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Objectives

- **Name** one characteristic that makes a material biodegradable.
- **Identify** two types of solid waste.
- **Describe** how a modern landfill works
- **Name** two environmental problems caused by landfills.





The Generation of Waste

- **Solid waste** is any discarded solid material, such as garbage, refuse, or sludges.
- Solid waste includes everything from junk mail to coffee grounds to cars.
- Every year, the United States generates more than 10 billion metric tons of solid waste.





The Generation of Waste

- Many products we buy today are used once and then thrown away.
- As a result, the amount of solid waste each American produces each year has more than doubled since the 1960s





Space and Waste

- Many towns are running out of space to dispose of the amounts of waste that people create.
- In 1987, a barge was loaded with 3,200 tons of garbage and left the town of Islip, New York, in search of a place to unload its waste.
- The barge sailed for more than five months but no one would accept the garbage.





Space and Waste

- The garbage was finally burned in New York, and the 430 tons of ash sent to Islip to be buried.





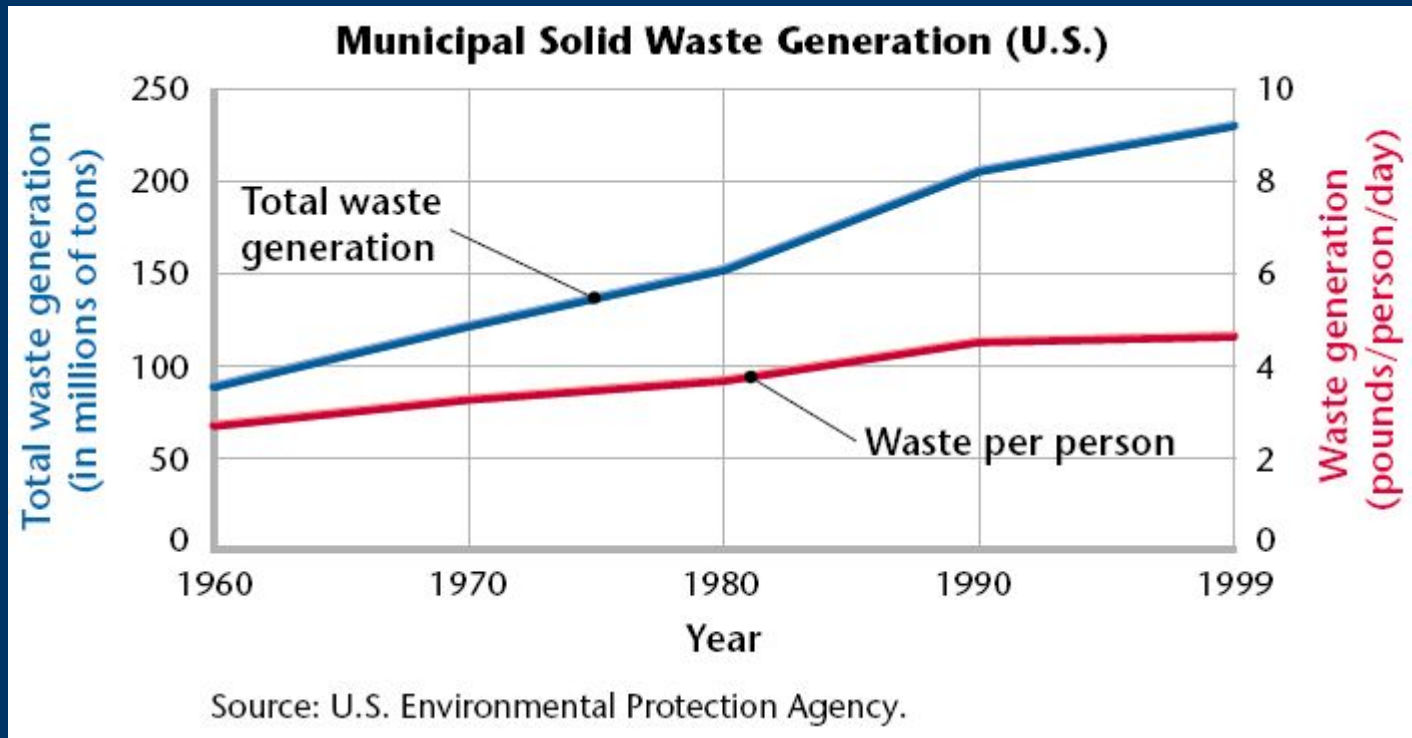
Population and Waste

- It is getting harder to dispose of the waste we create because the human population continues to grow, while available land decreases.
- Today, the average person living in the United States produces 4.4 pounds of solid waste per day.





Population and Waste





Not All Wastes Are Equal

- Wastes are made from two basic materials:
 - biodegradable materials
 - nonbiodegradable materials.
- A **biodegradable material** is a material that can be broken down by biological processes.
- **Nonbiodegradable** material cannot be broken down by biological processes.





Not All Wastes Are Equal

- Plant and animal matter are biodegradable.
- Products made from natural materials, including newspapers, paper bags, cotton fibers, and leather, are usually biodegradable.
- Synthetic compounds are not biodegradable.
- Materials like polyester, nylon, and plastic are nonbiodegradable.





Plastic Problems

- Plastics are made from petroleum or natural gas, which consist mostly of carbon and hydrogen.
- Plastics combine these elements in molecular chains that are not found in nature.
- Microorganisms have not developed ways to break down the molecular structures of most plastics.
- Therefore, some plastics that we throw away may accumulate and last for hundreds of years.





Municipal Solid Waste

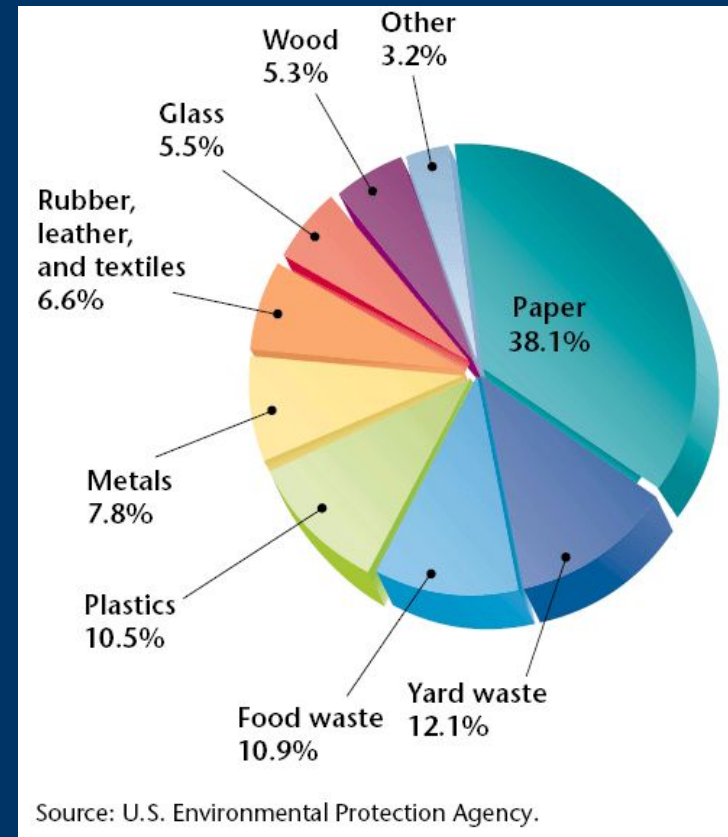
- **Municipal solid waste** is the waste produced by households and businesses.
- Most of what we throw out on a day-to-day basis is called municipal solid waste.
- The amount of municipal solid waste is growing much faster than the amount of mining or agricultural waste.





Municipal Solid Waste

- Municipal solid waste creates more than 210 million metric tons each year of solid waste. And this is only 2 percent of the total solid waste in the United States.



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Solid Waste from Manufacturing, Mining, and Agriculture

- Consumers indirectly create manufacturing waste by purchasing products that have been manufactured.
- Mining wastes include rock and minerals that are left exposed in large heaps, dumped in oceans and rivers, or disposed by refilling and landscaping abandoned mines.





Solid Waste from Manufacturing, Mining, and Agriculture

- Agricultural waste makes up 9% of the total solid waste but is biodegradable.
- The increased use of fertilizers and pesticides may cause agricultural waste to become more difficult to dispose of because the waste may be harmful if returned to the soil.





Landfills

- A **landfill** is an area of land or an excavation where wastes are placed for permanent disposal.
- More than 50% of the municipal and manufacturing solid waste in the United States ends up in landfills.

Where Waste in the United States Goes	
Waste-disposal method	Percentage of waste by weight
Stored in landfills	57
Recycled	28
Incinerated	15





Landfills

- Landfills must contain the waste that is buried inside and keep it from causing problems with the environment.
- Waste inside a landfill must not come into contact with the soil and groundwater surrounding the landfill.
- Landfills are maintained by covering wastes each day with a layer of soil, plastic, or both.





Problems with Landfills

- **Leachate** is a liquid that has passed through solid waste and has extracted dissolved or suspended materials from waste, such as pesticides in the soil.
- Leachate is a problem for landfills because it may contain chemicals from paints, pesticides, cleansers, cans, batteries, and appliances.
- If landfills are not monitored properly, leachate can flow into groundwater supplies and make nearby wells unsafe to drink.





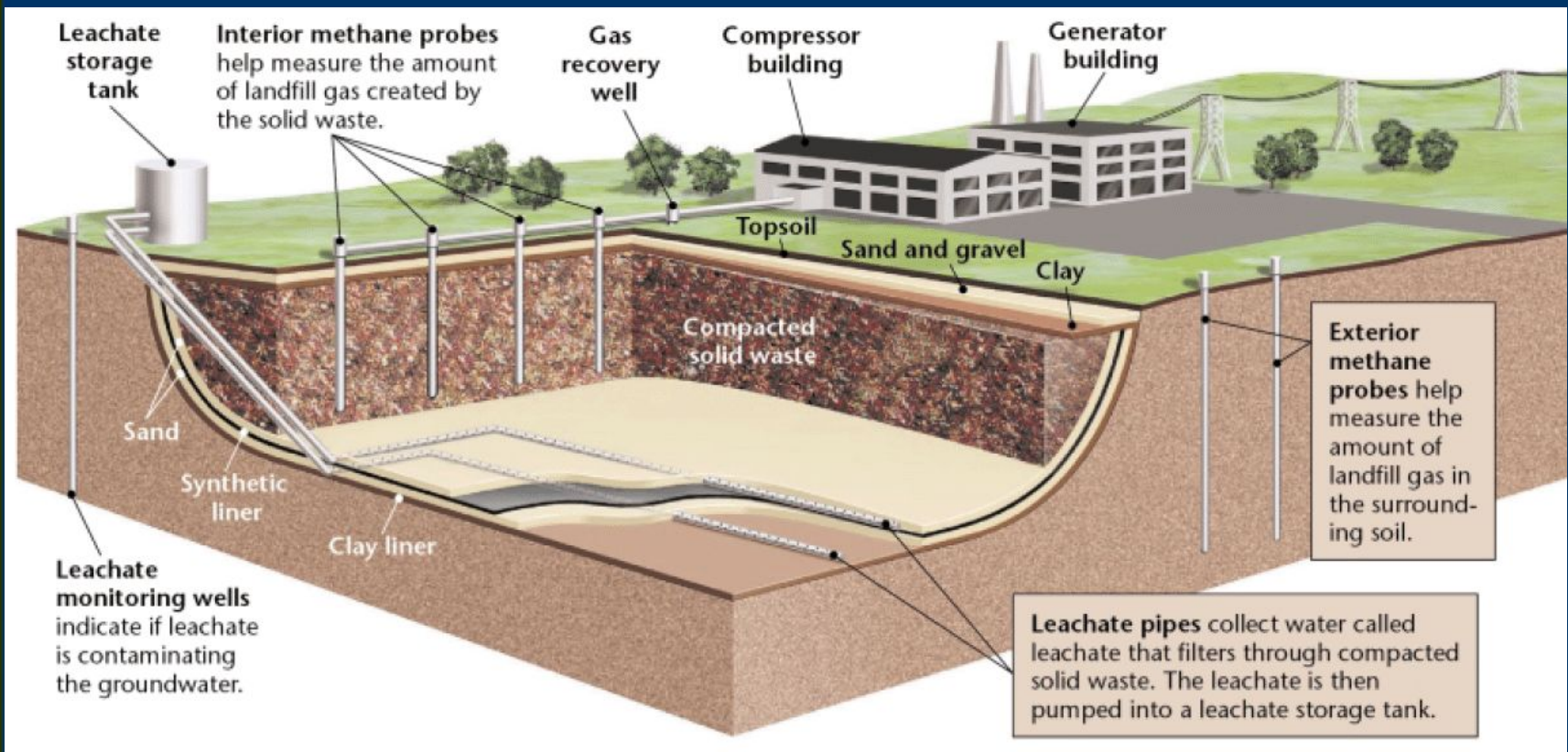
Problems with Landfills

- Methane, a highly flammable gas, presents another problem for landfills.
- Methane forms as organic wastes decompose deep in the landfill where there is no oxygen.
- Methane gas can be pumped out of landfills and burned to generate electricity.
- If methane gas production is not monitored safely, it may seep through the ground and into basements of nearby homes and cause explosions.





Parts of a Modern Landfill





Safeguarding Landfills

- The Resource Conservation and Recovery Act, passed in 1976 and updated in 1984, requires that new landfills be built with safeguards to reduce pollution problems.
- New landfills must be lined with clay and a plastic liner and must have systems for collecting and treating leachate, as well as vents to carry methane out of the landfill.
- Adding safeguards to landfills, however, increases the cost of building them. Also, finding acceptable places to build landfills is difficult.





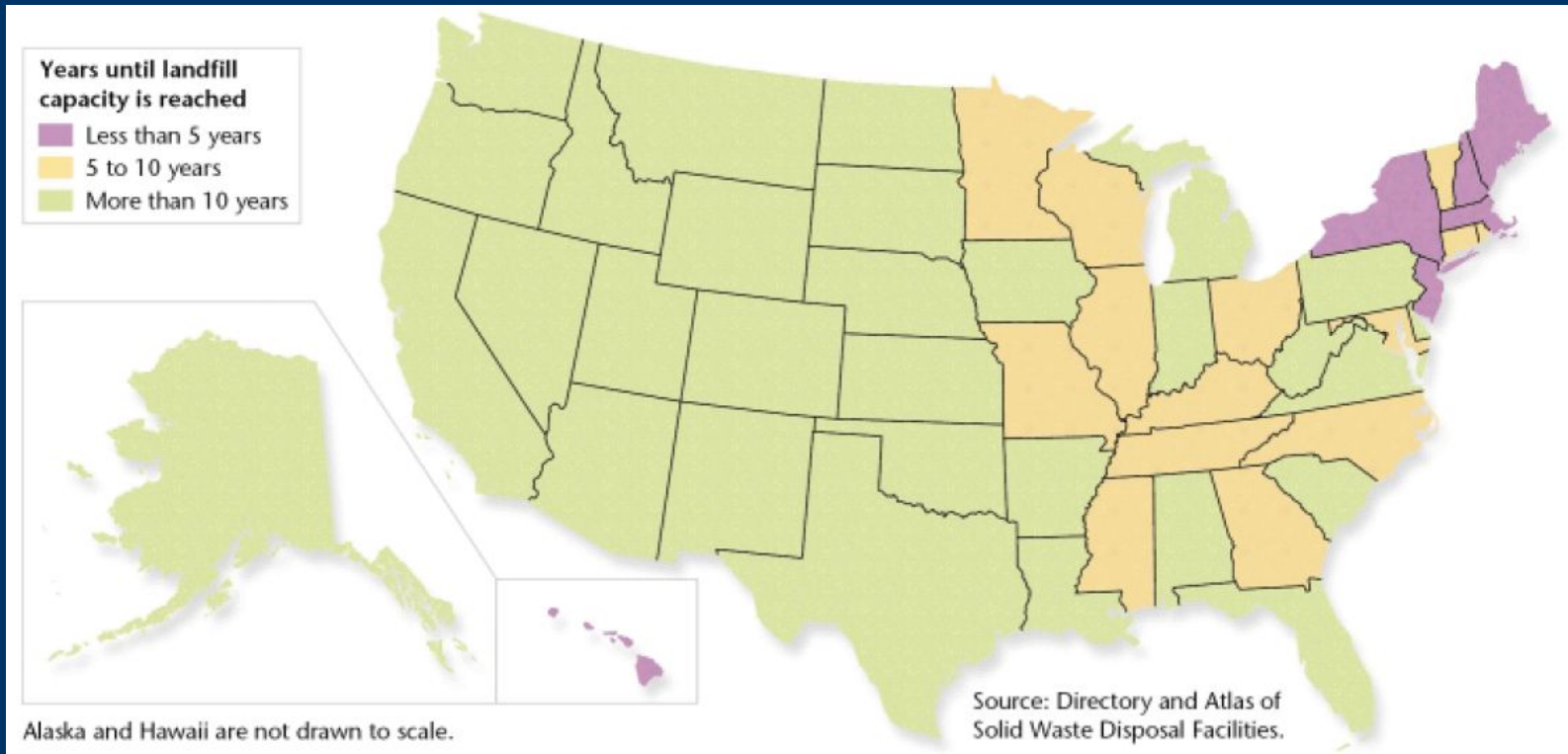
Building More Landfills

- We are currently running out of space that we are willing to develop for new landfills.
- The materials we bury in landfills are not decomposing as fast as we can fill landfills. Even biodegradable materials, like newspapers, take several years to decompose.
- The total number of active landfills in the United States in 1988 was 8,000. By 1999, the total number of active landfills decreased to 2,300 because many of the landfills had been filled to capacity.





Building More Landfills



The EPA estimates that active landfills in 20 states will be filled to capacity within 20 years.



Incinerators

- In 1999, the U.S. had 102 operational incinerators that were capable of burning up to 94,000 metric tons of municipal solid waste per day.
- Incinerators are one option for reducing the amount of solid waste in landfills.
- Incinerated materials do not disappear, but the weight of solid waste is reduced.





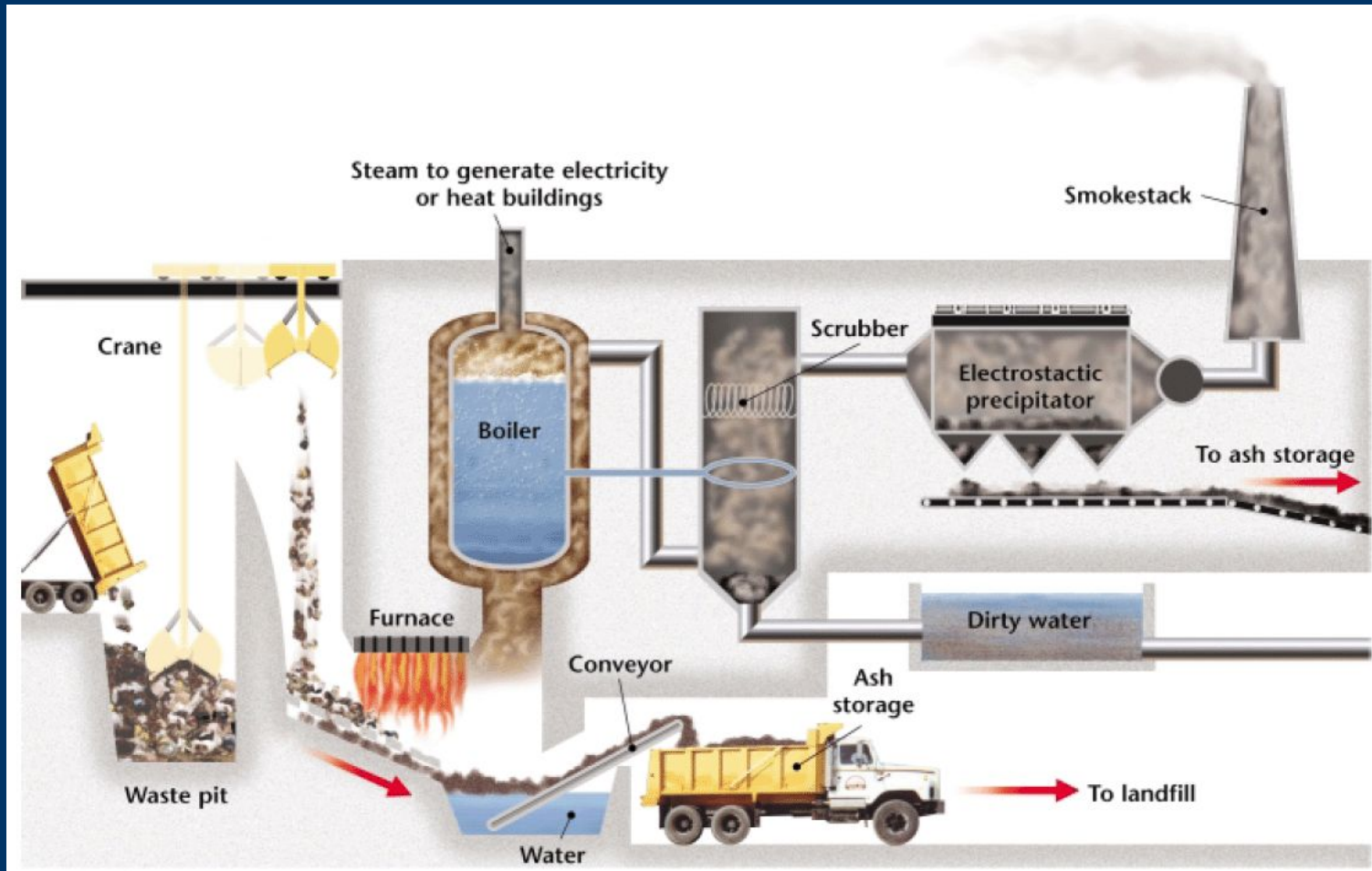
Incinerators

- Incinerated materials can be more toxic than before it was incinerated.
- Special air pollution control devices help control the amount of toxins released into the air.
- However, even incinerators with these special air pollution control devices release small amounts of poisonous gases and particles of toxic heavy metals into the air.





Incinerators





Objectives

- **Identify** three ways you can produce less waste.
- **Describe** how you can use your consumer buying power to reduce solid waste.
- **List** the steps that an item must go through to be recycled.
- **List** two benefits of composting.
- **Name** one advantage and one disadvantage to producing degradable plastic.





Reducing Solid Waste

- **Source reduction** is any change in the design, manufacture, purchase, or use of materials or products to reduce their amount of toxicity before they become municipal solid waste.
- Source reduction also includes the reuse of products or materials.
- If we produce less waste, we will reduce the expense and difficulty of collecting and disposing of it.





Buying Less and Lasting Longer

- Consumers can influence manufacturers to reduce solid waste by buying products that have less packaging or that can be used more than once.
- For example, you could purchase dish towels instead of paper towels.
- Manufacturers could also reduce waste and conserve resources by redesigning products to use less material and to last longer.





Recycling

- **Recycling** is the process of recovering valuable or useful materials from waste or scrap. Recycling also refers to the process of reusing some items.
- Making products from recycled materials usually saves energy, water, and other resources. For example, 95% less energy is needed to produce aluminum from recycled aluminum than from ore.
- About 70% less energy is needed to make paper from recycled paper than from trees.





Recycling: A Series of Steps

- The steps of recycling include:
 - collecting and sorting discarded materials by type
 - taking the materials to a recycling facility
 - cleaning the discarded materials so that they can be shredded or crushed
 - reusing the shredded or crushed material to manufacture new products
 - selling the new products to consumers





Recycling: A Series of Steps

- If more people purchase products made from recycled materials, there would be an increase in demand for these products.
- Manufacturers would then build more facilities to make recycled products and, in turn, make it easier for communities to recycle.





Composting

- **Compost** is a mixture of decomposing organic matter, such as manure and rotting plants, that is used as fertilizer and soil conditioner.
- Compost provides several benefits.

Benefits of Composting

- keeps organic wastes out of landfills
- provides nutrients to the soil
- increases beneficial soil organisms, such as worms and centipedes
- suppresses some plant diseases
- reduces the need for fertilizers and pesticides
- protects soil from erosion





Composting

- Yard waste often makes up more than 15% of a community's solid waste.
- Composting can be an effective way of handling biodegradable waste from businesses and homes.
- If all biodegradable wastes were composted, the amount of solid waste going to landfills could be reduced.





Changing the Materials We Use

- Simply changing the materials we use could eliminate much of the solid waste we produce.
- Recycling other common household products into new, useable products could also help eliminate solid waste.
- For example, plastic beverage containers can be recycled to make nonfood containers, insulation, carpet yarn, textiles, fiberfill, and more.





Degradable Plastics

- **Photodegradable plastic**, unlike nonbiodegradable plastics, is made to become weak and brittle when left in the sun for many weeks. Eventually, it breaks into pieces.
- **Green plastic**, is made by blending the sugars in plants with a special chemical agent to make plastics.





Degradable Plastics

- The production of green plastics requires 20 to 50% less fossil fuel.
- This plastic has also been engineered to degrade within 45 days of being thrown away.
- When green plastic is buried, the bacteria in the soil eat the sugars and leave the plastic weakened and full of microscopic holes.
- The chemical agent then gradually causes the long plastic molecules to break into shorter molecules.





Problems with Degradable Plastics

- The main problem with degradable plastics is that the plastic parts are only reduced to smaller pieces, not eliminated.
- Degradable plastics can help reduce the harmful effects that plastic litter has on animals in the environment.
- Although this type of plastic can help reduce the harmful effects of plastic litter, the plastic itself will remain just as long as regular plastics.





Objectives

- **Name** two characteristics of hazardous waste.
- **Describe** how one law that governs hazardous waste.
- **Describe** two ways in which hazardous waste is disposed.





Types of Hazardous Waste

- **Hazardous wastes** are wastes that are a risk to the health of humans or other living organisms.
- They may be solids, liquids, or gases. They often contain toxic, corrosive, or explosive materials.
- Some examples are
 - dyes,
 - cleansers,
 - solvents,
 - plastics,
 - and pesticides.





Types of Hazardous Waste

Types of Hazardous Waste

- dyes, cleansers, and solvents
- PCBs (polychlorinated biphenyls) from older electrical equipment, such as heating systems and television sets
- plastics, solvents, lubricants, and sealants
- toxic heavy metals, such as lead, mercury, cadmium, and zinc
- pesticides
- radioactive wastes from spent fuel that was used to generate electricity



Types of Hazardous Waste

- The methods used to dispose of hazardous wastes often are not as carefully planned as the manufacturing processes that produce them.
- An improperly maintained hazardous waste disposal site can leak toxic waste into the air, soil, and ground water.
- Federal laws were passed to clean up old waste sites and regulate future waste disposal.





Resource Conservation and Recovery Act

- The Resource Conservation and Recovery Act (RCRA) requires producers of hazardous waste to keep records of how their wastes are handled.
- The RCRA also requires all hazardous waste treatment and disposal facilities to be built and operated according to standards that are designed to prevent the facilities from polluting the environment.





The Superfund Act

- In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act, more commonly known as the Superfund Act.
- This act gives the EPA the right to sue the owners of hazardous waste sites who had illegally dumped waste.
- It also allows the EPA to force the owners to pay for the cleanup.





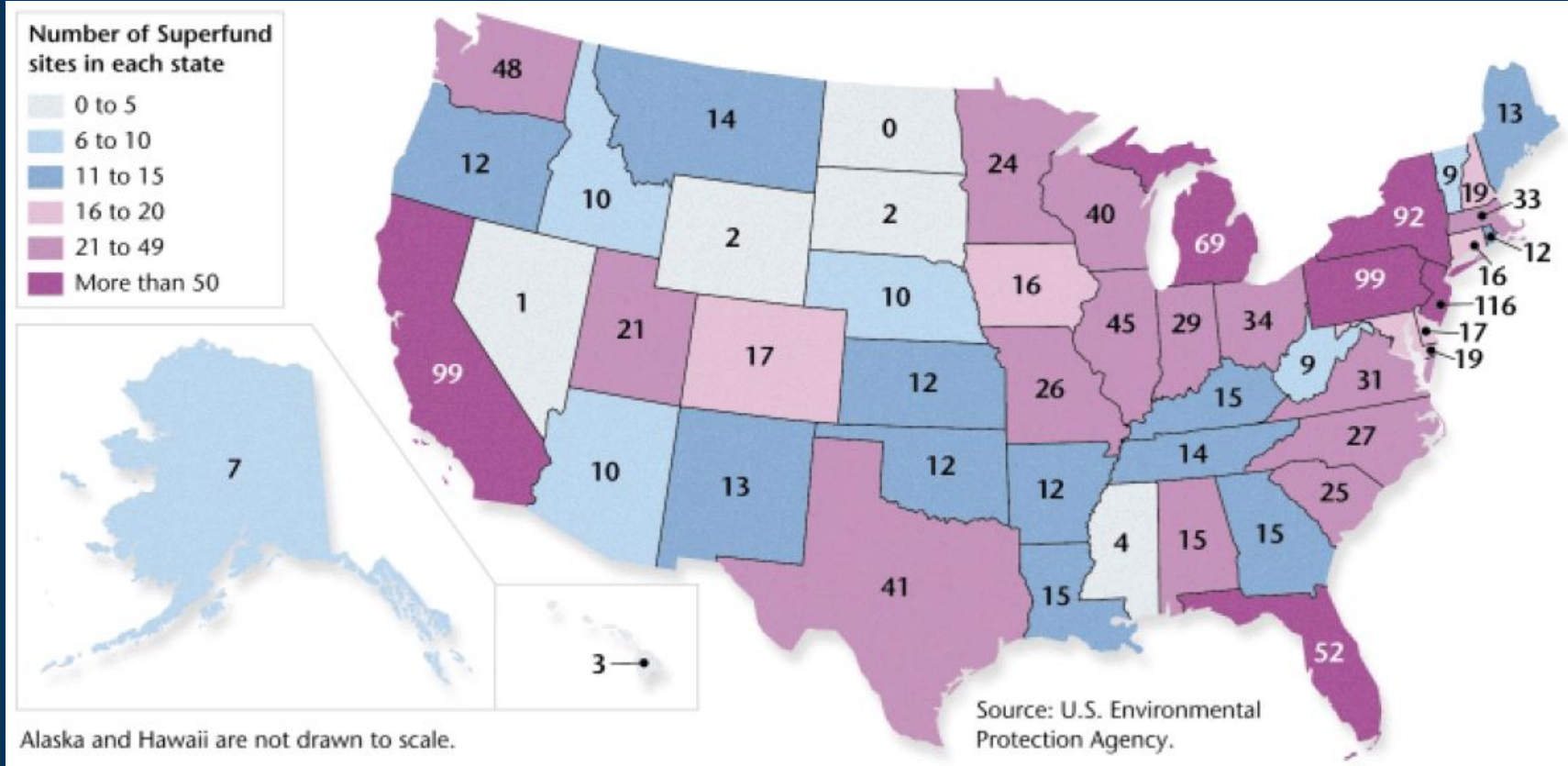
The Superfund Act

- Cleaning up improperly discarded waste is difficult and extremely expensive.
- The act also created a fund of money to pay for cleaning up abandoned hazardous waste sites.
- Cleanup has been completed at only 75 of the roughly 1,200 approved or proposed Superfund sites.





The Superfund Act





Preventing Hazardous Waste

- One way to prevent hazardous waste is to produce less of it.
- For example, manufacturers discovered they can redesign manufacturing methods to produce less or no hazardous waste.
- Such techniques save the manufacturers money by cutting the cost of materials as well as in cutting the cost of waste disposal.





Preventing Hazardous Waste

- Another way to prevent hazardous waste is to find a way to reuse it.
- For example, a company that would usually throw away a cleaning solvent after one use can instead sell it to another company that produces a product that is not harmed by small amounts of contamination in the solvent.





Conversion into Nonhazardous Substances

- Some types of wastes can be treated with chemicals to make them less hazardous.
- For example, cyanides, which are extremely poisonous compounds, can be combined with oxygen to form carbon dioxide and nitrogen.
- Wastes can also be treated biologically.
- Sludge from petroleum refineries, for example, may be converted by soil bacteria into less harmful substances.





Land Disposal

- Most of the hazardous waste produced in the United States is disposed of on land.
- Hazardous wastes in concentrated or solid forms are often put in barrels and buried in special landfills.
- These landfills have extra safety precautions to prevent leakage.





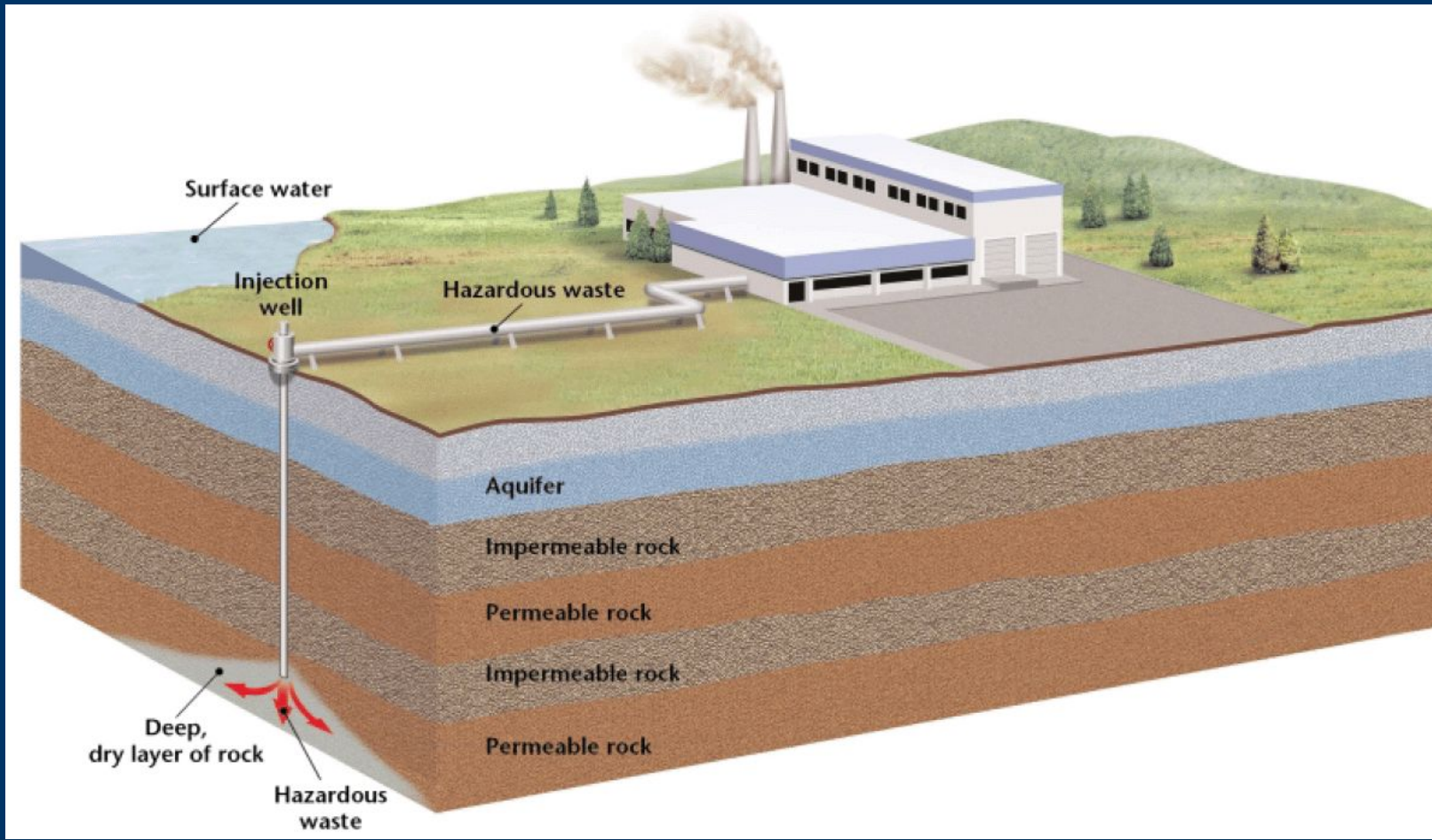
Land Disposal

- One type of land disposal facility uses deep-well injection.
- **Deep-well injection** involves deep-well disposal of hazardous waste.
- Deep-well injections pump hazardous wastes deep into the ground, where they are absorbed into a dry layer of rock below the level of groundwater.
- The wastes are then covered with cement to prevent contamination of the groundwater.





Land Disposal





Land Disposal

- A **surface impoundment** is a natural depression or a human-made excavation that serves as a disposal facility that holds an accumulation of wastes.
- Surface impoundments are basically ponds with sealed bottoms.
- Wastes accumulate and settle to the bottom of the pond, while water evaporates from the pond and leaves room to add more wastes.





Biologically Treating Hazardous Waste

- Some hazardous wastes can be absorbed, broken down, or their toxicity can be reduced when they are treated with biological and chemical agents.
- Certain bacteria and chemicals can be used to help clean up an area in the environment that has been contaminated with hazardous substances.
- Flowering plants and trees that absorb heavy metals can also be planted in contaminated areas.





Incinerating Hazardous Waste

- Some hazardous wastes are disposed of by burning in specially designed incinerators.
- Incineration can be a safe way, but it is generally the most expensive form of disposing waste.
- Incinerators need pollution-control devices and they need to be monitored for hazardous gases and particles.
- Incinerators produce ash that needs to be buried in a hazardous waste landfill.





Exporting Hazardous Waste

- Until recently, only local laws regulated waste disposal in the United States.
- Until the 1980s, companies would often send hazardous waste to landfills in other, less populated states.
- Hazardous wastes are now exported through international trade agreements to facilities in another countries that specialize in treating, disposing of, or recycling a particular hazardous waste.





Hazardous Wastes at Home

- Household products can also create hazardous waste.
- Some household products should be disposed of in specially designed hazardous waste landfills, and not down the drain or put in the trash for a solid-waste landfill.

Common Hazardous Household Products

- | | |
|-----------------|---------------|
| • motor oil | • pesticides |
| • paints | • fertilizers |
| • batteries | • cleaners |
| • computers | • antifreeze |
| • mobile phones | |





Disposing of Household Hazardous Waste

- More cities around the country have begun to provide collection for household hazardous waste to make sure they are disposed of properly.
- Trained workers sort the hazardous materials and send some for recycling and pack others into barrels for disposal.
- Used batteries and motor oil, for example, can be recycled.





Motor Oil

- It is illegal to pour motor oil on the ground or throw it in the trash.
- However, people in the United States throw away over 700 million liters (185 million gallons) of used motor oil every year. This does not include the oil disposed of by service stations and automobile repair shops.
- Motor oil can be recycled by taking it to an automobile service station. Some cities have designated oil-collection receptors. These cities recycle the used oil turned in by citizens.





Bellringer

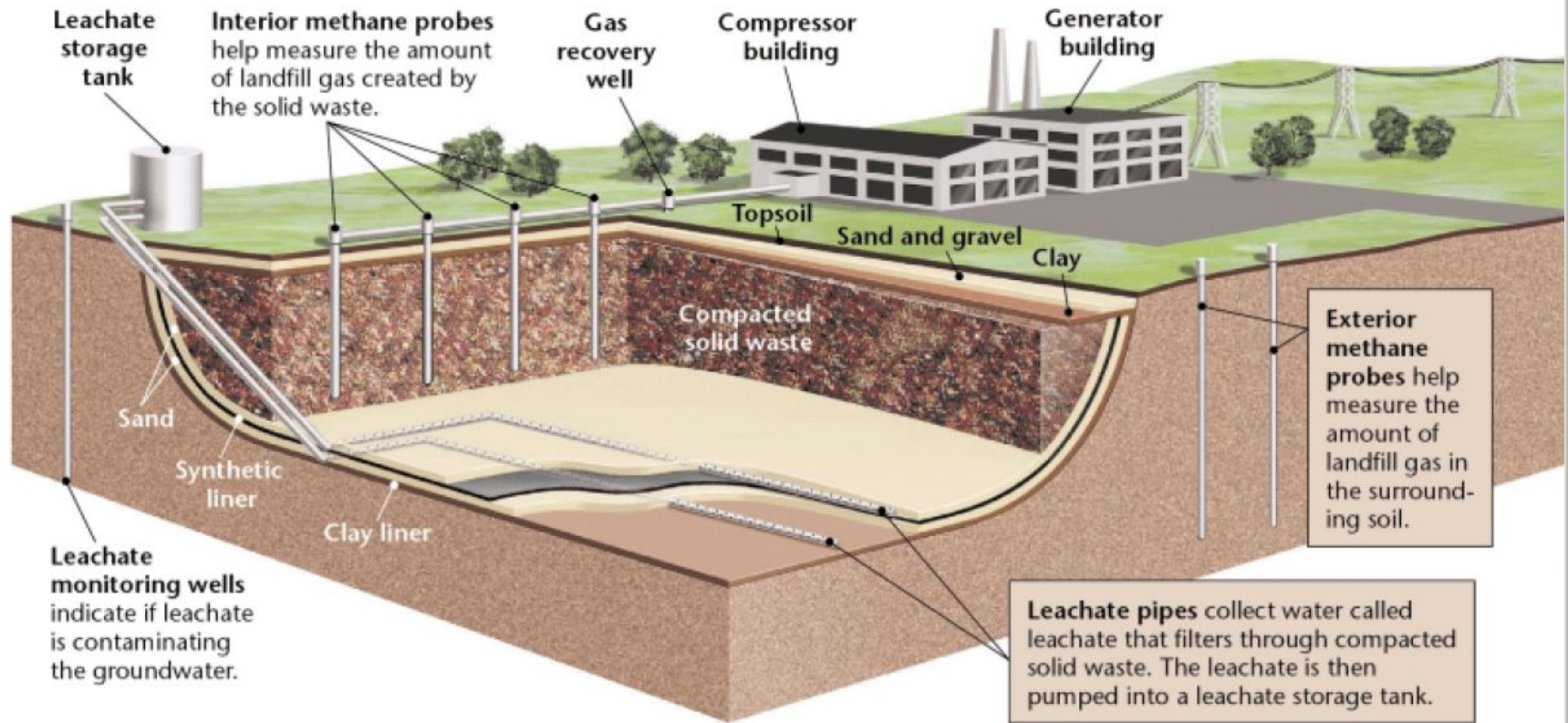
Section: Solid Waste

Imagine you are on an archeological expedition 500 years from now, and you have just come across a garbage dump that appears to date from the 21st century. List the types of objects you think you would find.

Write your response in your *EcoLog*.

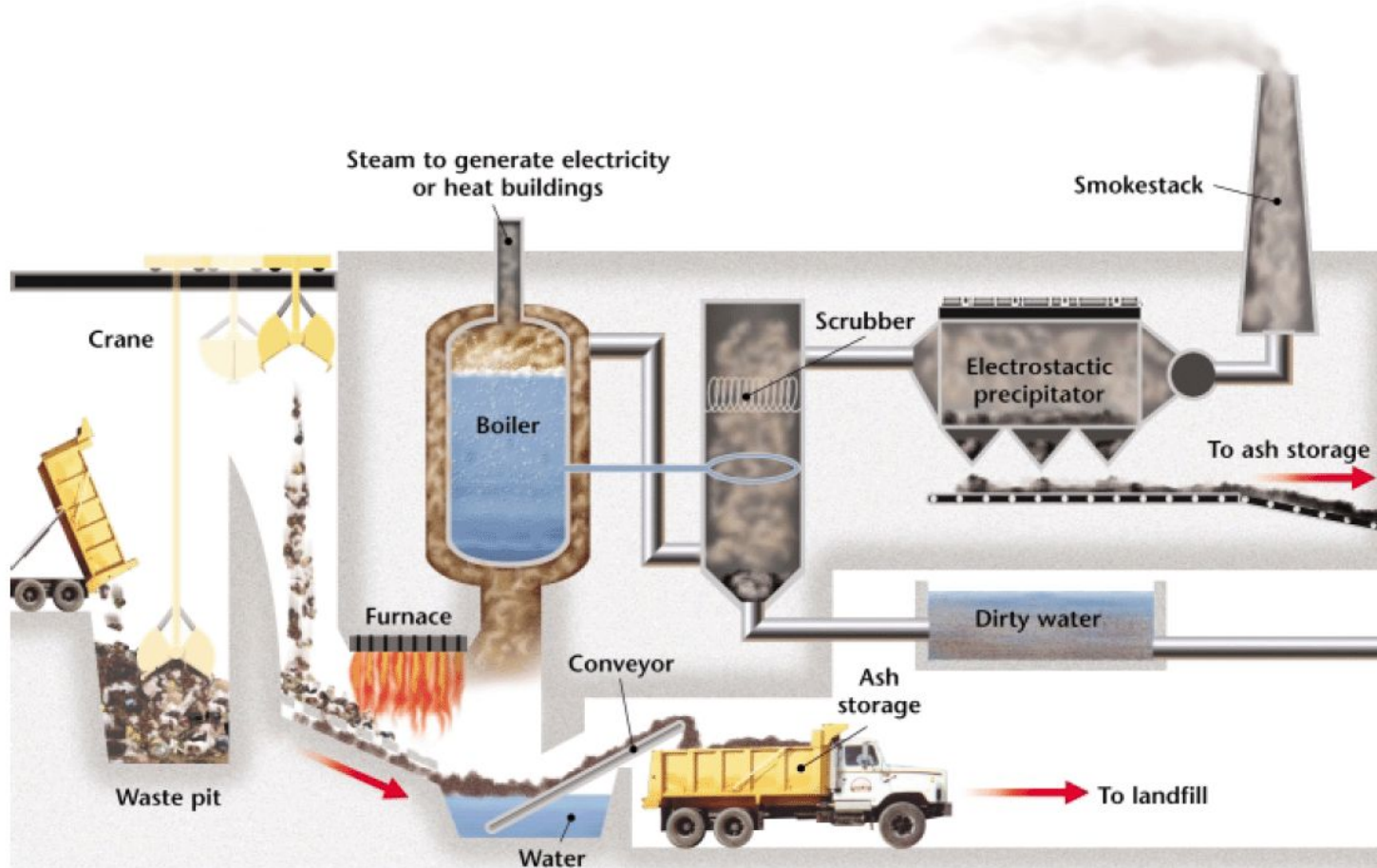


Sanitary Landfills





How a Solid-Waste Incinerator Works



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Bellringer

Section: Reducing Solid Waste

List all the disposable products that you bought in the last month. Describe any non-disposable or durable alternatives to these products. Why did you buy the disposable products instead of the non-disposable or more durable alternatives?

Write your responses in your *EcoLog*.



Bellringer

Section: Hazardous Waste

Write a definition of hazardous waste in your own words and list substances that you consider hazardous.

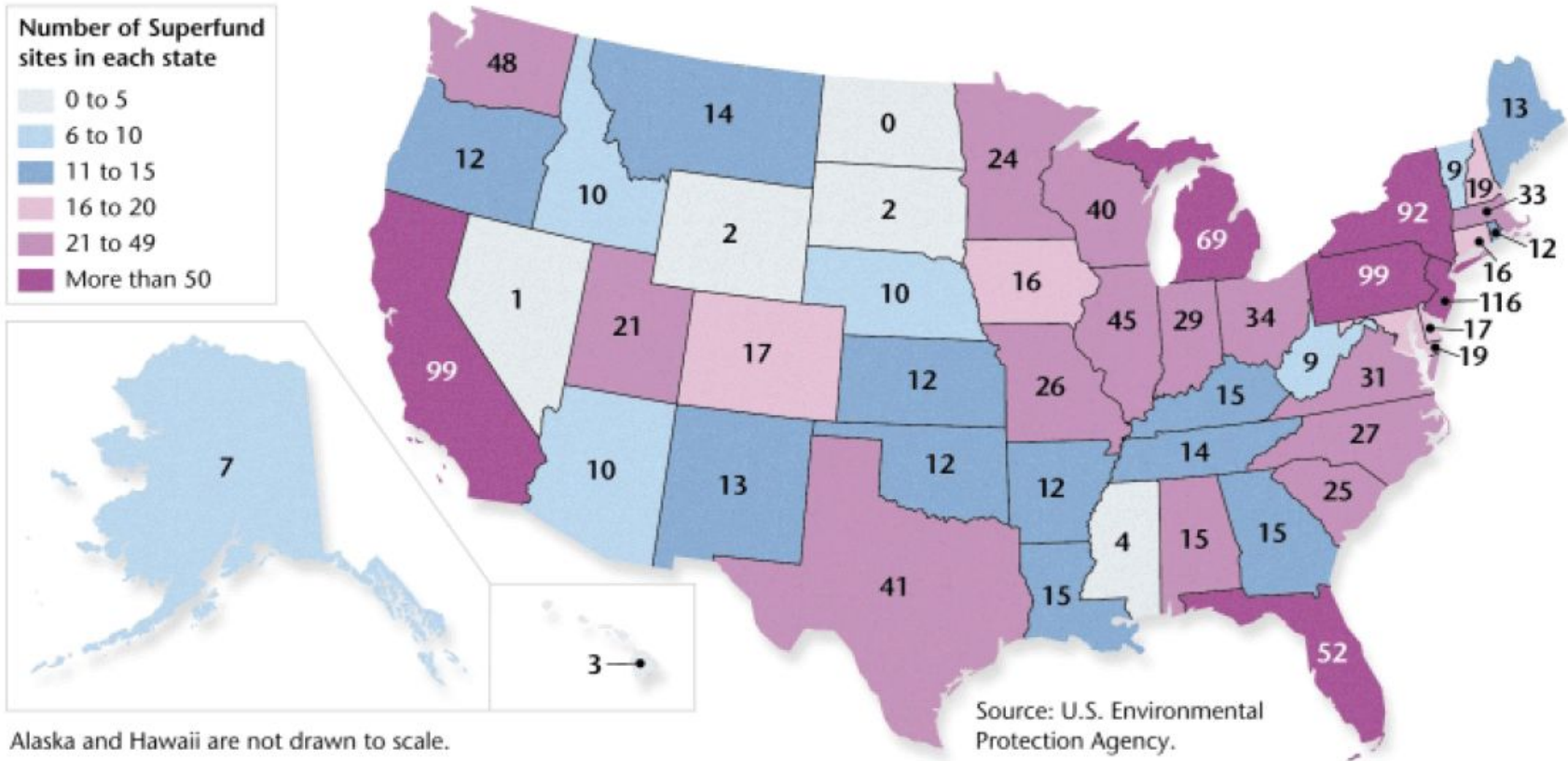
Write your responses in your *EcoLog*.



Superfund Sites

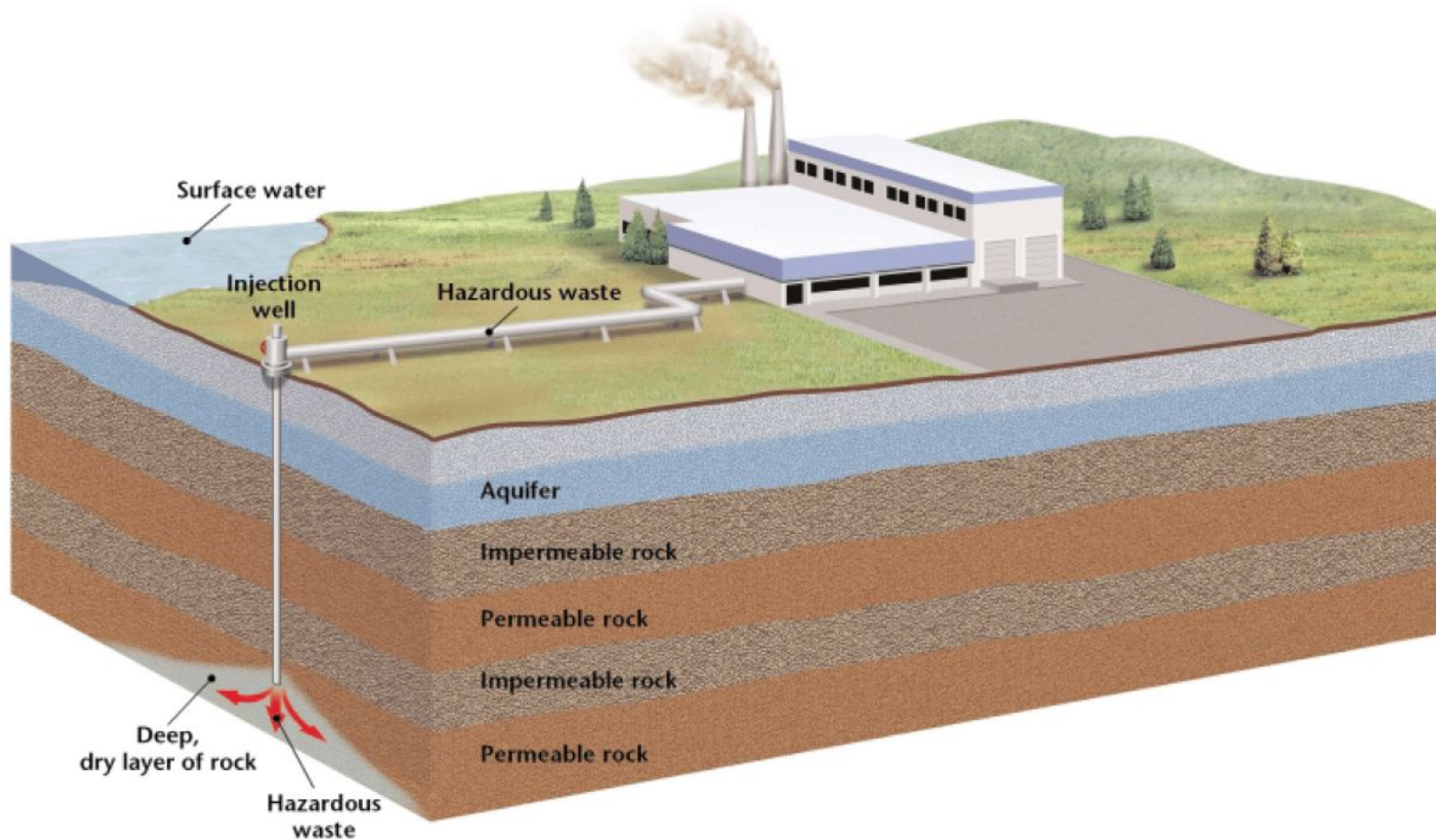
Number of Superfund sites in each state

- 0 to 5
- 6 to 10
- 11 to 15
- 16 to 20
- 21 to 49
- More than 50





Hazardous-Waste Deep-Well Injection





Multiple Choice

1. Which of the following is biodegradable?
 - A. a nylon jacket
 - B. a plastic cup
 - C. a television set
 - D. a wool sweater



Multiple Choice

1. Which of the following is biodegradable?
 - A. a nylon jacket
 - B. a plastic cup
 - C. a television set
 - D. a wool sweater



Multiple Choice, *continued*

2. What is source reduction?

- F. Source reduction is a method of which we can produce less waste.
- G. Source reduction is a method of reducing recyclable materials.
- H. Source reduction is a process that changes the number of landfills.
- I. Source reduction is a process that allows manufacturers to make more products from plastics.



Multiple Choice, *continued*

2. What is source reduction?
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Multiple Choice, *continued*

3. What is the relationship between packaging and solid waste?
- A. Packaging made of plastic decreases the amount of solid waste.
 - B. Packaging has little effect on the amount of solid waste produced.
 - C. Packaging that can be recycled increases the amount of sold waste.
 - D. Packaging for single-serving items increases the amount of solid waste.



Multiple Choice, *continued*

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 - C. Packaging that can be recycled increases the amount of sold waste.
 - D. Packaging for single-serving items increases the amount of solid waste.



Multiple Choice, *continued*

4. Which of the following statements is true?

- F. There is little danger of hazardous waste entering groundwater if the waste is disposed of through deep-well injection.
- G. During the 1990s the amount of waste generated per person remained almost constant, decreasing the total amount of waste generated.
- H. Composting could reduce the amount of waste that restaurants, food-processing plants, and animal feedlots send to land-fills.
- I. Landfills are the safest way to dispose of solid waste because the materials buried in them decompose quickly.



Multiple Choice, *continued*

4. Which of the following statements is true?

- F. There is little danger of hazardous waste entering groundwater if the waste is disposed of through deep-well injection.
- G. During the 1990s the amount of waste generated per person remained almost constant, decreasing the total amount of waste generated.
- H. Composting could reduce the amount of waste that restaurants, food-processing plants, and animal feedlots send to land-fills.
- I. Landfills are the safest way to dispose of solid waste because the materials buried in them decompose quickly.



Multiple Choice, *continued*

Use this graph to answer questions 5 through 7.





Multiple Choice, *continued*

5. If the most recyclable materials are paper, plastics, metal and glass, by what percentage would municipal solid waste be reduced if every person in the country recycled?
- F. 38%
 - G. 43%
 - H. 54%
 - I. 62%



Multiple Choice, *continued*

5. If the most recyclable materials are paper, plastics, metal and glass, by what percentage would municipal solid waste be reduced if every person in the country recycled?
- F. 38%
 - G. 43%
 - H. 54%
 - I. 62%



Multiple Choice, *continued*

6. Which of the following is a type of waste you would likely find under the category of “Other” in this pie graph?
- A. banana peels
 - B. glazed ceramics
 - C. grass clippings
 - D. industrial chemicals



Multiple Choice, *continued*

6. Which of the following is a type of waste you would likely find under the category of “Other” in this pie graph?
- A. banana peels
 - B. glazed ceramics
 - C. grass clippings
 - D. industrial chemicals



Multiple Choice, *continued*

7. By how much would the amount of municipal waste be reduced if every household in the country had a compost pile?
- F. 12%
 - G. 23%
 - H. 35%
 - I. 41%



Multiple Choice, *continued*

7. By how much would the amount of municipal waste be reduced if every household in the country had a compost pile?
- F. 12%
 - G. 23%**
 - H. 35%
 - I. 41%



Multiple Choice, *continued*

8. Where does municipal waste come from?
- A. agriculture and mining
 - B. households and business
 - C. manufacturing and business
 - D. mining and households



Multiple Choice, *continued*

8. Where does municipal waste come from?
- A. agriculture and mining
 - B. households and business
 - C. manufacturing and business
 - D. mining and households



Image and Activity Bank





Image and Activity Bank

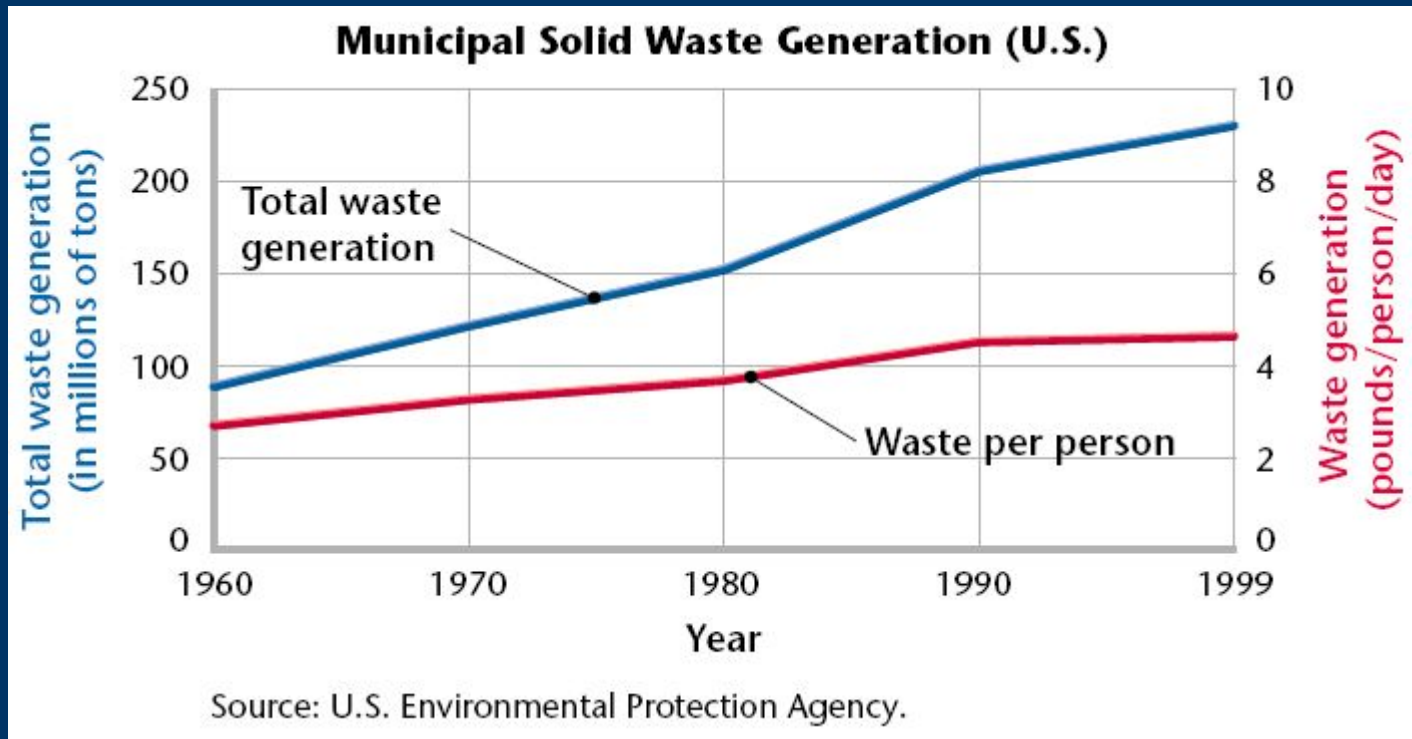




Image and Activity Bank

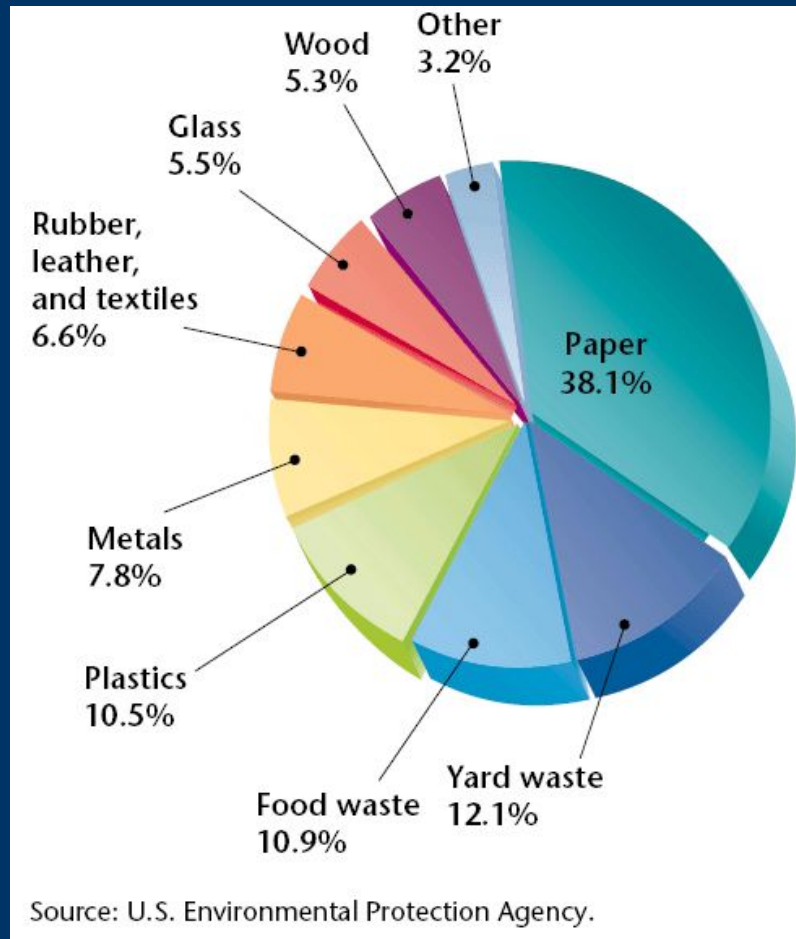




Image and Activity Bank

MATH PRACTICE



Municipal Solid Waste

The United States generated approximately 229.9 million tons of municipal solid waste in 1999. In 1998, the United States generated approximately 223 million tons of municipal solid waste. What was the percent increase in municipal solid waste generation from 1998 to 1999?



Image and Activity Bank

Where Waste in the United States Goes	
Waste-disposal method	Percentage of waste by weight
Stored in landfills	57
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Image and Activity Bank

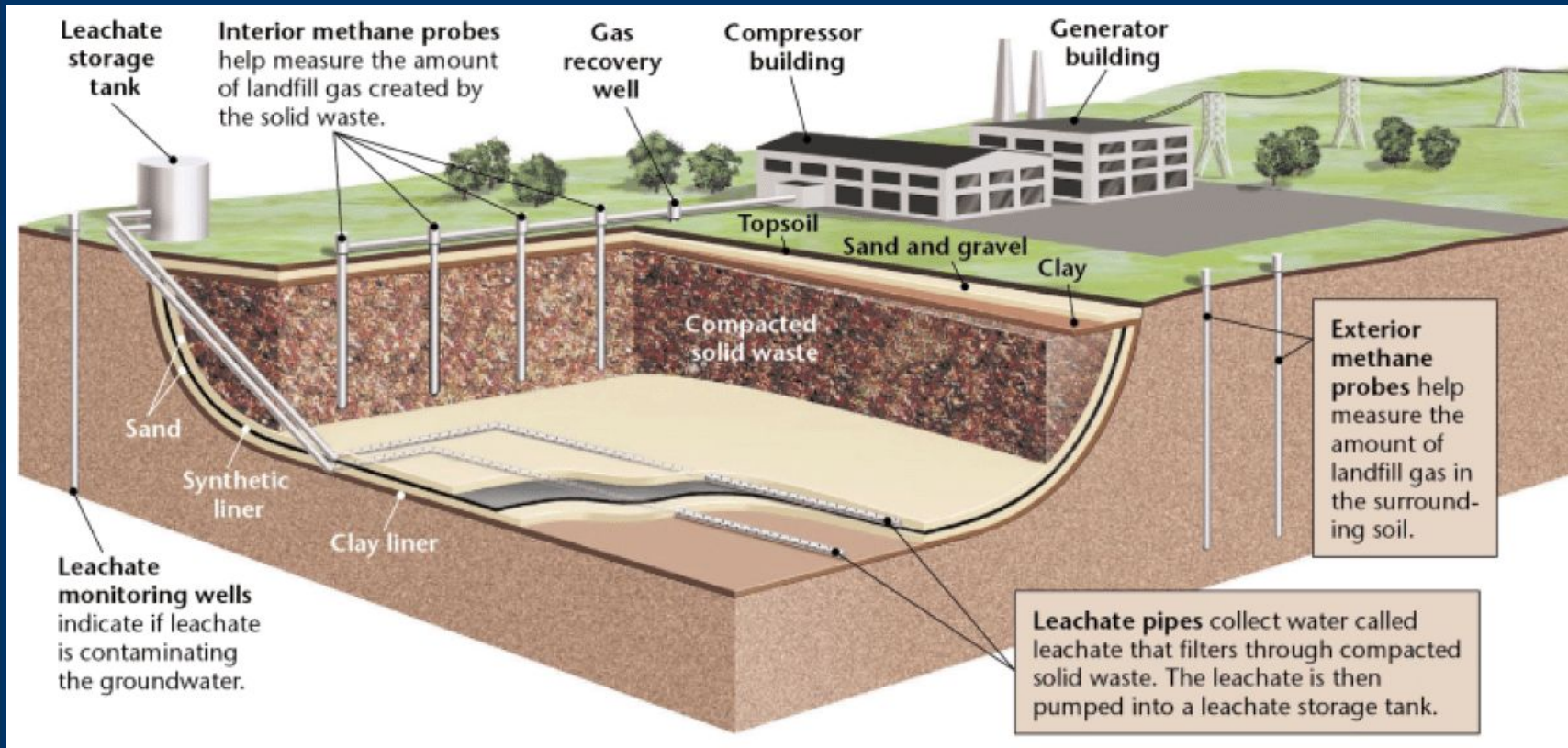




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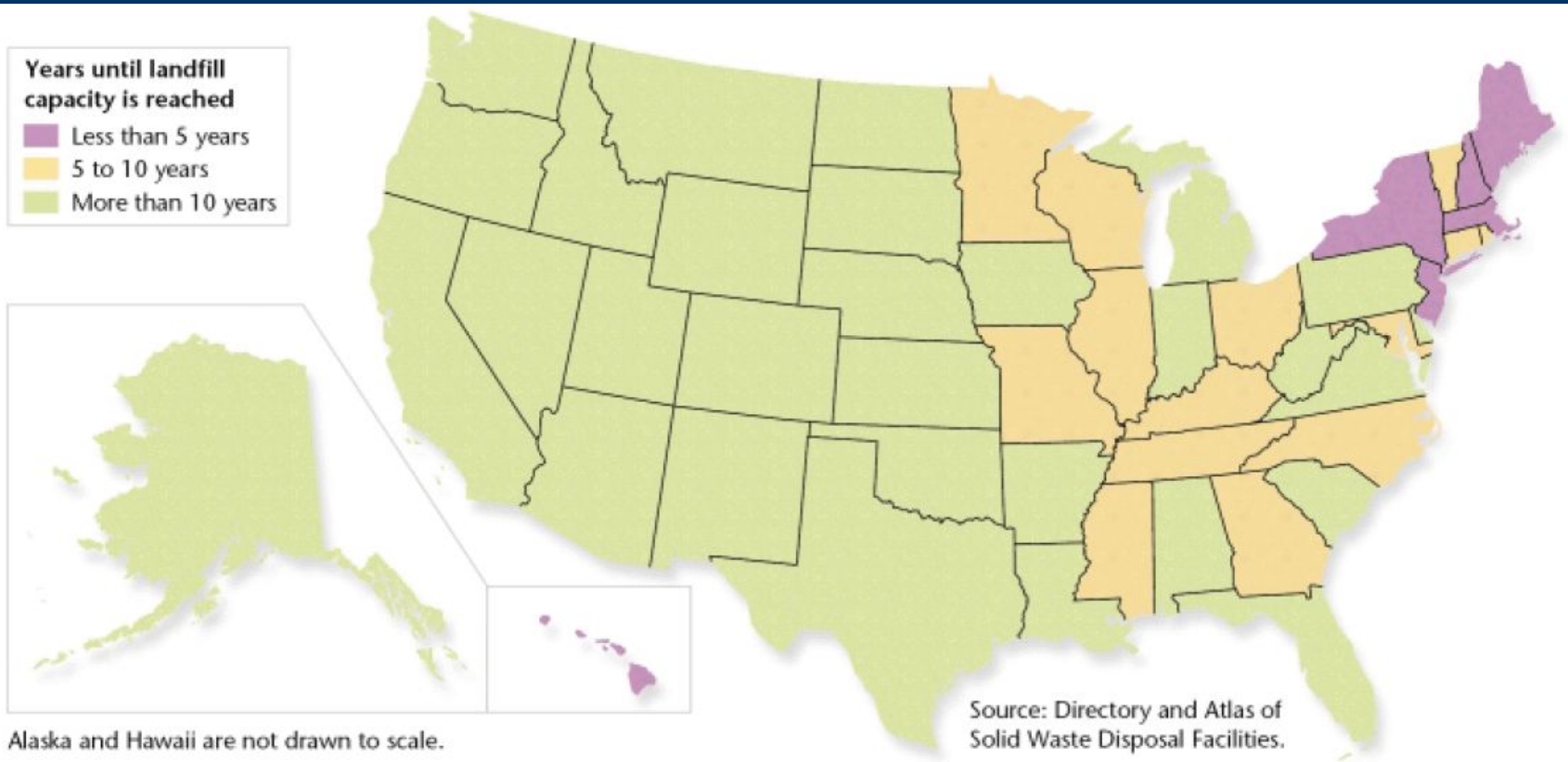




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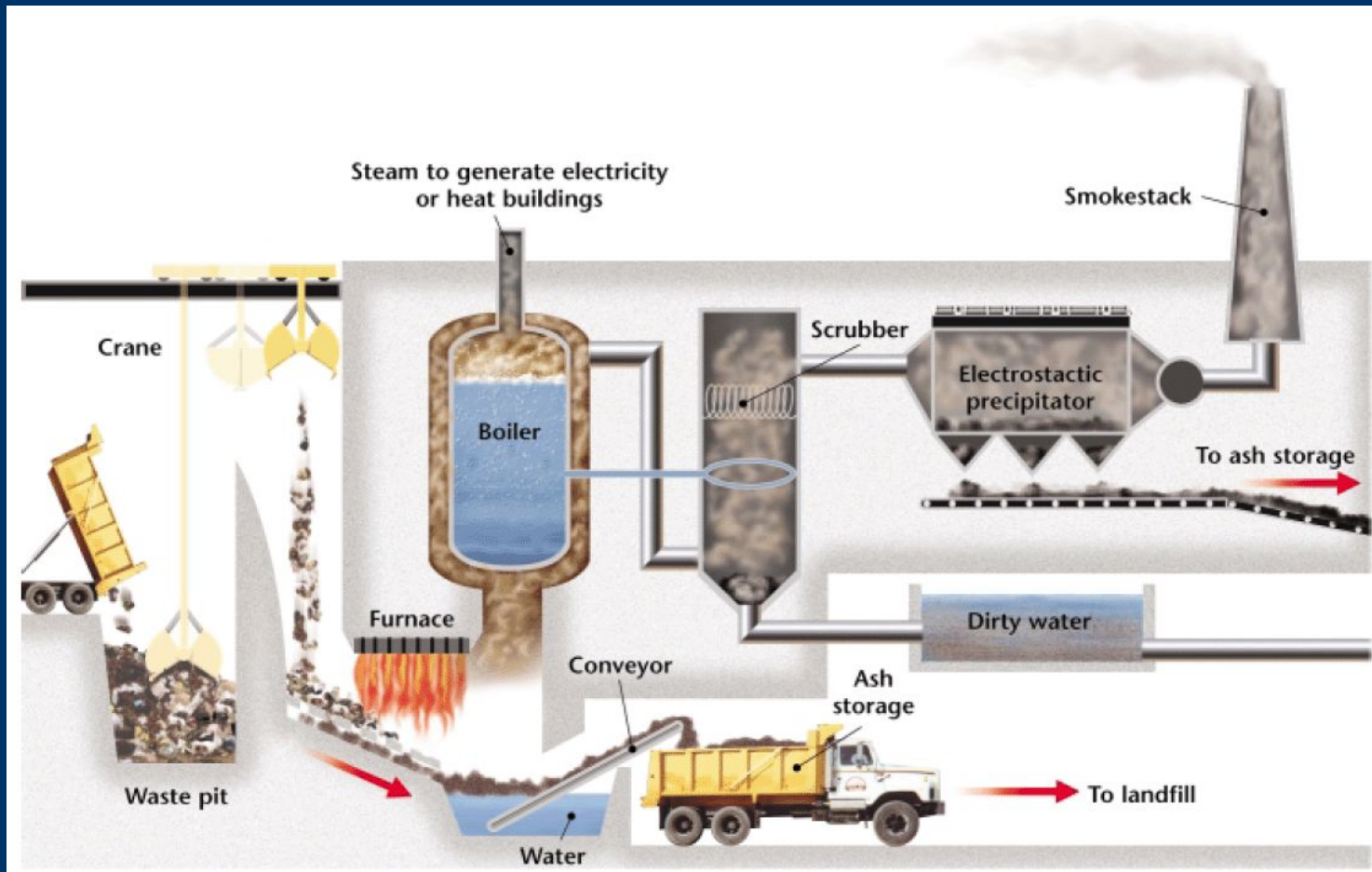




Image and Activity Bank

Benefits of Composting

- keeps organic wastes out of landfills
- provides nutrients to the soil
- increases beneficial soil organisms, such as worms and centipedes
- suppresses some plant diseases
- reduces the need for fertilizers and pesticides
- protects soil from erosion



Image and Activity Bank

Graphic

Organizer

Chain-of-Events Chart

Create the **Graphic Organizer** entitled "Chain-of-Events Chart" described in the Appendix. Then, fill in the chart with details about each step of the degradation of degradable plastics.

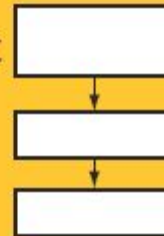




Image and Activity Bank

Types of Hazardous Waste

- dyes, cleansers, and solvents
- PCBs (polychlorinated biphenyls) from older electrical equipment, such as heating systems and television sets
- plastics, solvents, lubricants, and sealants
- toxic heavy metals, such as lead, mercury, cadmium, and zinc
- pesticides
- radioactive wastes from spent fuel that was used to generate electricity



Image and Activity Bank

Number of Superfund sites in each state

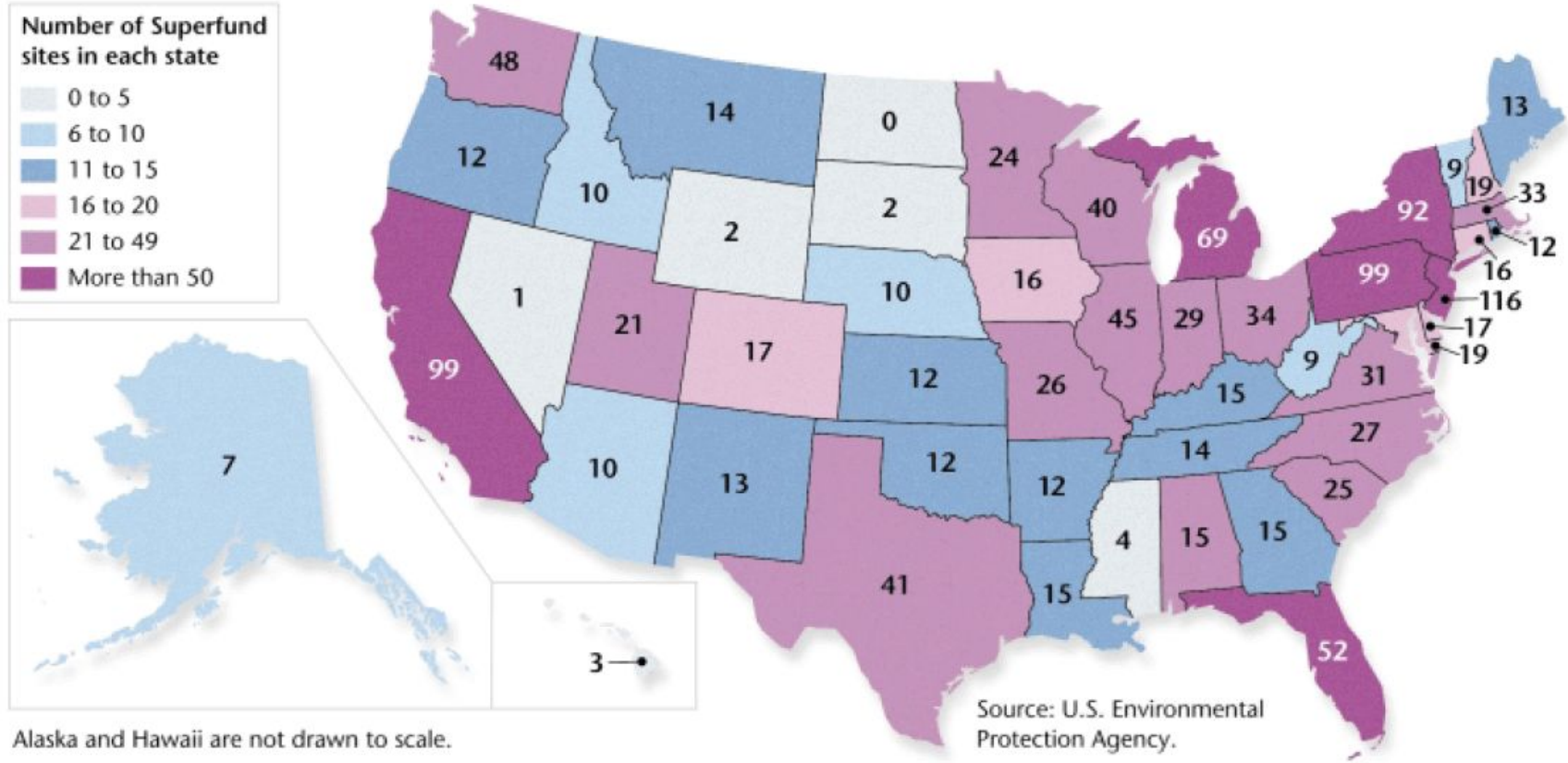
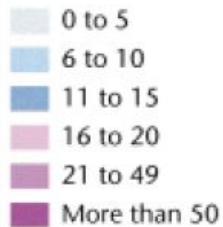




Image and Activity Bank

QuickLAB



Neutralizing Hazardous Waste



Procedure

1. Using a measuring spoon, obtain about a teaspoon of **baking soda**, and place it in a **500 mL beaker**. The baking soda will act as the base which will neutralize the acid.
2. In a separate **500 mL beaker**, pour approximately **200 mL of vinegar**. The vinegar is a weak acid.
3. Add the vinegar (acid) to the baking soda (base).

Analysis

1. What happened when you added the vinegar to the baking soda?
2. How is this lab similar to the technique used to convert some hazardous wastes into nonhazardous substances?



Image and Activity Bank

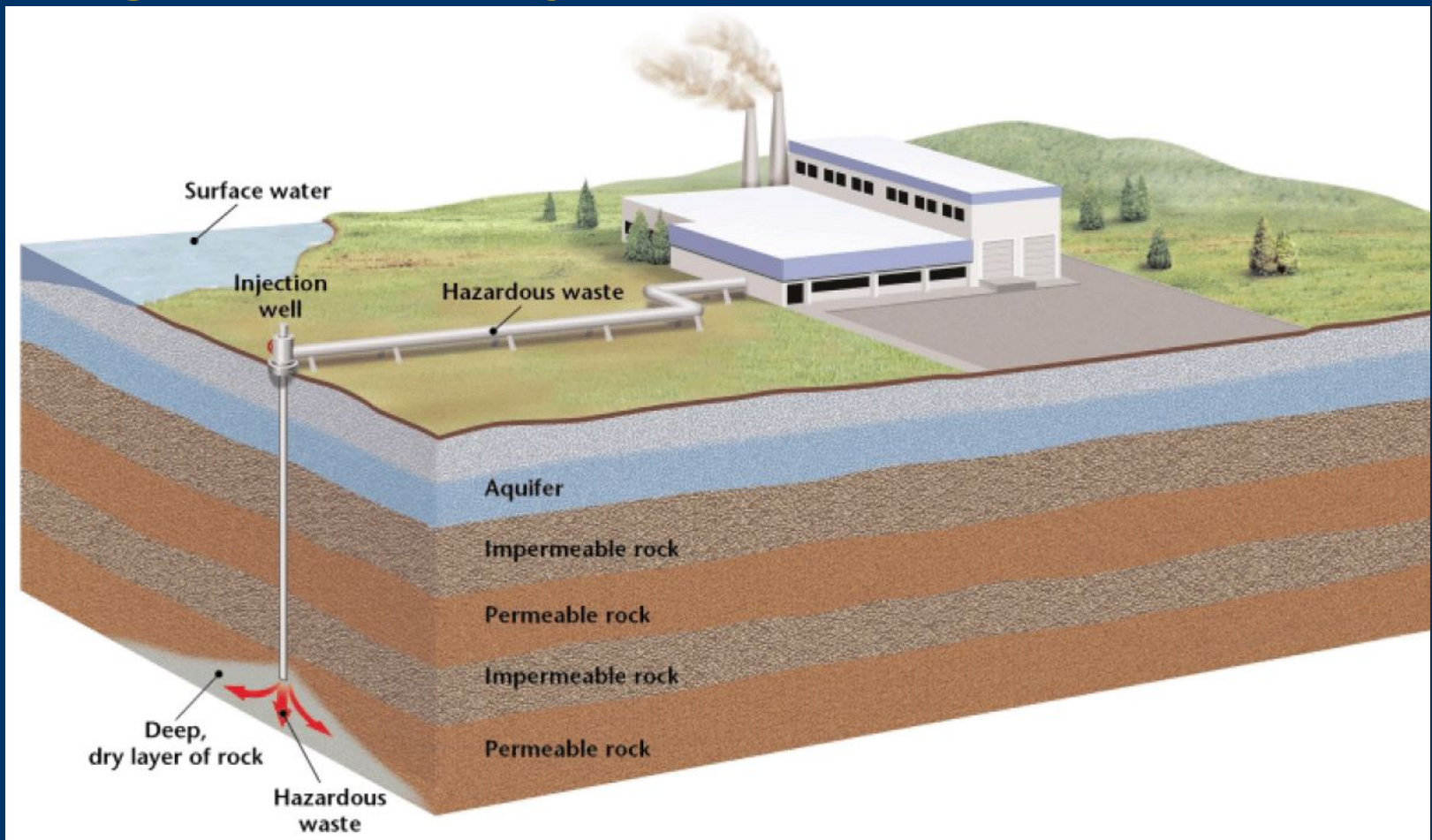




Image and Activity Bank

Common Hazardous Household Products

- motor oil
- paints
- batteries
- computers
- mobile phones
- pesticides
- fertilizers
- cleaners
- antifreeze