Discover the Source

Adapted From: The Pucker Effect. The Project WET Curriculum and Activity by The Watercourse and Council for Environmental Education (CEE).

Grade Level: Intermediate

Duration:
Preparation time: 90 minutes
Activity time: 50 minute

Setting: Classroom

Summary: Students must track down the origin of a toxic contaminant polluting the drinking water within a local community.

Objectives:
- Describe how underground point source pollutants move through groundwater.
- Analyze data from test wells they have "drilled" to identify point source contamination

Vocabulary: Groundwater, point source pollution, plume

Related Module Resources:
- Groundwater simulator

Materials (Included in Module):
- Cup of sand
- Grape-flavored drink powder
- Spray bottle
- Aluminum Lids
- Lemonade-flavored drink powder
- Sand
- Straws
- pH Papers

Materials Not Included in Module:
- Tap water
- Beakers
- Copies of Student Information Sheet and Worksheet

ACADEMIC STANDARDS: (ENVIRONMENT AND ECOLOGY)

7th Grade
4.3.7.B Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.
- Identify residential and industrial sources of pollution and their effects on environmental health.
- Explain the difference between point and nonpoint pollution.
- Explain how nonpoint source pollution can affect the water supply and air quality.

10th Grade
4.1.10.E Identify and describe natural and human events on watershed and wetlands.
- Identify the effects of humans and human events on watersheds.

4.3.10.B Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices.
- Explain how human practices affect the quality of the water and soil.

BACKGROUND: Since the industrial revolution, industries have deposited petroleum, oil, and chemical waste products into underground tanks. Over time, these tanks eventually erode, creating holes for the stored contaminants to seep out. A pollutant that is emitted from a single identifiable source (eroded underground tank, faulty landfills, septic tanks, aboveground dumpsites, effluent pipe, etc.) is termed **point source pollution**.

The product of point source groundwater pollution, called a **plume**, may spread for thousands of feet and persist for many years *after* the source is removed. Plumes seep through underground bedrock and ground water, similar to how smoke is emitted from a chimney. The size and shape of the plume are controlled by how viscous the contaminant is, how well it dissolves in water, the rate at which it is being emitted, the rate water moves through the ground, and possibly the rate at which pumps withdraw ground water.

Today, point source pollution from underground storage tanks is not as threatening as in the past thanks to several safety precautions created by scientists and enforced by legislature. Underground tanks are created out of stronger metals that are less corrosive than metals used in the past. Monitoring equipment is attached to underground tanks to detect if contaminants are seeping through the tank.

Scientists must monitor groundwater around underground tanks to test if any contaminant is being released from the tank. These precautions are necessary to ensure public safety. Additionally, many companies have spent millions of dollars cleaning up plumes emitted from their own underground storage tanks because they failed to properly monitor their tanks.

Unfortunately, point source pollution persists as a nuisance to water quality today. Underground waste tanks are not the only point source polluter, other sources include faulty sewage systems, sanitary landfills, and waste water disposal sites. Additionally, pollutants within the water can be tasteless, colorless, and odorless, making their detection seemingly impossible without water quality testing. Frequent water quality testing is needed to ensure that both city water and well water are free of contaminants.

PROCEDURE:

Background Activity (Strongly Recommended):

1) A **plume** is a continuous emission that may spread for thousands of feet and persist for many years *after* the source is removed.
2) Fill a glass-baking dish (or clear plastic take-out container) 1-inch deep with sand.
3) Bury the grape-flavored drinking powder (the contaminant) at one end of the dish.
4) Elevate the end with the powdered drink 1.5 inches.
5) Thoroughly wet the sand with the spray bottle – do not pour water directly on sand. You are creating the groundwater so that the drink spreads throughout the sand (creating the plume).
6) Ask students what conditions could have promoted this particular plume event? Examples of point source pollutants include leaking waste storage container, drainage pipe from a sewage treatment plant, industry, or off a street pipe.

Activity:

1. Ask students to form groups of 2-3 per group. Each group will represent a separate water quality team. Each team receives an aluminum cake pan filled with 1 inch of sand.
2. Tell students to bury a small amount of powdered lemonade drink mix somewhere within the sand. Once the contaminant has been hidden, have the students sketch a map showing where the contaminant has been hidden. After drawing the map, have teams switch pans with another team.
3. Copy and distribute the Student Information Sheet and Worksheet to the groups. Students are to use this sheet to complete their investigations and record their results. After their results have been recorded, compare their results to the maps made by the team that hid their contaminant.

DISCUSSION:

1. What problems will the town likely face even after the underground waste tanks have been removed?

(*The toxic lemonade plume will remain within the soil after the source is removed. Recall that a plume may spread thousands of feet in length, and may persist within the groundwater for years after the source has been removed*)

2. Other than the "toxic lemonade drink", what other contaminants have been known to pollute ground water?

(*Heavy metals from landfill sites, toxic chemicals from former chemical dump sites, oil and gas from underground fuel tanks, bacterial contamination from septic tank effluent, and industrially produced cyanides and phenols from steel mills are all potential ground water contaminants. Additionally, industrial hazardous wastes, agricultural runoff, fertilizers, pesticides, herbicides, oils, nutrients such as nitrates and phosphates, and PCBs that collect on the surface may percolate into the soil and further contaminate groundwater.)*

3. How did the toxic lemonade contaminant spread throughout the groundwater?

(*Recall that groundwater is in constant motion due to the force of gravity. As the toxic pollutant was leaking from the underground tank, it intermixed with the groundwater. Similar to ground water movement, the plume spread downgrade due to the gravitational forces displacing through the water table.*)

EVALUATION:

- Practice groundwater testing methods
- Identify a source of contamination using simulated groundwater testing methods
- Cite challenges to locating and cleaning underground contamination

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

Discover the Source STUDENT Information Sheet:

Your Task: Locate underground storage tanks that are leaking highly toxic lemonade by performing water quality tests.

Background: In the spring of 1995, the western Pennsylvania branch of the Allegheny Lemonade Corporation was forced to shut down after numerous complaints that their product was causing odd reactions in people who drank it. These victims claimed that after consuming the lemonade, their lips puckered out and their eyes bulged outward for up to 12 hours. The disease was later named pucker shock syndrome. Researchers later confirmed the victims' allegations by discovering a toxic, acidic ingredient within the lemonade mixture. The Allegheny Corporation later left western Pennsylvania, tearing down their building and presumably removing all of the contaminated equipment that had been in contact with the toxic substance. Recently, an outbreak of pucker shock syndrome has re-struck the community. City officials have hired a water-testing agency (you) to locate and remove the source immediately.

The Mission: The recent victims of pucker shock syndrome all resided with 5 miles of the old Allegheny Lemonade Corporation. Could the Allegheny Corporation have left underground storage tanks at the old plant location? Perhaps these storage tanks are now leaking, contaminating local drinking water with toxic lemonade? Your objective is to confirm or deny the hypothesis, using limited resources to track down the source of the toxic substance.

Tools Available:
1. Drill rig (straw)
2. Hygiene-O-Matic Sanitation Station (beaker of water)
3. State of the art, mobile testing facility (pH test paper)

Hints: A telltale sign of the toxic lemonade product is acidity. Using pH test paper, analyze soil acidity to track down the source of the contaminant. Regular tap water will leave the pH testing paper yellowish-green, while acidified water will turn the testing paper red. Due to recent budget cuts under the current administration, you will receive only 7 pH test strips to locate the source. If you fail your objective, pucker shock syndrome will continue to plague members of your town.

Procedures:
1. Write your laboratory group name and the scientists composing the group on the data sheet.
2. Elevate one end of the pan 1 inch.
3. Sketch an aerial drawing of the pan on the data sheet.
4. Fill a misting bottle with tap water. Test the acidity of the tap water with pH test paper, and record the reading on the data sheet. When the test paper dries, tape it to the data sheet to use as your control. The color of the test paper is what future uncontaminated soil will look like.

5. **<u>Slowly</u>** mist the site with water from the misting bottle for 5-10 minutes. No surface runoff should occur during this time.
6. Fill a beaker of water (sanitation station) with water. Rinse a straw (drill rig) with water.
7. Begin collecting and testing:
    a. Place the straw over the location you believe is a likely location of the contaminated plume.
    b. Press the straw into the desired soil location.
    c. Trap the soil sample into the straw by plugging the top of the straw with your index finger.
    d. Lift the straw from the soil.
    e. Place a small quantity of the collected sample onto the edge of the testing paper.
    f. Observe and record the test results.
    g. Rinse off the straw to eliminate contaminating the next sample.
    h. Repeat steps a through g until you have used all of your pH testing paper or you believe you have located the source. Remember to compare the color on your pH paper with the provided color scale.
8. Record the location of each test site on the data sheet by taping the dried test paper to the location.
9. When the contamination site is found, mark the location on the data sheet with a large "X".

DATA SHEET: DISCOVER THE SOURCE

Group Name_____ Date:_____
Scientists:_____
Misting Water pH Value (Control):_____Tape Control Paper Here_____
_____

Site Map

Raised End of Tray (Marked with an "X")

Low End of Tray