

LESSON 2: No Household Hazardous Wastes in a Landfill

LESSON'S CONCEPTS

- People, through their expectations, lifestyle choices, and personal use of resources and products, create varying amounts of waste, some of which may be hazardous.
- Household hazardous wastes should not be placed in the garbage. Household hazardous wastes that are placed illegally in garbage cans end up in a landfill and could potentially cause environmental and health problems (e.g., leachate polluting groundwater) associated with burying hazardous waste in landfills.

PURPOSE

Students will learn about landfill leachate. They will conclude that household hazardous waste should not go into the garbage because of the potential hazards to the environment and because it is also illegal.

OVERVIEW

In this lesson students will:

- Listen to a simulated letter from a garbage collector to learn why household hazardous wastes should not be placed in the garbage.
- Use models of landfills that they constructed in a previous unit or make new model landfills to design demonstrations on how household hazardous wastes affect the groundwater; and/or conduct experiments on leachate.
- Observe how water picks up pollutants in a landfill model, which they will create in a bottle.
- Sing a song about landfills and write a letter to the garbage collector describing what they did and what they learned in this lesson.
- Research, write about, and report to the class information about a local landfill and its connection to their community's water system.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS

- Using a model of a landfill, students complete and share a plan and then follow the plan to demonstrate how groundwater

could become polluted with household hazardous wastes if they are improperly disposed of in a landfill.

- "Public landfills must be planned responsibly to allow maximal use of the land once it is reclaimed. Toxic wastes buried in landfills adversely affect the groundwater supply and thus affect public water and public health." (*Science Framework*, page 97)
- "Students listen critically and respond appropriately to oral communication. They speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation." (*English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 26)
- "Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept . . . Students will : . . . record data using appropriate graphical representation (including charts, graphs, and labeled diagrams), and make inferences based on those data." (*Science Content Standards, Grades K–12; Grade 5; Investigation and Experimentation*, Standard 6g)
- Students write a letter to Vince, the garbage collector, and describe what they did in this lesson and what they learned.
 - Students "choose the form of writing (e.g., personal letter . . .) that best suits

the intended purpose.” (*English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 37)

- Students research, write about, and report to the class information about a local landfill and any connection it may have to their community’s water system.
 - “Water on Earth moves between the oceans and land through the process of evaporation and condensation. As a basis for understanding this concept, students know . . . the origin of water used by their local communities.” (*Science Content Standards, Grades K–12; Grade 5; Earth Sciences, Standard 3e*)
 - Students “write research reports about important ideas, issues, or events by using the following guidelines: (a) frame questions that direct the investigation; (b) establish a controlling idea or topic;

and (c) develop the topic with simple facts, details, examples, and explanations.” (*English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 31)

SCIENTIFIC THINKING PROCESSES

observing, communicating, comparing, classifying.

TIME

45–60 minutes to prepare for the lesson;
90–120 minutes to implement the lesson

VOCABULARY

aquifer, groundwater, leachate, water table
(*Note:* Students can look up these words in a dictionary or science textbook and then draw a model, labeling the parts.)

Note: If available, use the simulated landfill made in a bottle in Unit 1, Lesson 2.

PREPARATION

1. Read the “Background Information for the Teacher” at the end of this lesson.

Note: Determine which of the following two sections applies to you:

- “Section I, Working with Completed Landfills in Bottles.” If you kept the models of the landfill in a bottle from Unit 1, Lesson 2 (4–6 Module), then do Section I in “Preparation,” “Materials,” and “Procedure.” You will use two landfills for the class demonstration and additional bottles for group demonstrations or experiments.
- “Section II, Building Model Landfills in Bottles.” If your class does not have landfill models, do Section II in “Preparation,” “Materials,” and “Procedure.” You will be building two landfills in a bottle as a class. Then groups can build additional ones for their demonstrations or experiments.

2. If available, invite a landfill manager to speak to the class.

For “Section I, Working with Completed Landfills in Bottles”

1. Gather the models of the landfill in a bottle from Unit 1, Lesson 2 (4–6 Module).

2. Make a copy of “Our Plan for a Demonstration, Using Our Landfill in a Bottle” (page 535) for each group of students.
3. Make transparencies of “Diagram of a Landfill” (page 269) and “The Song: Landfill in a Bottle” (page 536).

For “Section II, Building Model Landfills in Bottles”

1. If needed, precut the 2-liter bottles to prepare them for students to use. Cut Bottle B nine inches from the cap; make an incision with a utility knife and cut around the bottles with scissors. (See “Construction of the Landfill in a Bottle” on page 533.)
2. Make transparencies of “Diagram of a Landfill” (page 269), “Layers in a Landfill in a Bottle” (page 534), and “The Song: Landfill in a Bottle” (page 536).
3. Make a copy of “Our Plan for a Demonstration, Using Our Landfill in a Bottle” (page 535) for each group of students.
4. Obtain maps of your community, which include the location of the landfill where your community’s garbage is taken. The maps should show creeks, rivers, and reservoirs. These can be road maps (car

clubs and insurance companies might donate a class set of these) and topographical maps (see “Resources” for sources).

MATERIALS

For “Section I, Working with Completed Landfills in Bottles”

- ___ A trash can of clean classroom trash, including a couple of empty containers of household hazardous products
- ___ Plastic tarp on which to spread out the trash
- ___ Models of the landfill in a bottle from Unit 1, Lesson 2 (4–6 Module)
- ___ Food coloring
- ___ Four cups of water
- ___ Transparencies of “Diagram of a Landfill” and “The Song: Landfill in a Bottle”
- ___ A copy of “Our Plan for a Demonstration, Using Our Landfill in a Bottle” for each group of students

Note: You might need additional materials for groups designing demonstrations or experiments in landfills in bottles (e.g., pH paper indicator strips).

For “Section II, Building Model Landfills in Bottles”

- ___ Transparencies of “Diagram of a Landfill,” “Construction of the Landfill in a Bottle,” “Layers in a Landfill in a Bottle” and “The Song: Landfill in a Bottle”
- ___ A trash can of classroom trash, including a couple of empty containers of household hazardous products
- ___ Plastic tarp on which to spread out the trash
- ___ Four rinsed 2-liter beverage bottles and caps (plus two more for each group of three to four students)
- ___ One-gallon bucket of regular soil (Do not use potting soil.)
- ___ Clay soil (soil can be mixed with clay to make the clay soil); approximately half cup per 2-liter beverage bottle
- ___ More clay or something that can be used as a cushioning material (e.g., piece of rubber foam, sponge, or outdoor carpet) between the plastic liner and the gravel
- ___ One-gallon bucket of gravel (or crushed rock)
- ___ Three-inch swatch of cheesecloth or nylon stocking
- ___ Two pieces of heavy plastic (e.g., a piece of plastic tarp)

- ___ Scissors, tape, two rubber bands, utility knife
- ___ A couple of letters from the garbage collector (copy or read from the lesson)
- ___ Food coloring
- ___ Two cups of water
- ___ Assorted small pieces of clean nonhazardous garbage between one-half and one inch in size (apple cores, banana peels, bread, leaves, aluminum foil, bottle caps, rubber bands, paper clips, pennies, cloth, plastic toy, newspaper, copy paper, plastic scraps, grass) to place in the landfills in bottles (Use some materials from the classroom’s trash can.)

Note: You might need additional materials for groups designing demonstrations in landfills in bottles (e.g., pH paper indicator strips).

For “Application”

- ___ Road and topographical maps of your community, which include the location of the landfill where your community’s garbage is taken

PRE-ACTIVITY QUESTIONS

- A. Have students sit in a circle. Place a package of clean garbage in the middle of the class (including some empty containers used for household hazardous products which have been rinsed out and the cap taped shut). Tell the class that this was just delivered. “Wait there’s a letter attached; let’s see what it says.

Dear Students,

My name is Vince and I pick up your garbage in my big garbage truck. You may not know me, but I come by your school and your homes every week. I take your garbage to a landfill. A landfill is an area where garbage is buried. How many of you have seen a landfill before?

I sent you some samples from a landfill. Open it up. What would you call this stuff? Do you throw any of this stuff into your garbage can at home?

Notice the empty containers of household hazardous products. I am glad that these are empty. What if they weren’t empty? Guess what could happen to me and my friends that work at the landfill if a container half full of household hazardous waste burst open? I’m sure you are careful to not break the law by throwing away household hazardous waste in a trash can. Once

in a trash can, it will be going to the landfill, and there, it could create all kinds of problems.

Thank you for keeping hazardous waste out of your garbage.

Sincerely,

Vince, the Garbage Collector”

B. Discuss with students:

- What happens to the trash after it goes into a garbage can? *A garbage truck picks it up.*
- How does it get in the garbage truck? *Garbage collectors usually pick up the garbage can and dump it into the garbage truck; sometimes garbage companies have machines that lift the garbage can and dump it into the back of the truck. Garbage is compacted in some trucks.*
- Where does the garbage truck take it? *To a transfer station or to the landfill. (If students do not know what a transfer station is, explain that it is a facility where waste is removed from small garbage trucks and loaded onto larger garbage trucks that take the garbage to a landfill.)*
- What could happen to the workers at a transfer station or the landfill if household hazardous wastes were dumped into a trash can? *They could get sick or injured by the hazardous wastes if the container breaks or explodes.*

PROCEDURE

Section I, Working with Completed Landfills in Bottles

Note: Do this section if you have landfills in bottles from Lesson 2 in the unit, “Managing and Conserving Natural Resources.”

- A.** Tell students: “We received another letter from Vince, the Garbage Collector, and it says:

Dear Students,

How have you been? I just got another break from hauling garbage and wanted to drop you another note. There are some important things you should know about landfills. Did you know that when it rains, the water can go right through the landfill and mix with the garbage? If you could look into the landfill, the water might appear black and smelly. This water, when

mixed with chemicals from the garbage, is called leachate. This contaminated water could go down into the soil and into the groundwater. In many areas of California, people dig wells and pump the groundwater to the surface to be used for drinking and washing.

Well, some people got together and decided that it was important to make sure that landfills do not pollute groundwater. So, they decided to make it a law that all new landfills must have a liner. A layer of clay soil is placed on top of existing soil, and then a plastic liner is placed on top of the clay. Another layer of clay or other material is placed on top of the liner to serve as a cushion to keep the liner from getting pierced by the crushed rock. Then crushed rock is placed on top of the liner, followed by another cushion to keep the soil from sifting into the crushed rock. Finally, a layer of soil is added and the garbage is placed on top of the soil. The liner helps catch the leachate (water that picked up contaminants from the garbage) so it will not enter the groundwater. The collection pipes then carry the trapped leachate out of the landfill to be treated.

I hope you can learn more about how leachate forms in landfills. Maybe your teacher can conduct a demonstration using model landfills. I think you will see how important it is to keep hazardous waste out of our landfill.

Sincerely,

Vince”

- B.** Discuss what *groundwater* is. Tell students that under the ground there are porous rocks, sand, and gravel through which water can move. This area is called an *aquifer*. In the aquifer is groundwater.
- Show the transparency, “Diagram of a Landfill.” Tell students that because groundwater is usually found under a landfill, it is important for the garbage in the landfills to be contained to keep it from polluting groundwater.
 - Tell students that they will help you demonstrate how groundwater can be contaminated by wastes in a landfill and how a special liner in a landfill can prevent groundwater contamination.
- C.** Select two landfills (which you completed in Lesson 2 in the unit, “Wisely Managing Natural Resources”) on which to conduct two demonstrations. Label one Landfill #1 and the other Landfill #2. The remaining

landfills can be used when students develop their own demonstrations or experiments.

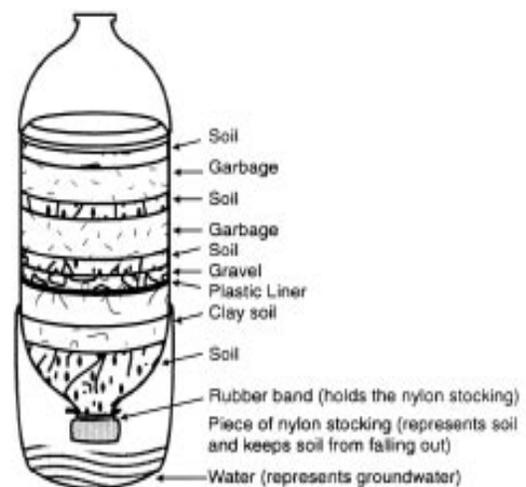
- D. Using Landfill #1, open the top of the landfill and dig through the soil until the garbage layer is reached. Ask different students to help you demonstrate the following:

1. Place ten drops of food coloring on top of the garbage. Tell students that this represents the contents of a container containing household hazardous waste that was thrown away into the trash. Explain to students that when the machines compacted the garbage at the landfill, the container with the household hazardous waste burst from the weight. Now it has leaked on the nonhazardous trash.
2. Re-cover the garbage with an inch of soil.
3. Ask students to suppose that the groundwater is located in the soil section below the plastic liner in their model landfills.
4. Simulate rain by pouring two cups of water into the landfill model.
5. Have students observe any color changes in the landfill and in the soil and gravel below the plastic liner. Explain that any colored water they see can represent leachate.
6. Determine whether the plastic liner stopped the leachate (with the household hazardous waste) from going into the groundwater.
 - Ask students to suppose that the plastic liner was torn. How could the groundwater be affected? *It could become polluted unless the clay soil keeps the leachate from reaching the groundwater.*
 - Explain to students that groundwater moves underground and can end up above ground in a spring or creek or other body of water many miles from the landfill site. What can happen to the polluted liquids from the landfill? *They could end up in groundwater and affect the drinking water for many miles.*

- E. Using Landfill #2, hold the landfill on its side as you unscrew the screw top on the bottom of the landfill. Have students assist

you with parts of the following procedure:

1. Using scissors, poke through the gravel, soil, and clay soil and puncture the plastic liner.
 2. Place a piece of nylon stocking (or cheese cloth) over the opening and secure it with a rubber band. This nylon stocking will keep the gravel in the bottle, yet will allow any leachate to leak through. If needed, review the meaning of leachate and leaching. *Leachate is the water that picked up contaminants, and leaching is the process of the water picking up contaminants.* (Note that in most cases the water comes from rain, but liquid can also be present in the garbage.)
 3. Add water to the bottom of the base of Bottle A (which will represent groundwater) to just below where the nylon stocking will be when the landfill is placed once more into its base (from Bottle A).
 4. Return the landfill to its base.
 5. Follow the steps above for Landfill #1, Part D, numbers 1 through 4.
 6. Have students observe any color changes in the landfill, in the soil and gravel below the plastic liner, and in the leachate leaking through the nylon. Then have students discuss what they have observed.
- F. Ask groups of students to come up with a way to show how household hazardous products, placed in the garbage, can end



up in a landfill and could affect workers at the landfill and/or pollute the environment. Another alternative is to show the importance of a liner, even if no household hazardous wastes are present in the landfill. Students should know that leachate from nonhazardous materials can mix together to create a hazardous liquid. Some examples for demonstrations and experiments are listed below, but groups should be encouraged to come up with their own ideas:

1. A group could pour water through a landfill and, using pH indicator paper strips, can test the pH of the leachate. Students can pour a half-cup of vinegar (to represent a household hazardous substance) into the landfill and test the pH again. They should notice that the pH has gone down, indicating that the water became acidic from the household hazardous waste. (You might have the group gather information about pH through various references and ask them to report their findings to the class.)
2. A group could bury a colorful piece of candy that would represent a leaking container of household hazardous waste. Make sure that the candy will dissolve and emit a color when water is added. (Students can help you identify what type of candy might work best.)

In the following demonstrations it might be necessary to water for a couple of weeks before the leachate forms from the nonhazardous trash in the model landfill.

3. A group could study suspended solids by draining the leachate (that dripped through the nonhazardous garbage layers) through a coffee filter.
4. A group can study dissolved solids by boiling off the liquid in the leachate and examining and weighing the residue. (This will need to be done with direct adult supervision.) The leachate could also be placed in a sunny location until the water evaporates, leaving a residue (this might take several days).

- G. Distribute a copy of “Our Plan for a Demonstration, Using Our Landfill in a Bottle” to each group.
 1. Ask students to complete the plan and then share their plans with the class.
 2. Once you have approved the plans, allow groups to gather materials and to use landfills in bottles to present their demonstrations in front of the class.
 3. Conduct a discussion on the groups’ presentations. Note that some demonstrations or experiments might not show obvious results, but the process students went through was most valuable.

Section II, Building Model Landfills in Bottles

Note: Do this section if you do not have landfills in bottles from a lesson in the unit, “Managing and Conserving Natural Resources.”

- A. Tell students: “We received another letter from Vince, the Garbage Collector. It says:

Dear Students,

How have you been? I just got another break from hauling garbage and wanted to drop you another note. I was thinking: you know everybody uses landfills every day, yet so few people know about them, and nobody wants one near his or her home. Anyway, I thought you might like to build model landfills and learn more about them. It would be a great way to become garbage experts and learn how to keep the environment from becoming polluted.

There are some important things you should know about landfills. Did you know that when it rains, the water can go right through the landfill and mix with the garbage? If you could look into the landfill, the water might appear black and smelly. This water mixed with chemicals from the garbage is called leachate. This contaminated water could go down into the soil and into the groundwater. People dig wells and pump the groundwater to the surface to be used for drinking and washing. Well, some people got together and decided that it was important to make sure that landfills do not pollute groundwater. So, they decided to make it a law that all new landfills must have a liner. A layer of clay soil is placed on top of soil, and then a heavy plastic liner is placed on top of

the clay. In some landfills a cushioning material is also placed under the plastic liner. Another layer of clay or other material is placed on top of the liner to serve as a cushion to keep the liner from getting pierced by the crushed rock. Then crushed rock is placed on top of the liner, followed by another cushion to keep the soil from sifting into the crushed rock. Finally, a layer of soil is added and the garbage is placed on top of the soil. The liner helps catch the leachate (water that picked up contaminants from the garbage) so it will not enter the groundwater. In addition, a system of pipes are placed on top of the liner to collect leachate. This leachate is then pumped up and stored until it is treated on site or at another treatment facility.

So you can learn more about how landfills are built, I have given directions to your teacher so you can build your own classroom model landfills.

Sincerely,
Vince”

Note: To demonstrate the process of leaching, especially for younger children, you might want to prepare some model landfills and fill them with different materials, one with soil, one with rock, and one with sand. Then let your students experiment with leaching water through these before you attempt to introduce the idea of groundwater.

- B.** Discuss what *groundwater* is. Tell students that under the ground there are porous rocks, sand, and gravel through which water can move. This area is called an *aquifer*. In the aquifer is groundwater. Show the transparency, “Diagram A, Diagram of a Landfill.” Tell students that since groundwater can be under a landfill, it is important for the garbage in the landfills to be contained to keep it from polluting groundwater. Tell students that they will help you demonstrate how groundwater can be contaminated by wastes in a landfill and how a special liner in a landfill can help prevent groundwater contamination.
- C.** The following are directions for preparing the bottle for the landfill model in a bottle. See “Diagram B” at the end of the activity to help you prepare these. You will need to prepare two landfills. Cut two 2-liter bottles as shown in the diagram:
- Cut Bottle B nine inches from the cap; for safety, make an incision with the

utility knife and then let the students cut around the bottles with scissors (for younger children the 2-liter bottles will need to be pre-cut); if any of the edges are jagged, trim them with scissors and place masking tape over them.

- The base of Bottle A will be the base of the landfill.
 - Remove the screw top on Bottle B.
 - Cover the top and neck of Bottle B with a piece of cheesecloth or nylon stocking and secure it with a rubber band.
 - Turn the top portion of Bottle B upside down and place it on top of the base.
 - After filling the landfill, you will place the top of Bottle A on top of the inverted Bottle B to form the cap.
 - Recycle the bottom portion of Bottle B.
 - Place one-half cup of gravel (about 2 inches) in the bottle to represent the aquifer.
- D.** Into one landfill, place soil on top of the gravel. Then alternate two inches of assorted garbage with one inch of soil.
- E.** Tell students that all new landfills require clay soils, plastic liners, leachate collec-



A landfill in a bottle constructed by Janet Cohen’s sixth-grade students at Gold Trail Elementary School.

tion systems, and gravel to be placed on the ground before garbage is added. The purpose of this is to protect the groundwater from water that has leached through the garbage, collecting pollutants. Note that even if household hazardous wastes were never placed in a landfill, leachate from nonhazardous materials can mix together

to create a hazardous liquid. However, the leachate from household hazardous waste is even more dangerous, and there are people who still illegally dump their household hazardous wastes into their garbage, which goes to the landfill.

- For the second landfill, project the transparency “Layers in a Landfill in a Bottle.” Have students place the following materials in the order listed:
 - A layer of soil on top of the gravel (or crushed rock)
 - A layer of clay soil about one-inch high on top of the soil
 - A plastic liner over the clay soil
 - A layer of clay or cushioning material
 - A layer of gravel over the liner (or crushed rock)
 - A layer of clay or cushioning material
 - A layer of soil
- Ask students why they were asked to place clay soil, a plastic liner, cushioning material, gravel (crushed rock), cushioning material, and soil before adding the garbage. *To keep the garbage from contaminating the soil and to protect groundwater.*
- Ask students what might be the purpose of the cushioning material. The cushioning material on top of the liner keeps the crushed rock or gravel from piercing the plastic liner, and the cushioning material on top of the crushed rock or gravel keeps soil from sifting down.
- If needed, explain to students that when it rains, the water can go right through the landfill and mix with the garbage. Then this polluted water can percolate through the soil and pollute the groundwater. So before the garbage is placed in a new landfill, or in an area next to an old landfill (if the landfill is being expanded), the following must be placed in the following order: clay soil is placed on top of the existing soil, a liner of plastic is placed on top of the clay soil, then gravel and more soil must be placed on top of the plastic

liner. The clay soil and liner help to keep the water, as it filters through the garbage, from seeping into the ground and reaching the groundwater.

- F. Provide students with clean pieces of garbage and ask them to place the garbage on top of the soil. They should pile the garbage about two inches high. Then they should cover the garbage with a one-inch layer of soil (see “Layers in a Landfill in a Bottle” at the end of the lesson).
 - Ask students why the garbage is covered with soil at the end of the day. *To keep garbage from being moved by the wind; to keep it from creating an odor; to keep insects and other animals away from it.*
 - Have students add a second layer of garbage and to top it with a one-inch layer of soil.
- G. You have constructed two landfills, one that will leak leachate and one that is designed to contain the leachate.
 1. Place ten drops of food coloring on top of the garbage. Tell students that this represents the contents of containers containing household hazardous waste that were placed illegally in the trash can. Explain to students that when the tractors compacted the garbage at the landfill, the containers with the household hazardous waste burst from the weight. Now they have leaked on the nonhazardous trash.
 - Gradually, pour two cups of water on top to simulate rainfall; cap the landfill with the top half of Bottle A.
 - Ask students to observe and describe what they see going on in their landfill.
- H. Do part “F” in “Section I, Working with Completed Landfills in Bottles.” Groups of students will come up with a way to show how household hazardous substances that are illegally placed in the garbage and end up in a landfill could affect workers at the landfill and/or pollute the environment. They might also conduct other demonstrations or experiments with leachate. Students will need to make their own landfills in bottles for their demonstrations.

DISCUSSION/QUESTIONS

- A. Where did leachate end up in each landfill?
On top of the plastic liner or in the groundwater.
- B. What are the problems of the leaking landfill?
The leachate could contaminate groundwater.
- C. How would a leaking landfill present a problem for the surrounding community? *The people might be using groundwater for drinking, cooking, and for other purposes.*
- D. How can you prevent leakage of leachate? (Note that in minimizing leakage through added design features, the cost of placing garbage in a landfill goes up.) *Watch what is thrown away into the garbage can; watch what is placed in the landfill.*
- E. Why should household hazardous waste be kept away from landfills? *It can pollute the groundwater and injure workers.*

APPLICATION

- A. Sing the song "The Song: Landfill in a Bottle" (sung to the tune of "Time in a Bottle"). (If you do not know the tune to this song, then recite the words as a poem.) Encourage students to write words that describe what they are learning in this unit to tunes they know.

No Poisons in Landfills

(Sung to the tune of "Peanut Butter and Jelly")

Chorus:

*Poison, poison in landfills don't mix.
Poison, poison in landfills not good.*

*First you take the HHW to the hazard place on
Saturday or on Sunday.*

*Then you get a pat on the back, and thank you,
and thank you.*

Chorus:

*Poison, poison in landfills don't mix.
Poison, poison in landfills not good.*

*Next they say you saved the Earth,
You're a hero, you're a hero.*

*Then you go home with a smile on your face.
You did it, you did it.*

Submitted by Janet Cohen's sixth-grade class at Gold Trail Elementary School.

- B. Ask students to write a letter to Vince telling him what they have done and learned in this lesson.

Dear Vince,
Thank you for all the information. We have learned a lot about landfills. We learned how dangerous household hazardous products and waste can be to plants, animals, and people. We also learned that when the leachate gets to the groundwater it contaminates our drinking water, so it's important that the leachate does not reach the groundwater. That's why the landfills have plastic liners.

Submitted by Stacy Byers, sixth-grade teacher, Cajon Park School, Santee Elementary School District.

- C. Provide maps of your community which include the location of the landfill where your community's garbage is taken and the locations of local creeks, rivers, and reservoirs. If available, invite a landfill manager to speak to the class.
 - Have students do research to find answers to the following questions (each question can be given to a group of students to research, write about, and report to the class). Students can also develop their own list of questions to research.
 - Where is the landfill that our school's garbage is taken to and how far away is it from the school?
 - How long has this landfill been in operation? Has a liner been installed?
 - What creeks and other bodies of water are found close to the landfill?
 - Where does our school (or community) get our drinking water? If it comes from a reservoir, are there any connections between the bodies of water near the landfill and the reservoir? If it comes from a well, can the groundwater under the landfill be connected to the groundwater from which our community gets water?
 - If there is no apparent connection between the landfill and our drinking water, what communities are close to the landfill? What type of problems might the landfill create for the nearby communities?
 - How long can this landfill be used? Are there plans for expansion?

- What if our drinking water gets contaminated by the leachate from a nearby landfill? (Students can write a narrative on what they perceive the problems and the solutions would be.)
- After all group presentations, students can be asked to write a research report about key ideas, issues, or situations that (1) frame questions to direct the investigation and establish a controlling idea/topic; and (2) develop the topic with simple facts, details, examples, and explanations.

Project Idea: If a landfill is located within the drainage area of your community, have students obtain samples of water from nearby creeks, streams, and reservoirs. They can test the water samples for various pollutants. Students can also go on a field trip and visually evaluate the stream or other bodies of water. They can observe how clear the water is, whether aquatic insects live there, and whether fish and other wildlife are present. This can indicate the health of the stream or reservoir. See the “Resources” section for curricular guides to help you with this project.

EXTENSIONS

- Assign students to search the archives of local media for stories about problems with a local landfill. Ask them to note the types of remediation used and the extent to which such measures were successful in alleviating the expressed problems.
- If possible, arrange to take students to see a local landfill or take slides of landfills to show the class.

RESOURCES

Videos

It All Adds Up (Waste/Pollution). The Outside Story with Slim Goodbody series. Produced by Agency for Instructional Technology (AIT) and the Slim Goodbody Company, 1991 (15 minutes).

Stresses the importance of dealing with waste responsibly and shows various ways in which humans dispose of waste. Encourages students to reduce, reuse, and recycle much of the waste they create.

Kids Talkin’ Trash. San Leandro, Calif.: Alameda County Waste Management Authority, 1995. Distributed by the California Integrated Waste

Management Board (14 minutes).

The first part of this video shows a landfill. In the rest of the video, students learn how to make less garbage and protect the environment by practicing the four R’s: reduce, reuse, recycle, rot.

Curricular Guides

Adopt-A-Watershed series. Hayfork, Calif.: Adopt-A-Watershed, various dates.

A series of activity guides on watersheds designed for various grade levels. Includes curricular guides on wildlife, plant life, geology, fish, and other topics. Includes books for each grade span (e.g., primary, intermediate, high school).

Project WET: Water Education for Teachers. Bozeman, Mont.: Watercourse; and Houston, Tex.: Western Regional Environmental Education Council, 1995.

Contains a variety of activities about water and aquatic systems.

Water Inspectors: Examining Water. Santa Barbara, Calif.: California Aquatic Science Education Consortium, nd.

Lessons include plans on how to make water measuring devices (e.g., Meyer Water Sampler, water density indicator) to test creek or lake water.

Sources of Topographical Maps

Maps can be purchased and a free copy of “Topographic Map Symbols” can be obtained from the Western Distribution Branch, U.S. Geological Survey, Box 25286, Federal Center Building 41, Denver, CO 80225. You will need to obtain a free copy of *California Catalog of Topography and Other Published Maps* to help you identify the map you need before ordering it from the U.S. Geological Survey.

DeLorme Mapping Co. *Northern California Atlas and Gazetteer* or *Southern California Atlas and Gazetteer*. Can be obtained from DeLorme Mapping Co., P.O. Box 298, Freeport, ME 04032.

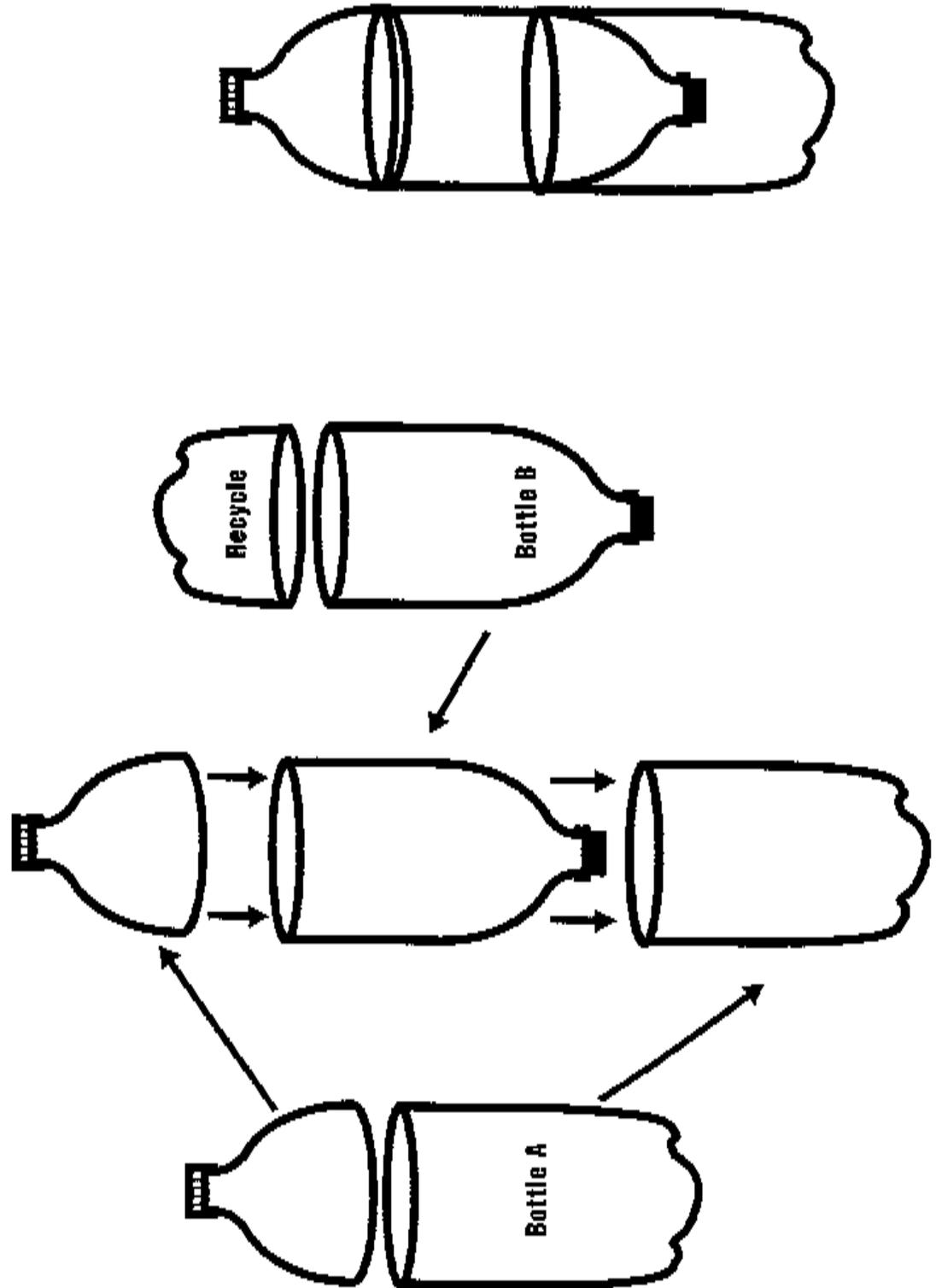
These contain topographical maps of the specified areas (northern California or southern California).

Many engineering supply stores or stationery stores sell topographical maps.

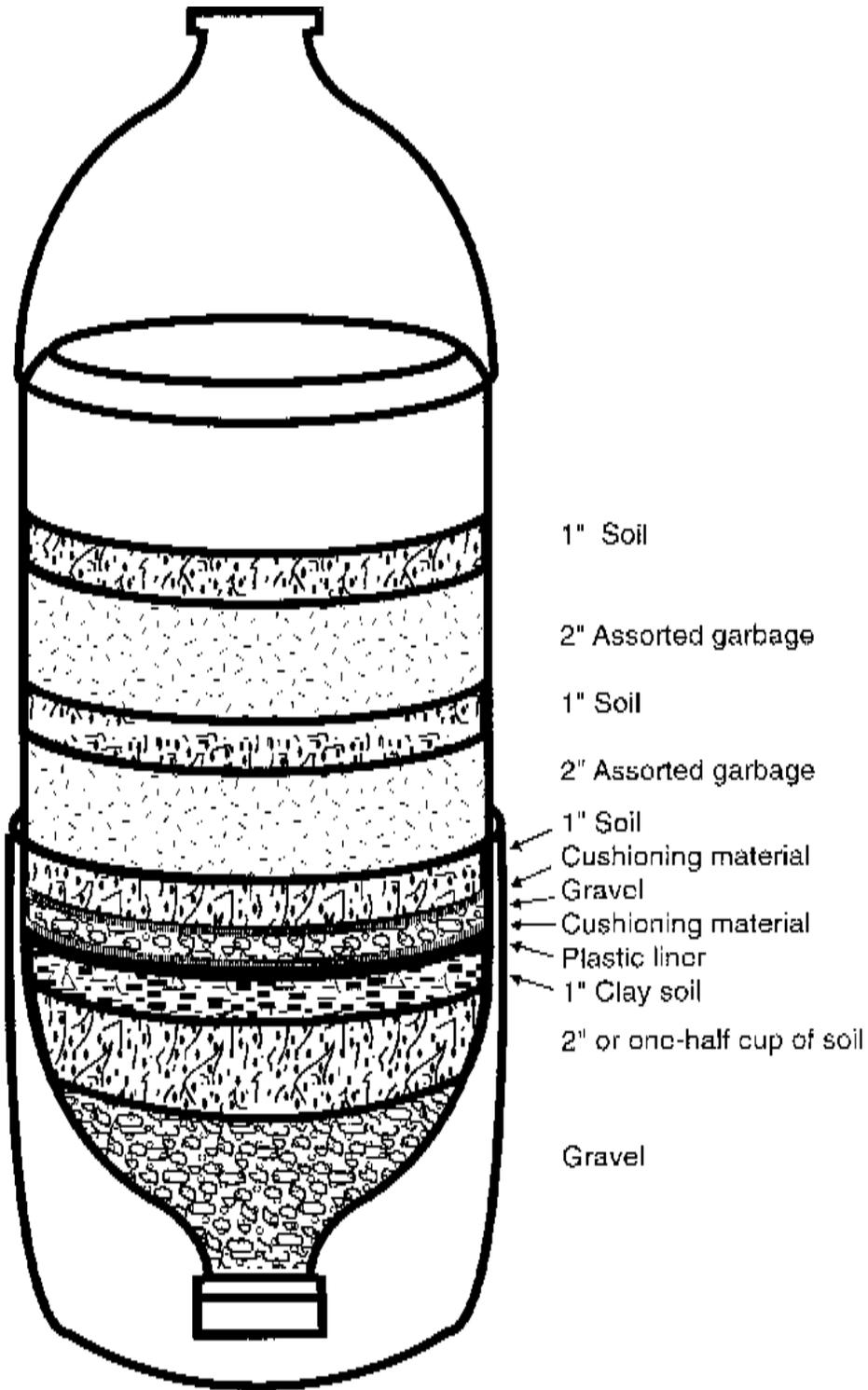
Websites

See “Appendix F–III, Landfill websites.”

CONSTRUCTION OF THE LANDFILL IN A BOTTLE



LAYERS IN A LANDFILL IN A BOTTLE



Names: _____

OUR PLAN FOR A DEMONSTRATION, USING OUR LANDFILL IN A BOTTLE

For safety reasons you will not be allowed to use any actual household hazardous wastes for this demonstration. Therefore, you will need to use safe alternatives that could still demonstrate what you want to show.

As a group, please answer the questions below:

1. Using a landfill in a bottle, what do you want to demonstrate that has to do with household hazardous wastes or with leachate?

2. How will you do this?

3. What materials will you need?

4. How long will it take to conduct the demonstration?

5. Get teacher approval.

Extra credit: Draw a picture of the setup of your demonstration. Make sure to label the parts.

THE SONG: LANDFILL IN A BOTTLE

(Sung to the Tune of "Time in a Bottle.")

If I could make a landfill in a bottle,
The first thing that I'd like to do
Is to keep any household hazardous waste
From being thrown in a landfill by you.

If I could protect the groundwater
By lining all landfills right now,
I'd gather all people who'd listen
And explain it to them, with a bow.

But there never seems to be enough money
For solid waste directors to do this;
They try to up the tipping fees,
But not one citizen ever sees
The wisdom . . .

If people recycled their used oil
And reduced their use of all things,
I'd show every one how much happiness
A healthy world with no pollution brings.

If people stopped dumping the wastes
That are hazardous into a dump site,
I'd say everyday till eternity passes away
What we're doing is right.



BACKGROUND INFORMATION FOR THE TEACHER

There are some people that indiscriminately throw household hazardous wastes, such as lead-based paint, used motor oil, nail polish remover, and oven cleaner, into the garbage. Most people do this without realizing the potential threat to garbage collectors or landfill workers who could come in contact with household hazardous waste in garbage. Nor do people understand the significant risk of groundwater contamination that household hazardous waste could pose if dumped in landfills with inadequate safety features, such as lack of plastic liners.

When a household hazardous product is ready to be discarded, it is called household hazardous waste. Note that in most cases, empty containers that contained household hazardous products are not considered hazardous waste if none of the product remains in the container. Whenever possible, household hazardous products should be used up. If not used up, they should be taken to a household hazardous waste collection center or to a collection event. It is illegal to dispose of household hazardous waste in any other way. (More information on this topic is provided in lessons 3 and 4.)

Household hazardous waste should not be placed in a garbage can to be dumped in a landfill because it could cause environmental problems, such as contaminating the groundwater. To learn how household hazardous waste can end up in groundwater, it is necessary to understand the route that water takes as it travels through the water cycle. When it rains, some water runs off into streams, rivers, lakes, and the ocean, and some water seeps down from the surface to the water table or aquifer. An aquifer is a layer of permeable rock, sand, or gravel, where groundwater collects. The water table is the top of the groundwater.

When it rains on a landfill, the passing water can pick up many of the components of our solid waste. Water which has percolated down through substances (such as garbage in a landfill), picking up chemicals or particles of matter as it seeps down, is called leachate. Some chemicals and particles dissolve in the water and move with the water. Hazardous wastes, such as used motor oil, paint products, cleaners, and batteries, all contain chemicals which can

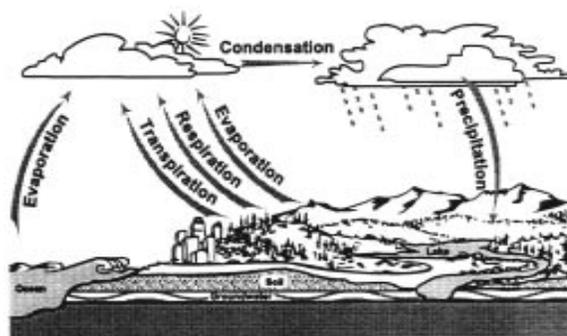
contaminate leachate. As other wastes decompose, additional hazardous substances may be produced and dissolve in leachate. Leachate can run off the landfill into streams and other surface waters. If leachate from a landfill seeps down into the ground and reaches the water table, it can contaminate groundwater. With over half of all Americans dependent on groundwater for their drinking water needs, contaminated groundwater constitutes a significant health problem.

Usually, groundwater contamination from landfills can be prevented through specific strategies and the use of technology. The first strategy is for consumers to reduce, as much as possible, the amount of waste they dispose of in landfills. This practice of waste prevention will conserve the natural resources that were used to make the product and also conserve landfill space. It will also postpone the need for creating additional landfills. Note that even discarded products that were not initially hazardous could combine to contaminate leachate.

The second strategy to prevent groundwater contamination is to prevent materials, such as household hazardous wastes, from entering the waste stream that goes to the landfill. People can make certain that they never throw away their household hazardous wastes in the trash. They can take their household hazardous wastes to a local household hazardous waste collection center. The waste materials will then be properly recycled or disposed of in a safe manner that protects against environmental damage. (This topic is explained in Lesson 4.)

Finally, groundwater can be protected through

The Water Cycle



the application of scientific and technological knowledge. For example, the geology of a potential landfill site is carefully analyzed. New landfills are not built on soils which easily transport water. Water can move easily through sand and gravel, but does not flow through silts and clays as easily. This is why a layer of clay soil is first applied to the entire landfill site before covering the site with a thick plastic liner. The clay and plastic liner are required in all new landfills and in the expansion of older landfills. The purpose of the plastic liner and clay soil is to keep leachate from reaching the groundwater. Often a geotextile cushion is placed above, and sometimes also below, the plastic liner, to protect the liner from being punctured.

Landfill operators must also install a leachate collection system to remove the liquid that gathers at the base of the landfill. The leachate is pumped through the pipes to a holding tank and then pumped out of the tank when it is full. It is then transported to a wastewater treatment plant or other waste processing facility.

Monitoring systems on landfills are set up to test the surrounding areas to make certain that preventative measures are working and that groundwater is not being contaminated. In addition, all landfill operators must conduct methane (natural gas) monitoring to ensure that gases given off by the decaying garbage do not become a health or environmental risk. (Note

that methane gas production is not addressed in this module.)

In response to growing discoveries about landfill issues, government officials are increasing measures to safeguard the public's health. Existing facilities are subject to inspection and the allocation of specific permits by local health departments or other regulatory agencies. Permits to operate and plans for closure of all landfills must be approved by the California Integrated Waste Management Board. Local enforcement agencies at the county level conduct frequent inspections, and inspections are conducted by California Integrated Waste Management Board every 18 months to ensure compliance with state laws and regulations.

Understanding the role landfills play in managing our solid wastes and their potential environmental impacts will enable us to use our natural resources more efficiently.

The focus of this lesson is on the contamination of groundwater, which can be caused by household hazardous waste placed in a landfill. For additional activities about landfills, see Lesson 2, "Away to the Landfill," in Unit 1 of the 4-6 Module.

For more information, see "Appendix B-IV, Landfill Issues," and "Appendix B-VI, Household Hazardous Wastes."



A geotextile cushion is placed on top of the plastic liner at the expansion site of the Eastlake Sanitary Landfill in Lake County.