be filled with the same amount of water and all holes need to be identical in size. Direct students to fill one of the cups with water and keep track of the time it takes to empty.

Instruct students to take the second cup and make a slightly larger hole. Repeat the activity cited above and compare the results.

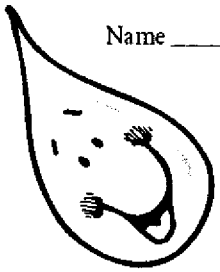
Distribute the copies of the Water Leaks are Water Sneaks worksheet. Read the opening together and have students complete the "Take a Guess?" question. Help students calculate and record their answers on the worksheets.

Explain that fixing a leaky faucet is pretty easy, but they shouldn't try to do this without their parents' help. Emphasize that they should report any leaking faucets to their parents.

Discuss the questions and the procedure for collecting the school and home information with students. Have students complete the "School Leaks Hunt Report."

EXTENSIONS: Convert cup measurements to their metric equivalents. Create reminders to turn off dripping faucets, for posting at school.

SOURCE: Seattle Water Department Water Conservation Teachers' Guide



Name _____

WATER LEAKS ARE WATER SNEAKS WORKSHEET

Leaks are sneaky. They can waste a lot of water. Even water from a tiny leak could fill up a swimming pool in a year! Us this worksheet to help find and stop the water sneaks!

TAKE A GUESS?

How much water do you think a faucet with a slow drip leaks in one hour? ___ gallons

MY LEAK TEST RESULTS

Small Leak Test:

It took ____ seconds to empty one cup.

Big Leak Test

It took ____ seconds to empty one cup.

QUESTIONS

1. How many cups of water would be wasted by the small leak in 60 seconds? _____

Five minutes? _____

2. How many cups of water would be wasted by the large leak in 60 seconds? _____

Math Tip: Divide number of cups by the time it takes (seconds or minutes) to get the answer.

Bonus Question: How much water would be wasted with a big leak in an hour, a day, one month?

SNEAKY LEAK TIPS

Gently tighten dripping faucets. If they still leak, report them to your teacher or parent.

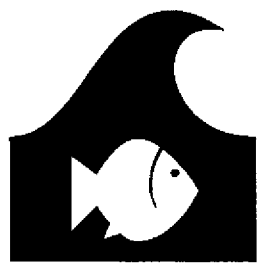
Leaky toilets are really sneaky! If you hear them hiss like a snake, or think they might be leaking, tell an adult.

Help an adult fix faucet and toilet leaks.

SCHOOL LEAKS HUNT REPORT

I found _____ leaky faucets at school.

I was able to stop _____ of the faucets from dripping and reported the other faucets and toilets to a teacher.



ACTIVITY: Dying to Know...

OBJECTIVE: Plan and conduct simple investigations, using appropriate tools, measures and safety rules.

PURPOSE: It's estimated that one in five toilets has some sort of leak. Students will be able to determine if their toilets are leaking and combine the data from their home toilets with class data to determine the "sneaky" leak rate of toilets.

MATERIALS:

Dye tablets or liquid food coloring

PROCEDURE: Explain to students that hidden leaks in toilets are among the biggest water wasters of all. Sometimes you will know if the toilet is leaking – if, for example, everyone in the family is downstairs and, mysteriously, the upstairs toilet flushes. Explain that one way a student can be a leak detector is to have their parents remove the top of the toilet tank and add one dye tablet (or several drops of food coloring) to the water in the tank. Have them block off the toilet from use and wait 20 minutes. If the toilet bowl is tinged with colored water, the toilet has one or more leaks and needs fixing. Have the student make a chart of the number of toilets in their home, noting which, if any, leaked and why. Bring the data back to class and create a chart showing how many toilets failed. Did one in five fail? Discuss the results and the impacts of overloading the on-site sewage system with water.

EXTENSION: Have the students check their home toilets after repair to see if the fix stopped the leak. Have the students test the toilets at the school.

ACTIVITY: Water Diary

OBJECTIVE: Record and report observations, explanations and conclusions using oral, written and mathematical expressions.

PURPOSE: To demonstrate the quantities of water that an average family uses on a daily basis.

MATERIALS:

Average Water Volumes chart

Measuring Family Water Use chart

PROCEDURES: Ask students to keep a diary of water use in their homes for three days. Students should make a chart (similar to Measuring Family Water Use), adding any appropriate activities that are not listed.

Ask students to review the table of average water volumes required for typical activities and then answer the following questions using the data from their three-day water use diary.

a. Estimate the total amount of water your family used in the three days. Give your answer in liters.

b. On average, how much water did each family member use during the three days? Give your answer in liters per person per three days.

c. On average, how much water was used per family member each day? Give your answer in liters per person per day.

d. Compare the daily volume of water used per person in your household (answer c) to the average daily water volume used per person in the United States (325 liters per person per day). What reasons can you offer to explain any differences?

Finish the discussion by asking the students to identify ways in which their families could reduce their water consumption.

EXTENSION: As a community action activity, involve the school in adopting water conservation practices and calculate the amount of water used before and after practice changes.

SOURCE: Activity adapted with permission from: American Chemical Society. Chemistry in the Community. Dubuque, IA: Kendall/Hunt Publishing Co., 1988, pp. 11, 16-17. Extension activity from Cooperative Extension Service Water Quality/Quantity Program for Youth.

AVERAGE WATER VOLUMES REQUIRED FOR TYPICAL ACTIVIITES

Use	Volume	
	In liters	IN GALLONS
Tub bath	130 L	35 gal
Shower (per minute)	19 L	5 gal
Washing machine Low setting High setting	 72 L 170 L	 19 gal 45 gal
Dishwashing By hand By machine	 40 L 46 L	 10 gal 12 gal
Toilet Flushing	11 L	3 gal

MEASURING FAMILY WATER USE

DATA TABLE	DAYS		
	1	2	3
Number of persons in family			
Number of baths			
Number of showers Length of each in minutes			
Number of washing machine loads Low setting High setting			
Dish washing Number of times by hand Number of times by dishwasher			
Number of toilet flushes			
Other uses and number of each Cooking Drinking Making juice and coffee			

ACTIVITY: Household Hazardous Waste Roundup

OBJECTIVE: Plan and conduct simple investigations using appropriate tools, measures and safety rules.

PURPOSE: The students will learn to identify levels of household cleaner hazards in their homes and a least-toxic alternative for each cleaning product.

MATERIALS:

Begin Right Under Your Roof brochure

Household Hazardous Inventory Worksheet

PROCEDURES: Have the students read the Begin Right Under Your Roof brochure in class. Distribute and review the chart. Have students work with their parents to search out the various chemicals used in their home and complete the worksheet. Once the class has collected the data, have the students identify which materials in the home are classified as hazardous waste and why. Explain that these hazardous wastes are often sent down the drain into an on-site sewage system and can cause the system harm.

EXTENSIONS: Have the students make a least-toxic cleaning product, compare it to the commercially available product and see if there is a difference in its cleaning ability. Conduct a review of the cleaning materials used in your school.

SOURCE: Adapted from the WAVES: Water And Vashon's Ecosystems curriculum, Vashon Island School District.

Household Hazardous Waste Inventory

Few people realize that many of the products they have in and around their homes are potentially toxic or hazardous to their health. That's why you should be careful when you and your parents look around your home while working on this inventory. Be careful not to spill or disturb any hazardous or toxic products you may find. Wash your hands thoroughly if you come in contact with a container that might be leaking.

Here's What You'll Do:

1. Team up with your parents and do this inventory together.

2. Check off those products you find and add any other toxic or hazardous materials you may find. Remember that not all household products are toxic.

3. Record the approximate quantities of materials you find.

4. Rate how toxic or hazardous each product is, using the Begin Right Under Your Roof brochure.

5. Decide how the products will be used or disposed of. Refer to the brochure for disposal locations.

6. Use the brochure insert to determine possible alternatives to hazardous materials that are found in your home.

HOUSEHOLD WASTE INVENTORY WORKSHEET

Do You Have?	How Much?	Your Rating	How Will It Be Used or Disposed?
Kitchen / Bath			
Drain Cleaners			
Abrasive Cleaners			
Household Disinfectants			
Other			
Other			
Other			
Laundry Room			
Detergent			
Dry Cleaning / Spot Remove			
Bleach			
Other			
Other			
Other			

***1 = Caution, *4 = Warning, *6 = Hazardous**

HAZARDOUS WASTE INVENTORY WORKSHEET

Do You Have?	How Much?	Your Rating	How Will It Be Used or Disposed?
Garage or Basement			
Waste Auto Oil			
Gasoline			
Old Antifreeze			
Used Brake / Transmission Fluid			
Old Batteries			
Cans of Old Paint			
Stains or Preservatives			
Solvents or Paint Thinners			
Paint Strippers / Finish Removers			
Rat Poison			
Insecticides			
Herbicides			
Slug Bait			

***1 = Caution, *4 = Warning, *6 = Hazardous**

ACTIVITY: Touring Your School's On-Site Sewage System

OBJECTIVE: To observe and describe a scientific technology.

PURPOSE: To help students understand the components of a large on-site sewage system and how they work.

MATERIALS:

Tour guide – Facilities Manager for your school.

PROCEDURES: The facilities manager for the school will take the students on a tour of the school's on-site sewage system.

COMMENTS: If possible, arrange the school tour when the septic tanks will be pumped out so that students can observe the pumper and the techniques for checking the sludge and scum levels.

ACTIVITY: Off-Site Wastewater Treatment

OBJECTIVE: Identify the parts of a system, how the parts go together and how they depend on each other.

PURPOSE: To help students understand the components of a large municipal sewage system and how they work.

MATERIALS:

Sewage Treatment Plants handout
Sewage Treatment Plants Worksheet

PROCEDURE: Have the students read the Off-Site Wastewater Treatment handout and discuss with them the different components of a treatment facility. Then ask them to complete the accompanying worksheet. Explain that a municipal system is similar to an on-site sewage system, but it is much larger. Have the students discuss the similarities between the two sewage treatment systems and identify components with the same function.

EXTENSION: Make an appointment to visit a local sewage treatment plant.

SOURCE: Adapted from the WAVES: Water And Vashon's Ecosystems curriculum, Vashon Island School District.

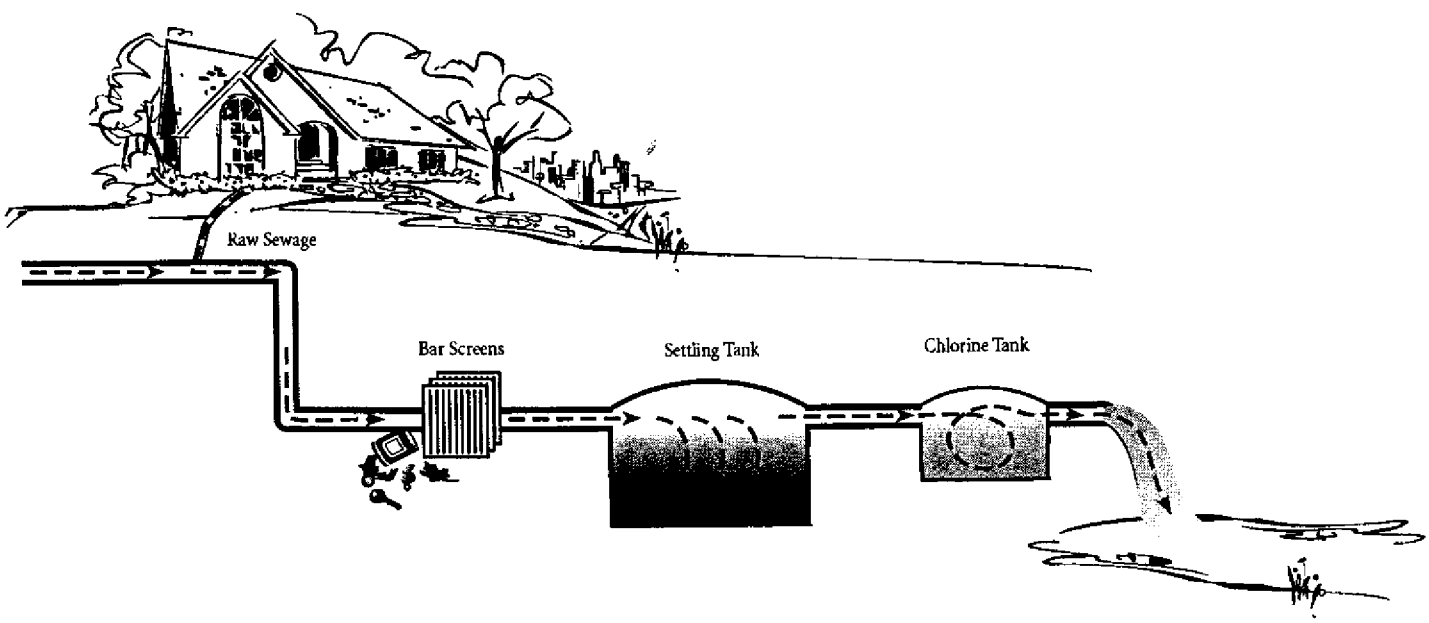
Sewage Treatment Plants

From the times of the Greeks and the Romans until the 1850's, very little was done with human wastes in large cities other than moving them from place to place. In some cities, the wastes were often stored outdoors, later to be carted off by manure merchants to the outskirts of the city. In cities near large bodies of water, wastes were dumped into the streets and washed down open sewers, eventually finding their way to the nearest rivers or bays. These activities did not provide for ways to avoid contaminating the soil or water where wastes were dumped. The result of this lack of waste treatment often led to disease and even death.

There are two common ways that cities now deal with their sewage wastes. These systems are called primary treatment and secondary treatment. In some areas additional treatment or "advanced" treatment is employed.

STEPS IN PRIMARY SEWAGE TREATMENT

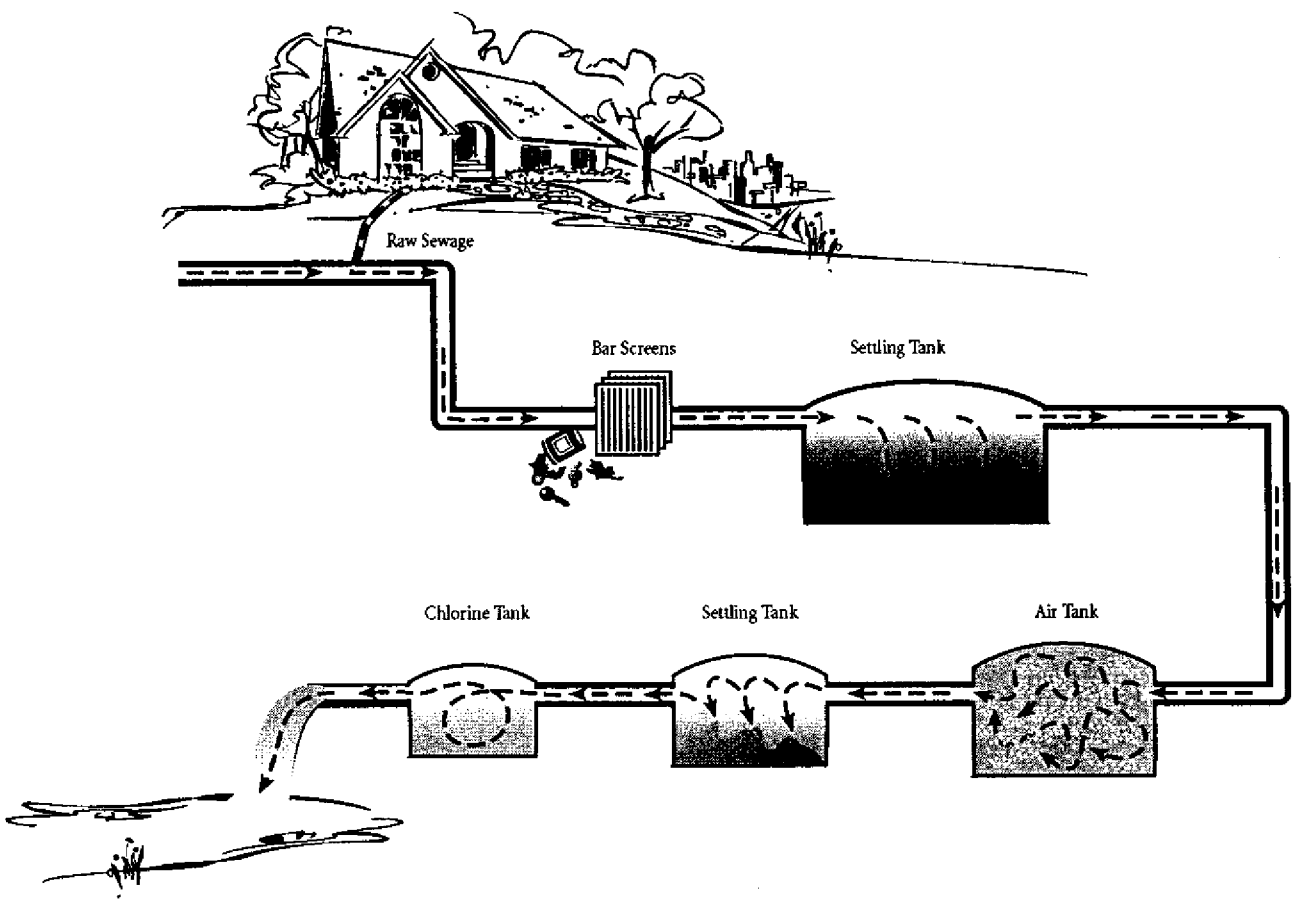
1. The sewage enters the plant from the sewer lines and passes through a large metal screen called a bar screen. The bar screen removes any large pieces of debris, which have entered the sewer lines.
2. From the bar screen, the sewage wastes enter a tank called the grit chamber, within which small rocks, dirt and sand can settle out and be removed to a landfill.
3. After passing through the grit chamber, the flow of the wastewater is slowed as it enters a sedimentation tank where the solid wastes can settle out of the water. A skimmer is often used to remove any floating materials. The solids that sink to the bottom of the tank form a material called sludge. The sludge can be dried and disposed of in landfills or used as fertilizer in the forest for trees. Sludge could contain hazardous wastes, such as heavy metals, pathogens (viruses, bacterium or fungus), and toxic organic compounds.
4. Before it is emptied into a nearby river or bay, the effluent from the sedimentation tank is chlorinated to kill most of the harmful microorganisms.



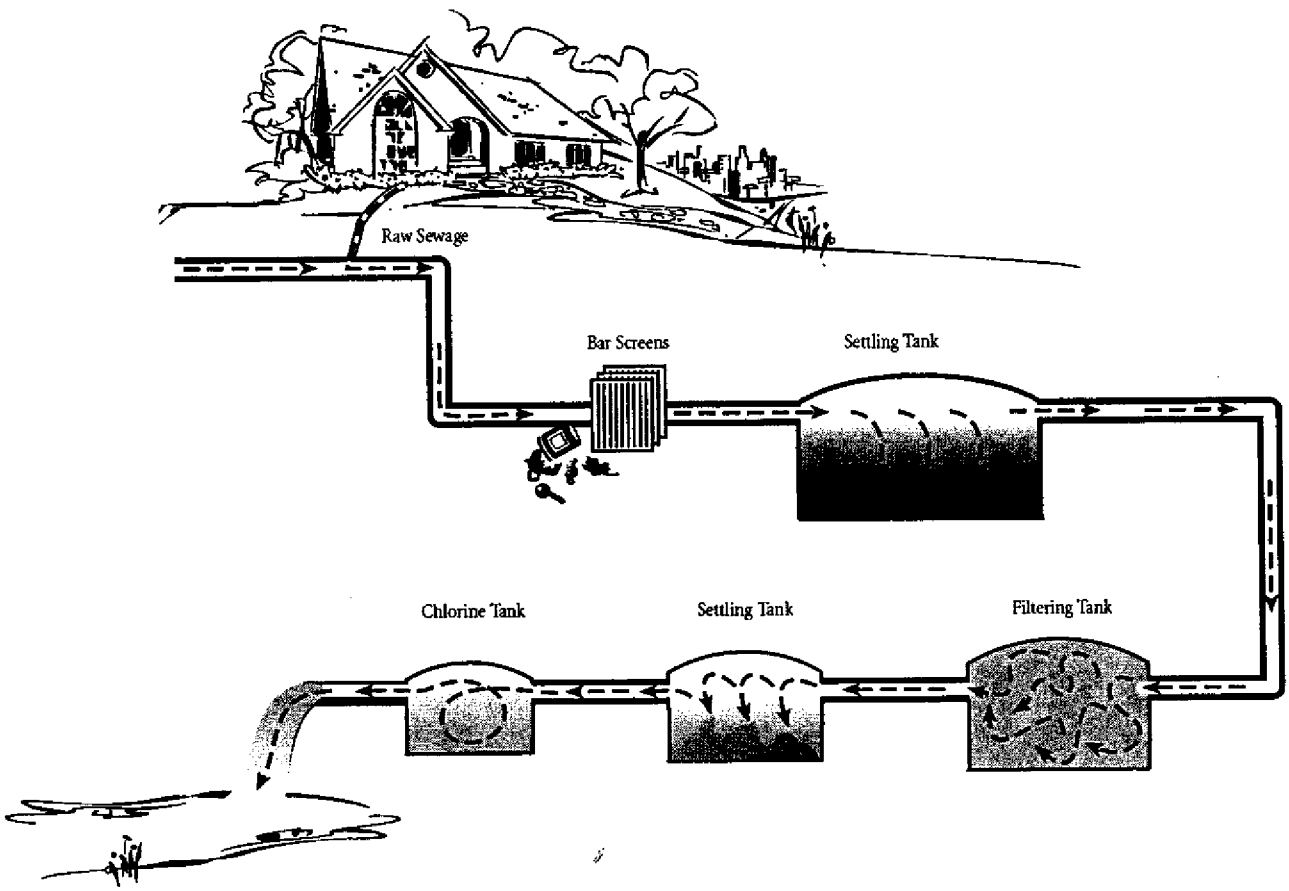
STEPS IN SECONDARY SEWAGE TREATMENT

Secondary sewage treatment is a requirement in the Puget Sound area. The steps of secondary sewage treatment begin once the wastewater has gone through the sedimentation tank of the primary treatment plant. Currently there are two methods being used for secondary treatment, activated sludge and trickling filter.

1. The activated sludge method speeds up the digestion process. This is done by pumping air into the wastewater from the sedimentation tank and allowing the microorganisms to feed on the waste materials for several hours in another settling tank. The effluent is then chlorinated and pumped into a river or bay.

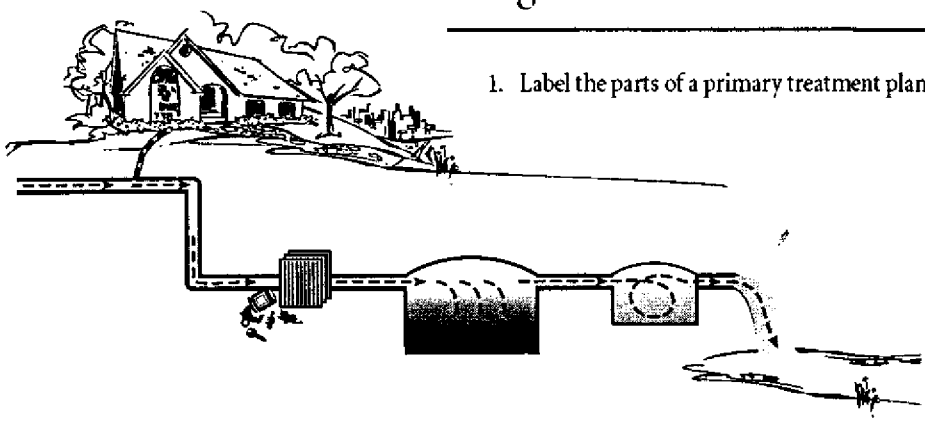


2. The trickling filter method uses 1m- to 3m- (3 ft- to 10 ft-) thick layers of stones, through which the wastewater from the sedimentation tank passes. The microorganisms growing on the stones digest most of the wastes as it passes through the filter. The effluent from the bottom of the tank is then allowed to undergo further settling. It is then chlorinated and finally pumped into a river or bay.

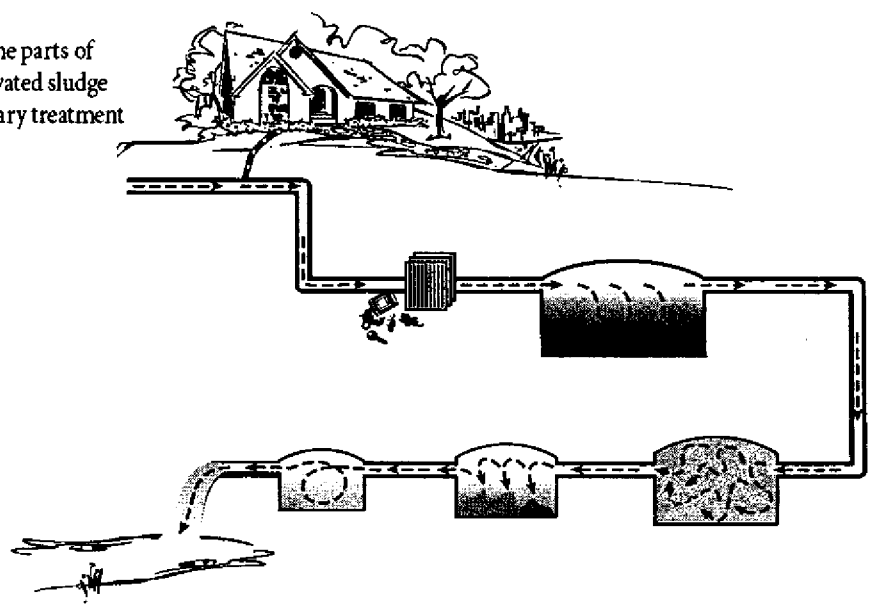


Sewage Treatment Plants Worksheet

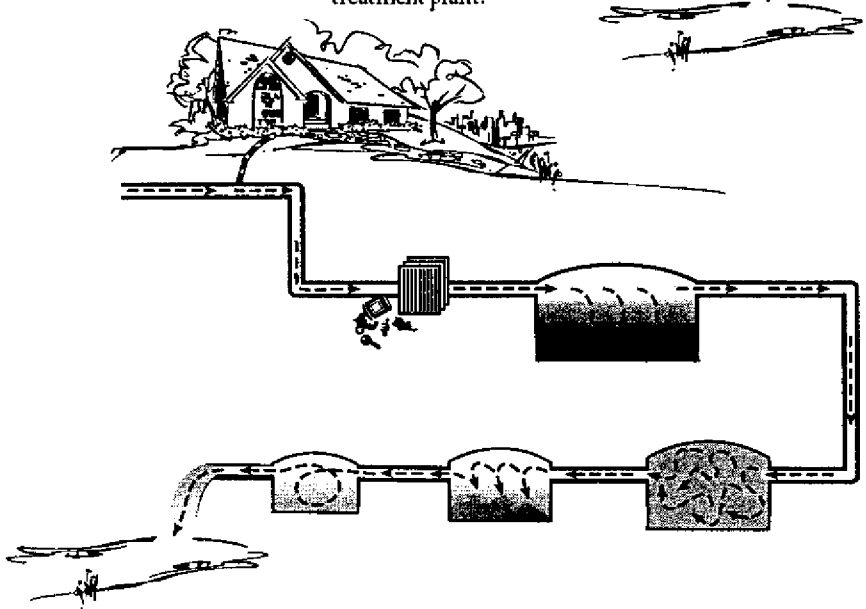
1. Label the parts of a primary treatment plant.



2. Label the parts of an activated sludge secondary treatment plant.



3. Label the parts of the trickle filter secondary treatment plant.



4. Define these terms:

Primary treatment

Secondary treatment

Sludge

Bar screen

Sedimentation tank

5. Describe what happens to the water and wastes that enter a secondary activated sludge treatment plant.