

# Hazardous Waste: Cleanup and Prevention





Our lifestyles are supported by complex industrial activities that produce many different chemicals and chemical wastes. The industries that produce our clothing, cars, medicines, paper, food, fuels, steel, plastics, and electric components use and discard thousands of chemicals every year. At home we may use lawn chemicals, solvents, disinfectants, cleaners, and auto products to improve our quality of life. A chemical that presents a threat or unreasonable risk to people or the environment is a hazardous material. When a hazardous material can no longer be used, it becomes a hazardous waste. Hazardous wastes come from a variety of sources, from both present and past activities. Impacts to human health and the environment can result from improper handling and disposal of hazardous waste. Based on its characteristics, a substance is hazardous if it falls into one or more of the following categories:

**Corrosive** – capable of chemically wearing substances away (corroding) or destroying them. Corrosives can eat through metal, burn skin on contact, and give off vapors that burn eyes. For example, most acids are corrosive.

**Ignitable** – capable of bursting into flames. Ignitables pose a fire hazard and irritate the skin, eyes, and lungs. Gasoline, paint, and furniture polish are ignitable substances.

**Reactive** – capable, under normal conditions, of changing into something else in the presence of other chemicals. When this happens a reactive substance can explode or create some poisonous gases. For example, chlorine bleach and ammonia are reactive.

**Toxic** – poisonous to people and other organisms. Toxics can cause illness—ranging from severe headaches to cancer—and even death if swallowed or absorbed through the skin. Pesticides, weed killers, and many household cleaners are toxic.

Ideally, hazardous wastes are reused or recycled by a manufacturer, or properly stored, transported, and disposed of to prevent their release into the environment. However, this is not always the case. Storage tanks and barrels can catch fire or leak. Spills can occur at a factory or during transportation. The most technically advanced landfill or storage lagoon can leak. Once hazardous wastes are released, they can be moved by wind, water, or gravity. The cleanup of hazardous wastes can become more difficult the farther the waste moves from the source of contamination. Protecting people and the environment by identifying and cleaning the Nation's most serious hazardous waste sites is the major goal of the U.S. Environmental Protection Agency's Superfund program.

This poster displays various hazardous waste sites and different types of cleanup, methods (labeled in red) used on these sites. Also displayed is how hazardous waste moves once it is released in the environment. The poster is folded into 8.5" x 11" panels; the front and back sides can easily be photocopied.

## ACTIVITY

### Movement of Hazardous Wastes

#### Introduction

A hazardous waste enters the environment when the substance goes from a controlled condition—inside a truck, barrel, storage tank, landfill—to an uncontrolled condition in the air, water, or land. Once hazardous wastes are released, they can move about under the influences of water, wind, and gravity. Dissolved and liquid hazardous wastes can occur in precipitation, runoff, or surface water (rivers, streams, lakes, or ponds) and can be moved down through the soil to ground water. Contaminated ground water also can move into lakes, streams, or rivers. The following activity demonstrates the movement of contaminants from the land to ground water and surface water. This activity also demonstrates the difficulty in cleaning up the contamination.

#### Objectives

Students will:

1. Observe how a contaminant moves from land to water and between surface and ground water; and
2. Experience the difficulty of cleaning up contaminated water.

#### Materials

Each group will need:

1. One 266-mL clear plastic cup;
2. Sufficient clean pea-size gravel to fill the 266-mL clear plastic cup 3/4 full;
3. Three 240-mL paper cups;
4. One pump dispenser from liquid-soap or hand-lotion containers;
5. 3.8 liters of water; and
6. One bottle of food coloring.

#### Teacher Preparation

1. This activity is designed for students to work in groups of three.
2. Display a copy of the poster titled "Hazardous Waste: Cleanup and Prevention" on the classroom wall several days prior to conducting this activity.
3. Fill a clear plastic cup 3/4 full of clean pea-size gravel for each group.
4. Using an ice pick or awl, punch 8-10 small holes in the bottom of one of the paper cups for each group. When filled with water, this cup will be used to simulate rain.
5. Fill one paper cup (without holes) 3/4 full of water for each group.

#### Procedure

1. Divide the class into groups of three. Provide each group with one clear plastic cup 3/4 full of pea-size gravel, one paper cup with holes in the bottom, one paper cup with no holes, one paper cup 3/4 full of water, and one pump dispenser.
2. Instruct students to hold the paper cup with holes in the bottom over the cup containing the pea-size gravel then pour enough water into the cup with the holes until all but the top one centimeter of the pea-size gravel is saturated.
3. Instruct students to dig a hole in the center of the gravel until they have created a lake. The lake should be about 1/4 full of water. Have students observe the connection between the level of water in the lake, and how it corresponds to the level of water in the gravel.
4. Add two drops of food coloring to the pea-size gravel surrounding the lake. The food coloring represents contamination from improper disposal of chemicals. Have students hold the paper cup with holes in the bottom over the cup containing the pea-size gravel at the location where the food coloring was added, then pour a small amount of water into the paper cup with holes in the bottom and observe what happens to the contaminant. If necessary, students can add more water until the contaminant appears in the lake.
5. Have students place the pump dispenser in the gravel down to the water level on the opposite side of the lake from where the contaminant was placed. Pump water into the paper cup with no holes. Observe the color of the water in the cup. Continue to pump water until the color of the water being pumped changes to the color of the contaminant.
6. Have students add small amounts of clean water to their model lakes while pumping. Students should continue to add clean water and pump out contaminated water until the water becomes clear. This will require pumping the pump dispenser several hundred times.

#### Interpretive Questions

1. Where did the contaminant pumped from the ground water come from?

Answer: From the spill located on the opposite side of the lake.

2. How was the contaminant transported?

Answer: By water

3. Were both the lake and the ground water impacted by the contaminant?

Answer: Yes

4. Was it easy to clean up the contaminated water?

Answer: No. It took a lot of water and pumping to remove the contamination.

5. What would happen if the water was not cleaned?

Answer: Drinking water might become contaminated, animals that live in or drink the water in the lake might become ill.

## ACTIVITY

### Hazardous Waste -- Sources to Disposal

#### Introduction

Hazardous materials are chemicals that can have harmful effects on our health or the health of plants and animals. When a hazardous material can no longer be used, it becomes a hazardous waste. Hazardous wastes come from a variety of sources. The largest quantities of hazardous wastes occur as by-products of manufacturing processes. Hazardous wastes can be produced by some service industries. Our household garbage also can include hazardous wastes. Ideally, these wastes are reused or recycled. The following activity is designed to provide students with an opportunity to learn where hazardous wastes are located in their community and where they are disposed.

#### Objectives

Students will:

1. Identify some of the sources of hazardous waste in their communities; and
2. Identify, if available, approved disposal areas for the hazardous wastes.

#### Materials

1. A map of the local community. This can be either a county or city map but should include the location of the school.
2. Four colored markers (blue, red, yellow, green).
3. Paper and pencil.
4. Poster titled "Hazardous Waste: Cleanup and Prevention."

#### Teacher Preparation

1. Contact the local county or city government and inquire about the locations of the landfill(s), location of any recycling centers, and how and where local industries and individuals dispose of their hazardous wastes. Ask what materials the recycling centers and landfill accept. Determine the population of your community.
2. Prior to initiating this activity, display the community map and a copy of the poster titled "Hazardous Waste: Cleanup and Prevention" in the classroom where students can see it.

#### Procedure

1. Begin a class discussion about the use of chemicals in your community. This should include those produced by local industry and those used by individuals. Inform students that they are going to identify the producers, consumers, and disposal location of these chemicals. Circle the location of the school on the map in blue. As a group, have the students identify and locate on the map sources of hazardous waste in their community. Possible answers include: gasoline

stations, auto repair/paint shops, dry cleaners, hospitals, medical laboratories, garden supply stores, farms, fast food restaurants, large factories, and petroleum refineries. Locate these sources on the map in red. Discuss how these possible sources dispose of their hazardous wastes. Locate where the waste is disposed of in yellow (landfill, incinerators, storage area, recycling centers). Trace the most direct route of transportation in green between the sources of hazardous waste and the location of the waste disposal site(s).

2. Select one of the students as a notekeeper. As a group, have the students identify 10 potentially hazardous materials they or their families use around the house. The notekeeper should write the answers on the chalkboard or on a flip chart. Possible answers include: motor oil, gas, antifreeze, rug cleaners, floor polish, paints, stains, oven cleaner, pesticides, weed killers, and disinfectants. Have students copy this list and take it home. With their parents, have each student determine the quantities of these materials currently available in their homes. Caution the students not to handle the hazardous materials but only to inventory what is in the house.

#### Interpretive Questions

1. Discuss the transportation and disposal of hazardous wastes produced in the community. Are hazardous wastes transported past the school? Are waste disposal areas able to safely handle your community's hazardous waste? What could be done to reduce the risk of exposure to hazardous wastes in your community? What could be done to reduce the amount of business and household hazardous waste in your community?
2. What can you do? Possible Answers: Have a hazardous waste awareness day. Encourage your parents, relatives, and school to participate in your community's hazardous waste recycling program. If your community does not have a recycling center for hazardous wastes, write to local county officials and ask why. Always follow labeled instructions when using hazardous materials and dispose of waste in an environmentally safe way. Find out what companies in your area are doing to prevent hazardous waste problems.

#### DEFINITIONS

<b>Aquifer</b>	- An underground body of porous sand, gravel, or fractured rock filled with water and capable of supplying useful quantities of water to a well or a spring.
<b>Contamination Ground Water</b>	- The introduction of harmful or hazardous matter into the environment. - Water beneath the land surface that moves through porous or fractured rocks and soils.
<b>Hazardous Materials</b>	- Chemicals that are corrosive, ignitable, toxic, or reactive, that present a threat or unreasonable risk to people or the environment.
<b>Hazardous Waste Storage Lagoon Monitoring Well</b>	- A hazardous material that can no longer be used. - A small pond used for storage of liquid wastes. - A well used for the purpose of sampling the quality and determining the direction of flow of ground water.
<b>Precipitation Superfund</b>	- Rain, snow, sleet, mist, or hail. - The Federal law passed in 1980 to investigate and clean up the Nation's most serious abandoned and uncontrolled hazardous waste sites. It is administered by the U.S. Environmental Protection Agency in cooperation with State and Tribal governments.
<b>Water Table Well</b>	- The top of the water surface within an aquifer. - An opening drilled or dug into an aquifer that is deep enough to go below the water surface.

## Poster Series

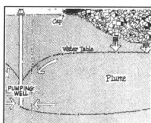
This poster is part of a series of water-resources education posters developed through the U.S. Geological Survey's Water Resources Education Initiative, a cooperative effort between public and private education interests. Partners in the program include the U.S. Geological Survey, Bureau of Reclamation, and the U.S. Fish and Wildlife Service of the U.S. Department of the Interior; the National Oceanic and Atmospheric Administration; the U.S. Environmental Protection Agency; the U.S. Army Corps of Engineers; the Nebraska Groundwater Foundation; and the National Science Teachers Association.

The other posters in the series are entitled "Oceans--Coastal Hazards: Hurricanes, Tsunamis, Coastal Erosion", "Watersheds: Where We Live", "Wetlands: Water, Wildlife, Plants, & People!", "Water: The Resource That Gets Used & Used & Used for Everything!", "How Do We Treat Our Wastewater?", "Navigation: Traveling the Water Highways!", "Ground Water: The Hidden Resource!", and "Water Quality...Potential Sources of Pollution". The posters in the series are designed to be joined to create a large wall mural. A schematic of the wall mural is displayed on this panel. The gray shaded spaces represent the posters listed above. The black shaded space represents this poster.

OCEANS	WATERSHEDS	HAZARDOUS WASTE
WETLANDS	WATER USE	WASTEWATER TREATMENT
NAVIGATION	GROUND WATER	WATER QUALITY

Water-resources topics of the posters are drawn in a cartoon format by the same artist. All poster are available in color. The reverse sides of the color posters contain educational activities: one version for children in grades 3-5 and the other for children in grades 6-8.

## Movement



Hazardous wastes released on the land surface can move downward through the ground and into ground water by the force of gravity. Once the wastes are in contact with the ground water, dissolved chemicals move with the water, potentially impacting wells used for drinking water or irrigation. If the wastes are water soluble, they can mix throughout the entire ground-water system. If the wastes are not soluble, they can float on or sink in the ground water.



Hazardous wastes can be released into the air and moved to other locations by wind. Once the wastes are dispersed, they can be breathed by humans and animals. These wastes also can be removed from the air by precipitation and deposited on land or water surfaces where they become available to plants and animals.

## Cleaning Up Hazardous Wastes

Before any cleanup takes place at a hazardous waste site, the soil, water, and air are tested to determine what hazardous substances are present and how serious the risk may be to human health and the environment. The type of method used to clean up the waste depends upon the result of the evaluation process. The steps in the cleanup process are: site discovery, assessment, selection of cleanup methods, cleanup, and maintenance.

## Response to Emergency



Sometimes hazardous wastes pose an immediate threat to people and the environment. These situations require an emergency response. An example is a truck carrying hazardous waste turning over and spilling the chemicals on the road. Once the immediate danger is dealt with, the site is evaluated to determine if additional cleanup is necessary.

## Area Cleanup



When the threat to human health or the environment is not immediate but could occur in the near future, different methods are used to control and clean up the hazardous waste. Sometimes the waste can be cleaned up in a few days, or it might take several years. Cleanup methods are designed to prevent direct human contact with the contaminants from the site, remove the hazardous waste from the site, and prevent contaminants from spreading off the site. For example, leaking barrels full of hazardous wastes could be removed from the area, and the soil could be treated. In certain situations, monitoring wells are installed for the purpose of determining the quality and movement of hazardous waste in ground water.

## Containing and Treating



Some hazardous waste sites have been created by years of contamination and require years, even decades, to clean up—such as a leaking landfill containing hazardous wastes. Cleanup can include treating the contaminated ground water and capping the waste materials to prevent additional water from moving hazardous wastes off site.

## ORDERING INFORMATION

Copies of all the posters in the series (see Poster Series Panel) can be obtained at no cost from the U.S. Geological Survey. Write to the address below and specify the poster title(s) listed on the Poster Series panel, and grade level(s) desired. The poster "Water: The Resource That Gets Used & Used & Used for Everything!" is also available in black-and-white, intended for coloring by children in grades K-2. In addition, the poster "Water: The Resource That Gets Used & Used & Used for Everything!" with activities intended for grades 3-5 is available in Spanish. There is a minimum shipping charge of \$20.00 or actual cost if greater and \$3.50 handling charge (total \$23.50 in U.S. dollars) applying to ALL orders shipped to locations that are not a U.S. State or Territory.

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## ACKNOWLEDGMENTS

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## U.S. ENVIRONMENTAL PROTECTION AGENCY

The mission of the U.S. Environmental Protection Agency (EPA) is to improve and preserve the quality of the environment, nationally and globally. The EPA works to protect human health and the natural resources on which all human activity depends. In response to growing public concern over health and environmental risks posed by hazardous waste sites, Congress established the Superfund program in 1980 to clean up these sites. The EPA, in cooperation with States and Tribal governments, locates, investigates, and cleans up hazardous waste sites throughout the United States. Superfund's main goal is to protect human health and the environment. It is funded mainly by taxes placed on the chemical and petroleum industries.

## U.S. GEOLOGICAL SURVEY

As the Nation's largest water, earth, and biological science and civilian mapping agency, the USGS works in cooperation with more than 2,000 organizations across the country to provide reliable, impartial, scientific information to resource managers, planners, and other customers. This information is gathered in every state by USGS scientists to minimize the loss of life and property from natural disasters, to contribute to the conservation and the sound economic and physical development of the Nation's natural resources, and to enhance the quality of life by monitoring water, biological, energy, and mineral resources.

U.S. Department of the Interior  
U.S. Geological Survey

MIDDLE SCHOOL