Nature's Cleaning Process

Students learn how a septic system cleans wastewater by performing an experiment.

Level(s): 6-8

Subject(s): Physical Science, Chemistry, Life Science

Virginia SOLs: 6.5 f, g; 6.9 a**;** LS4 b; LS12 e; PS2 c, e;

Objectives: Students will be able to describe how a septic system works.

Materials: **per Group:**

- Jar of murky water (with soil and/or organic debris mixed in)
- Flower pot filled with layers of sand and or gravel
- Cotton plug for the drainage hole at the bottom of the flower pot
- Empty jar
- Food coloring

Estimated Time: 45-60 minutes

Background Information:

Common Disposal Methods: Sink/Toilet, p.168.

On Site Waste Treatment: The Septic System, p.170.

Preparation: Have the materials described above in "Materials**"** set up where groups can use them.

Activity Procedure:

1. One student pours the murky water into the flower pot that is held by another student. The flower pot is held over the empty jar.

2. Ask the students to describe the difference between the murky water before it was poured into the flower pot and what drains out of the flower pot and into the glass jar. Ask the students what happened to the debris in the water.

3. Explain that the flower pot simulates the drain field or septic system, that is used in many rural areas to process waste water. Ask the students to describe how they envision a drain field working. Why are drain fields used? Have students list where the water come from that enters a drain field (sink, shower, toilet, etc.)

4. Ask the students to describe what would happen if too much water was poured into the flower pot at one time. Continue the demonstration to find out. Have the students discuss how this might relate to a real septic system

5. Ask students what would happen if toxic chemicals were present in the waste water. Using food coloring to represent the presence of toxic or hazardous chemicals, repeat the demonstration. What chemicals might families dispose of in the toilet or kitchen sink which would enter the septic drain field. How would this affect the ground water? How should these chemicals be disposed of? How necessary is it that these chemicals are used?

6. Assign the article *On Site Waste Treatment: The Septic System* referenced above in "Background Information"

Assessment Opportunities:

1. Have students draw a diagram of a septic system and explain how it cleans waste water.

2. Have students list three common hazardous household products that should not be disposed of down the drain.

Extensions:

1. Have the students perform the experiment using solutions listed in the lesson plan *Invisible Passengers* (p.95) to test if they can still detect the odor of the various solutions.

2. Ask each student, with the help of a parent, to identify one toxic or dangerous chemical used in their home, and an alternative that is less dangerous or harmful when released into the ground water. Create a bulletin board or poster listing these options.

3. Have students design an experiment that would simulate the function of the septic tank before performing the septic drain field simulation.

From **Two H's and an O: A Teaching Resource Packet on Water Education**, pp.99-100.

Common Disposal Methods: Sink and Toilet

from the **No Waste Anthology**. p.205.

When you pour something down the sink or flush it down the toilet, where does it go? It either goes to sewage system or the septic system.

The sewage system is a network of underground pipes that collects liquid waste from each house, store, office, factory and building and brings it together into huge pipes called trunk lines. These trunk lines carry enormous volumes of waste.

Not all that long ago sewage used to be dumped directly into river, lakes, bays and oceans. What problems did this create?

Now most cities and towns have sewage treatment plants to clean up the sewage before it is pumped into a local water source. The pipes for these plants are so big you could probably stand up in them.

At the sewage plant the water is treated with chlorine to kill any disease-causing organisms in the raw sewage. Much of the solid materials and some of the heavy metals are also removed by allowing them to settle out of solution. Common heavy metals are lead, zinc, mercury and cadmium. Exposure to heavy metals, in any other than small concentrations, can be harmful to human and environmental health.

Some of the hazardous substances in the sewage biodegrade, while others, including some the heavy metals, settle out in a residue called sludge. This sludge is usually disposed of in a landfill, but is sometimes applied as a fertilizer to farming and/or forest land.

Some hazardous chemicals can be absorbed by plans. These plants, in turn, can accumulate and concentrate to dangerous levels. This process is called bioaccumulation. As a substance moves from one organism to another through being eaten or absorbed, the substance is said to move through the food chain. Each link in the chain may accumulate the hazardous substance at higher concentrations. Human beings are often at the top of a food chain, which means the food we eat has a chance to bioaccumulate many times. The EPA has set standards for the level of hazardous substances in sludge that may be used on farm or garden soils producing food.

If you poured a hazardous item down the sink, which food chain could these hazards enter?

Today we are only starting to recognize and understand the environmental damage caused by hazardous household products. There is no doubt that treatment removes or makes less harmful some of the hazardous substances found in sewage. Some hazards, however, are not removed and are pumped out into bodies of water such as rivers that will carry them to the Chesapeake Bay.

If your house is not connected to a sewer system, it is probably attached to a septic tank. Gallons of water and sewage go through these septic systems every day.

Bacteria break down much of the waste entering a septic system. However, if you pour or flush hazardous waste into a septic system, the waste can kill these helpful bacteria and will contaminate the septic system's drain field soil or the septic tank sludge. The sludge, removed every four or five years from the septic tank is disposed of either at a sewage treatment plant in a septic lagoon or in a sludge landfill (basically a hole in the ground). The septic system cannot last indefinitely if the sludge tank is not pumped out periodically. At best, bacterial action will stop allowing harmful substances into groundwater and at worst the drain field will get blocked and cause the stem to back up.

The suspected cancer causing chemical trichlorethylene, a powerful solvent and degreaser, has leached from septic tank drain fields in several places in the country to contaminate local wells. This compound, used in the past as a cleaner for septic tanks, is the suspected source. Chlorinated compounds make good cleaning agents, but they are persistent, toxic and mobile. Bacteria that can break down non-chlorinated substances cannot biodegrade these compounds, which pass into a drain field and ultimately may end up in drinking water sources.

On Site Waste Treatment: The Septic System

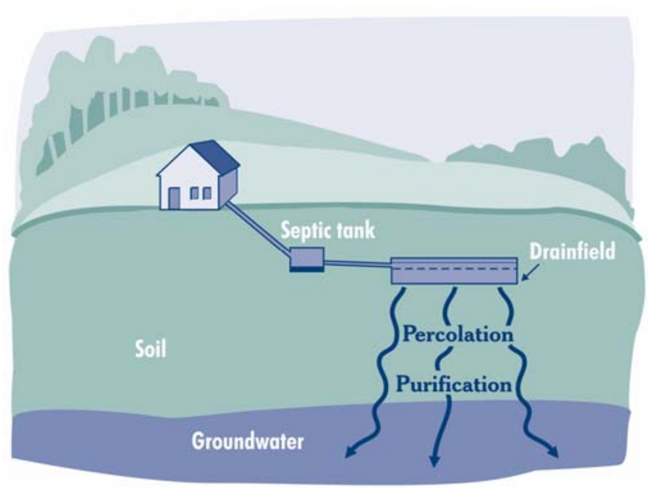
Twenty-three percent of the U.S. population relies on onsite wastewater treatment systems, most of which are septic systems. A septic system is a highly efficient, self-contained, underground wastewater treatment system. Because septic systems treat and dispose of household wastewater onsite, they are often more economical than centralized sewer systems in rural areas where lot sizes are larger and houses are spaced widely apart.

Septic systems are simple in design, which makes them generally less expensive to install and maintain than centralized systems. And by using natural processes to treat the wastewater onsite, usually in a homeowner's backyard, septic systems don't require the installation of miles of sewer lines, making them less disruptive to the environment.

A septic system consists of two main parts – a septic tank and a drainfield. The septic tank is a watertight box, usually made of concrete or fiberglass, with an inlet and outlet pipe. Wastewater flows from the home to the septic tank through the sewer pipe. The septic tank treats the wastewater naturally by holding it in the tank long enough for solids and liquids to separate. The wastewater forms three layers inside the tank. Solids lighter than water (such as greases and oils) float to the top, forming a layer of scum. Solids heavier than water settle at the bottom of the tank, forming a layer of sludge. This leaves the middle layer of partially clarified wastewater.

The layers of sludge and scum remain in the septic tank, where bacteria found naturally in the wastewater work to break the solids down. The sludge and scum that cannot be broken down are retained in the tank until the tank is pumped. The layer of clarified liquid flows from the septic tank to the drainfield.

A standard drainfield (also known as a leachfield, disposal field or a soil absorption system) is a series of trenches or a bed lined with gravel or course sand, and buried one to three feet below the ground surface. Perforated pipes or drain tiles run through the trenches to distribute the wastewater. The drainfield treats the wastewater by allowing it to slowly trickle from the pipes out onto the gravel and down through the soil. The gravel and soil act as biological filters.



If you own a septic system, it is important that it be properly maintained to extend its life and prevent contamination of ground and surface water. How often you need to pump the solids out of the septic tank depends on three major factors:

- The number of people in your household;
- The amount of wastewater generated (based on the number of people in the household and the amount of water used);

- The volume of solids in the wastewater (e.g., using a garbage disposal will increase the amount of solids).

Although your septic tank absorption field generally does not require maintenance, you should adhere to the following rules to prolong its functional life:

Do not drive over the absorption field with cars, trucks or heavy equipment;
Do not plant trees or shrubbery in the absorption field, because the roots can get into the lines and plug them;
Do not cover the absorption field with hard surfaces, such as concrete or asphalt. Grass is the best cover, because it will help prevent erosion, and help remove excess water.
Do divert surface runoff water from roofs, patios, driveways and other areas away from the absorption field.

Homeowners wanting to take good care of their septic systems should make note of the following items that should never be flushed down the drain or toilet. These items can overtax the system, or clog the pumps and tiles.

hair combings	coffee grounds
dental floss	disposable diapers
kitty litter	sanitary napkins
tampons	cigarette butts
condoms	gauze bandages
fat, grease or oil	paper towels

And NEVER flush chemicals that could contaminate the surface and groundwater, such as:

paints	varnishes
thinners	waste oils
Photographic solutions	pesticides

According to the EPA, properly sited, constructed and managed onsite wastewater treatment systems are an effective means of protecting human health and the environment. In addition to the advantages in construction and maintenance costs mentioned above, they also avoid potentially large transfers of water from one watershed to another, that can occur with centralized collection and treatment.

If you are looking for more information on how to properly maintain your septic system, avoid potential system problems, or are planning on buying or selling a home with a septic system, you can download free brochures at www.nesc.wvu.edu/nsfc/
nsfc_septicnews.htm.

Sources:

1. "Septic System Information", *NSFC Septic News*, www.nesc.wvu.edu/nsfc/nsfc_septicnews.htm.

2. *USEPA Onsite Wastewater Treatment Systems Manual*, www.adwwa.org/news.htm.

Mini Water Treatment Simulation

Students will do an activity that simulates the steps in the water treatment process using plastic cups, including aeration, coagulation, sedimentation, filtration and chlorination.

Level(s): 6-8

Subject(s): Physical Science, Chemistry, Life Science

Virginia SOLs: 6.5 f, g; 6.9 a**;** LS4 b; LS12 e; PS2 c, e;

Objectives: Students will understand the steps required to insure safe and pure drinking water for the community.

Materials: **Per Student:**

- 1 *Water Treatment Student Activity Shee*t

Per Group:

- Clear plastic cups with one cup water and approximately ½ teaspoon of soil stirred in
- 2 styrofoam cups (approximately 10 oz.)
- 1 small piece of paper toweling
- 1 teaspoon powdered alum (from drug store)
- ½ to 2/3 cup clean sand
- ¼ cup clean gravel
- 2 drops of simulated chlorine (do not use chlorine: make a mixture of yellow food coloring to simulate adding chlorine for purification)

Estimated Time: 1 hour

Background Information: *Water Treatment Plant*, p.175.

Preparation: Have the materials described above in "Materials**"** set up where groups can use them.

Activity Procedure:

1. Discuss the need for water treatment for municipal household water use. Discuss the steps in the water purification process.

2. Hand out the Student Activity Sheets and go over the steps in the water treatment process.

3. Pass out the materials and have each group poke 10-12 small holes in the bottom of the cup (this will be used as a filter cup in Step #4).

3. Have students process their water by following the steps on the Student Activity Sheet. Some students may need to be "talked through" the process.

4. Students should add 1 or 2 drops of simulated chlorine bleach to their final water sample.

5. Compare each group's final sample.

Assessment Opportunities: Give students a handout with the five steps (aeration, coagulation, sedimentation, filtration, disinfection) listed out of order. Ask them to put them in order and write a brief description of each one.

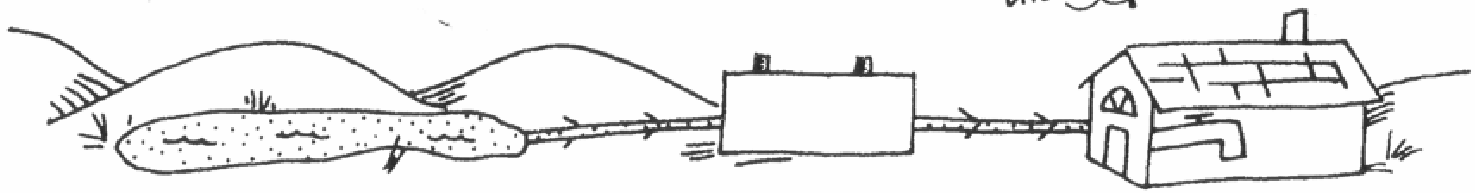
Extensions:

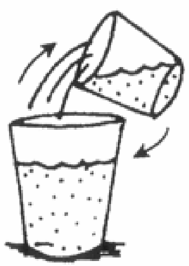
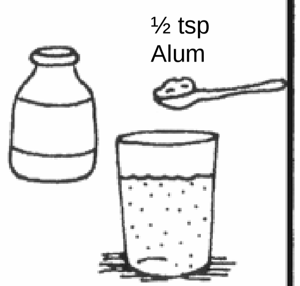
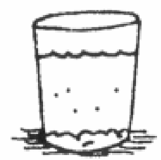
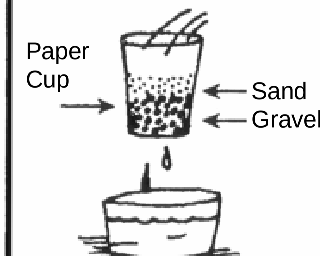
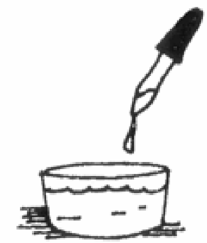
1. Discuss what might happen if the steps are taken out of order. Try the experiment again in a different order and compare the results.

2. Arrange a class trip to the local water treatment plant for a tour of the facility.

From **The No Waste Anthology**, pp.55-57.

Water Treatment from the Reservoir to the Tap!



Step 1: **Aeration**	Step 2: **Coagulation**	Step 3: **Sedimentation**	Step 4: **Filtration**	Step 5: **Disinfection**
				
Aerate water to release trapped gas.	Alum collects small dirt particles, forming larger sticky particles called "floc".	The larger "floc" particles settle to the bottom.	The "floc particles are trapped in the layers of sand and gravel.	A small amount of disinfectant is added to kill the remaining bacteria. The microorganisms are killed by this process. Do not do this step.
Observation:	Observation:	Observation:	Observation:	

Water Treatment Plant

Follow a drop of water from the source through the treatment process. Water may be treated differently in different communities depending on the quality of the water which enters the plant. Groundwater is located underground and typically requires less treatment than water from rivers, lakes and streams.