

Chapter 16

Waste Generation and Waste Disposal

What is better for the environment—a paper cup or a polystyrene cup?

Paper

Polystyrene

The Story of Stuff

- In the past three decades _____ of the planet's natural resources base have been consumed.
- In the US, we have less than _____ of our original forests left.
- Forty percent of waterways in the US have become _____.
- The US has 5% of the world's population but consumes _____ of the world's resources and creates _____ of the world's waste.
- If everybody consumed at US rates, we would need _____ planets.
- There are over _____ synthetic chemicals in commerce today.
- Only a handful of synthetic chemicals have even been tests for human health impacts and _____ have been tested for synergistic health impacts.
- In the US, industry admits to releasing over _____ of toxic chemicals in a year.
- The average US person now consumes _____ as they did 50 years ago.
- We each see more advertisements in one year than people 50 years ago saw in _____.
- In the US our _____ peaked sometime in the 1950s.
- In the US we spend _____ times as many hours shopping as our counterparts in Europe do.
- Average US house size has _____ since the 1970s.
- Each person in the US makes _____ pounds of garbage a day. That is _____ what we made thirty years ago.
- For every one garbage can of waste you put out on the curb, _____ garbage cans of waste were made upstream to make the junk in that one garbage can you put out on the curb.

Module 51—Only Humans Generate Waste

After reading this module, you should be able to

- explain why we generate waste and describe recent waste disposal trends.
- describe the content of the solid waste stream in the United States.

Humans generate waste that other organisms cannot use

- _____ Material outputs from a system that are not useful or consumed.
- _____ (**MSW**) Refuse collected by municipalities from households, small businesses, and institutions.

- Waste can be viewed as a _____.

Waste as a System (Fig. 51.1, p. 555)

Waste is a component of a human-dominated system in which products are _____, _____, and eventually _____ of (arrows are not proportional). At least some of the waste of this system may become the _____ of another system.

Is this system sustainable?

_____, If more resources are _____ rather than discarded, _____ raw materials and _____ energy will be needed and _____ waste will be created.

The Throw-Away Society (Fig. 51.3, p. 557)

Total MSW generation and per capita MSW generation had been _____ from 1960 through 2008. They have recently started to _____.

What does it mean to be a throw-away society?

How does planned obsolescence contribute to waste generation?

The solid waste stream contains materials from many sources

- _____ The flow of solid waste that is recycled, incinerated, placed in a solid waste landfill, or disposed of in another way.

Composition of Municipal Solid Waste (Fig. 51.1, p. 558)

(a) The composition, by weight, of MSW in the United States in 2011 before recycling. _____, _____, and _____ make up more than half of the MSW by weight.

(b) The breakdown of the material that is recovered and the material that is discarded. _____ makes up more than half of the material that is recovered. Food and yard waste make up almost _____ of material that is discarded.

Which group of materials could be removed from the waste stream most easily and would make the greatest impact?

E-Waste

- Electronic waste, including televisions, computers, portable music players, and cell phones accounts for roughly _____ percent of the waste stream but its effect is greater than this amount indicates.
- E-waste contains toxic metals such as _____ and _____ which can leach out of landfills.
- Even when e-waste is sent to be recycled, it is not always done so properly.

High Tech Trash

E-waste quiz

The Story of Electronics

Module 52—The Three Rs and Composting

After reading this module, you should be able to

- describe the three Rs.
- understand the process and benefits of composting.

The three Rs divert materials from the waste stream

- _____ A popular phrase promoting the idea of diverting materials from the waste stream. *Also known as the three Rs.*

Reduce

- Reduce is the first choice among the three Rs because reducing inputs is the _____ way to achieve a reduction in solid waste generation.
- _____ An approach to waste management that seeks to cut waste by reducing the use of potential waste materials in the early stages of design and manufacture.
- Source reduction can also increase energy efficiency; manufacturing produces _____ waste and can _____ disposal processes.
- Source reduction may also involve substituting less _____ materials or products.

Reuse

- Using a product or material that was intended to be _____.
- Optimally, no additional _____ or _____ are needed for the object to be reused.
- Energy may be required to _____ or _____ an object for reuse by someone other than the original user.

Recycle

- _____ The process by which materials destined to become municipal solid waste (MSW) are collected and converted into raw material that is then used to produce new objects.
- _____-**loop recycling** Recycling a product into the same product.
- _____-**loop recycling** Recycling one product into a different product.

Recycle (Fig. 52.2) Closed- and open-loop recycling.

(a) In closed-loop recycling, a discarded carpet can be recycled into a new _____, although some additional _____ and _____ are needed.

(b) In open-loop recycling, a material such as a beverage container is used once and then recycled into _____, such as a fleece jacket.

Recycle (Fig. 52.3)

Both the total weight of MSW that is recycled and the percentage of MSW that is recycled have _____ over time.

Seas of Plastic

Composting is becoming more popular

- Organic materials such as food and yard waste that end up in landfills are _____; the absence of oxygen in landfills causes organic material to decompose _____, which produces _____ gas.

Why is this not good?

- **Composting** Creation of organic matter (_____) by decomposition under controlled conditions to produce an organic-rich material that enhances soil structure, cation exchange capacity, and fertility.
- Materials suitable for compositing include _____ and vegetable by-products, animal _____, yard wastes, and _____ fiber not destined for recycling.

Vermicomposting: How Worms Can Reduce our Waste

Composting (Fig. 52.4) **A municipal composting facility.**
 A typical facility collects almost 100,000 metric tons of food scraps and paper per year and turns it into usable compost. Most facilities have some kind of mechanized system to allow _____ and _____ of the organic material, which speeds conversion to compost.

	Reduce	Reuse	Recycle
Effect on solid waste management			
Potential economic benefits			
Potential disadvantages			

Review questions

Module 53—Landfills and Incineration (Start on slide 54)

After reading this module, you should be able to

- describe the goals and function of a solid waste landfill.
- explain the design and purpose of a solid waste incinerator.

Fig. 53.1 Landfills are the primary destination for MSW

What is the destination of most MSW?

Landfill Basics

- _____ Liquid that contains elevated levels of pollutants as a result of having passed through municipal solid waste (MSW) or contaminated soil.
- _____ An engineered ground facility designed to hold municipal solid waste (MSW) with as little contamination of the surrounding environment as possible.
- _____ A fee charged for disposing of material in a landfill or incinerator.

Fig. 53.2 Landfill Basics

A modern sanitary landfill. A landfill constructed today has many features to keep components of the solid waste from entering the _____, _____, or nearby _____. Some of the most important environmental features are the _____, the _____ collection system, the _____—which prevents additional water from entering the landfill—and, if present, the _____ extraction system.

What items should not go in a landfill?

How is a landfill closed once it reaches capacity?

- A landfill must be closed when it reaches capacity to reduce or eliminate input and output of _____.
- It is capped with _____ and _____ and sometimes plastic.
- Topography is engineered to encourage water to flow off to the _____ rather than _____ the landfill
- _____ may be used to reduce erosion (and to make it look better)
- Construction is limited for many years, but it can be used for _____ or _____.

Choosing a Site for a Sanitary Landfill

- _____ The designation of a landfill location, typically through a regulatory process involving studies, written reports, and public hearings.
- Landfill siting has been the source of considerable environmental _____. People with financial resources or political influence often adopt a “not-in-my-backyard,” or _____, attitude about landfill sites.
- A site may be chosen not because it meets the safety criteria better than other options but because its neighbors lack the resources to mount an effective _____.

Environmental Consequences of Landfills

- No matter how careful the design and engineering, there is always the possibility that _____ from a landfill will contaminate underlying and adjacent waterways.
- The EPA estimates that virtually all landfills in the United States have had some _____.
- Even after a landfill is closed, the potential to harm adjacent _____ remains.
- Anaerobic decomposition generates _____ and _____—both greenhouse gases—as well as other gaseous compounds. The methane also creates an _____ hazard.

Incineration is another way to treat waste materials

- _____ The process of burning waste materials to reduce volume and mass, sometimes to generate electricity or heat.
- _____ The residual nonorganic material that does not combust during incineration.
- _____ Residue collected at the bottom of the combustion chamber in a furnace.
- _____ The residue collected from the chimney or exhaust pipe of a furnace.
- _____ A system in which heat generated by incineration is used as an energy source rather than released into the atmosphere.

Fig. 53.4 Incineration Basics

Environmental Consequences of Incineration

- Tipping fees are _____ at incinerators than at landfills.
- An incinerator may release _____ from the incomplete combustion of plastics and metals.
- Incinerators produce ash that is more concentrated and more _____ than the original MSW.
- Incinerator ash that is deemed toxic must be disposed of in a _____ landfill for toxic materials.

Landfill		Incineration	
Advantages	Disadvantages	Advantages	Disadvantages

p. 574 Review Questions

Other review questions (p. 567 & 560)

Module 54—Hazardous Waste

After reading this module, you should be able to

- define hazardous waste and discuss the issues involved in handling it.
- describe regulations and legislation regarding hazardous waste.

Hazardous waste requires proper handling and disposal

- _____ Liquid, solid, gaseous, or sludge waste material that is harmful to humans or ecosystems.
- Collection sites for hazardous waste must be staffed with specially _____ personnel.
- Hazardous waste must be _____ before disposal.
- The majority of hazardous waste is the byproduct of _____ processes.

Legislation oversees and regulates the treatment of hazardous waste

A number of laws and acts specifically cover hazardous waste:

- Resource Conservation and Recovery Act (RCRA) was designed to reduce or eliminate hazardous waste. Also known as “_____” tracking. RCRA ensures that hazardous waste is tracked and properly disposed of.

Regulation and Oversight of Handling Hazardous Waste

- _____ **Act** The common name for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); a 1980 U.S. federal act that imposes a _____ on the chemical and petroleum industries, funds the cleanup of abandoned and nonoperating hazardous waste sites, and authorizes the federal government to respond directly to the release or threatened release of substances that may pose a threat to human health or the environment.

The best know Superfund is probably Love Canal, NY. What happened there? (p. 576)

Look at Figure 54.2. Where are SuperFund sites in Georgia?

Legislation

- _____ Contaminated industrial or commercial sites that may require environmental cleanup before they can be redeveloped or expanded.
- Examples of Brownfields include old _____, industrial areas and waterfronts, _____, _____, and rail yards.
- The brownfields legislation lacks _____ liability controls to compel polluters to rehabilitate their properties.

Why would the United States send hazardous waste to other countries?

Why would the United States accept hazardous waste from other countries?

	RCRA	CERCLA
Also known as		
Goal		
Authorizes		

p. 578 Review Question

Module 55—New Ways to Think About Solid Waste

After reading this module, you should be able to

- explain the purpose of life-cycle analysis.
- describe alternative ways to handle waste and waste generation.

Life-cycle analysis considers materials used and released throughout the lifetime of a product

- **Life-cycle analysis** A systems tool that looks at the materials used and released throughout the lifetime of a product—from the procurement of raw materials through their manufacture, use, and disposal. *Also known as* **cradle-to-grave analysis**.
- Although life-cycle analysis may not be able to determine absolute environmental impact, it can be very helpful in assessing other considerations, especially those related to **resource conservation** and **pollution prevention** use.

Integrated waste management is a more holistic approach

- **Integrated waste management** An approach to waste disposal that employs several waste reduction, management, and disposal strategies in order to reduce the environmental impact of MSW.

Fig. 55.1 A holistic approach to waste management.

Depending on the kind of waste and the geographic location, reducing waste can take much less **energy** and **cost** than disposing of it. Horizontal arrows indicate the waste stream from **production** to **consumption** and curved arrows indicate ways in which waste can either be **recycled** or **incinerated** from the stream, thereby reducing the amount of waste incinerated or placed in landfills.

What might happen if a community made an investment in a large incinerator?

What is upcycling?