

Environmental Science, 15e

G. TYLER MILLER | SCOTT E. SPOOLMAN

16

**Solid And Hazardous
Waste**

Core Case Study: Electronic Waste

- E-waste: discarded electronics, televisions, cell phones, laptops, etc.
 - Exposes workers to lead, mercury, acids, and toxic metals
- Why is the U.S. allowed to export e-waste?
How does the EU deal with e-waste?
- Will you use the trade-in programs that U.S. communications providers offer?

16.1 What Are the Problems Related To Solid and Hazardous Waste?

- Solid waste contributes to pollution when valuable materials are not recycled/reused
- Hazardous waste not only contributes to pollution – it also causes natural capital degradation, health problems, and premature deaths

We Throw Away Huge Amounts of Useful Things

- Living in a throwaway society violates all the principles of sustainability
- Live more sustainably by viewing solid waste/pollution as potentially useful/economically valuable materials
 - How much can one get for a resource?
 - How can industrial/municipal solid waste be reused and recycled?
 - Can products be designed to curb waste?

Hazardous Waste Is a Serious and Growing Problem

- Toxic: discarded materials or substances that are poisonous, chemically reactive, corrosive, or flammable
 - Industrial solvents, hospital medical waste, car batteries, household pesticides, dry-cell batteries, ash/sludge (incinerators/industry)
- Radioactive: from nuclear power plants
 - Must be stored for 10,000 – 240,000 years
 - Currently no known way to safely store them

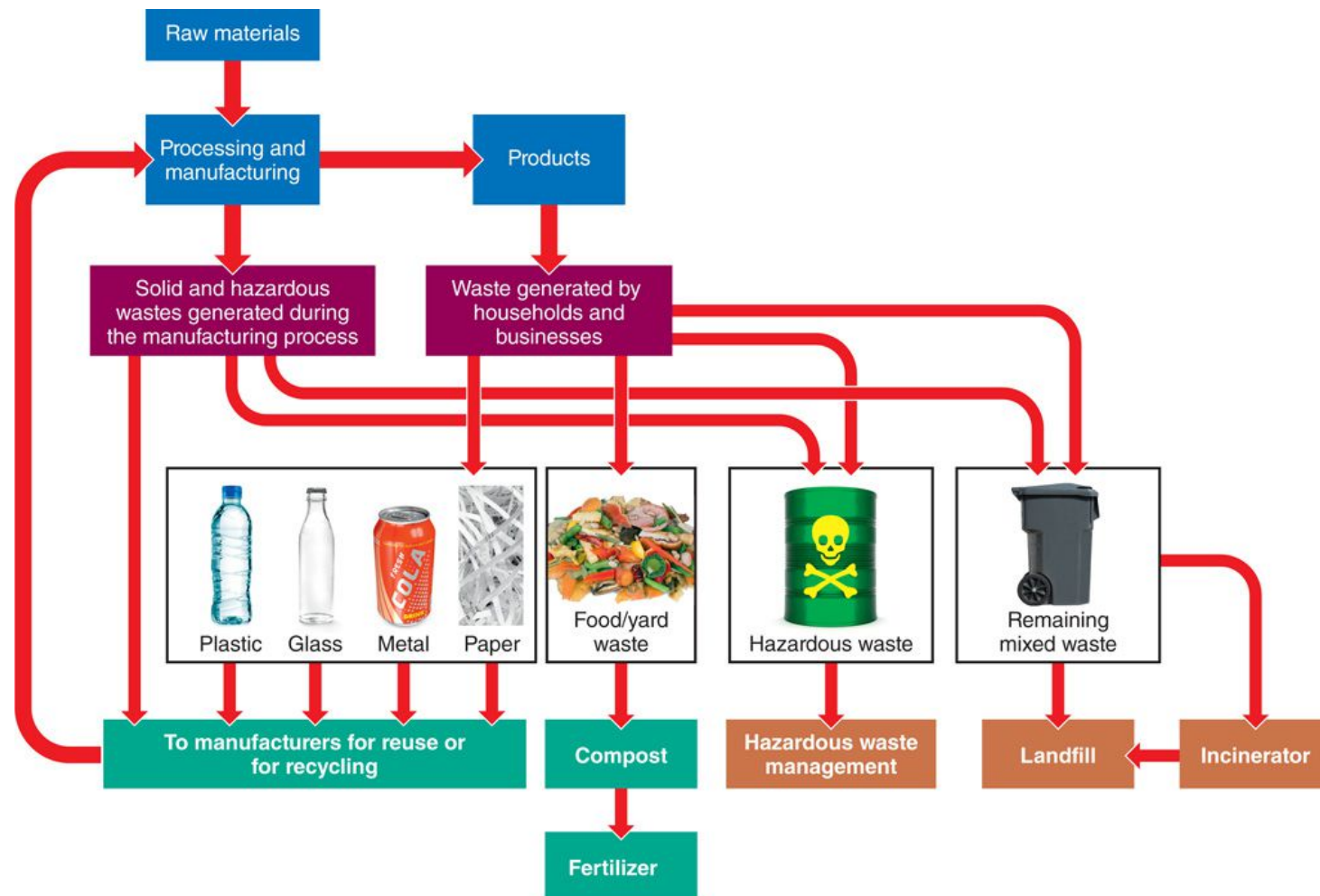
16.2 How Should We Deal With Solid Waste?

- The best way to deal with solid waste is prevention
 - Do not use it to start with if possible
 - Existing waste should be reused, recycled, or disposed of safely

We Can Burn, Bury, or Recycle Solid Waste or Produce Less of It

- Waste management: controlling wastes in ways that reduce environmental harm without trying to reduce the amount of waste produced
 - Burying/burning/shipping to another location
- Waste reduction: producing less/reusing, recycling, and composting existing waste
- Integrated waste management: strategies for waste disposal and reduction

Reducing and Managing Waste



© 2016 Cengage Learning. Photos from left to right: Mariyana Misaleva/Shutterstock.com. Sopotnicki/Shutterstock. Oleksiy Mark/Shutterstock. Christopher Kolaczan/Shutterstock. vilax/Shutterstock. MrGarry/Shutterstock. Le Do/Shutterstock

Refusing, Reducing, Reusing, and Recycling (4 Rs) Solid Waste

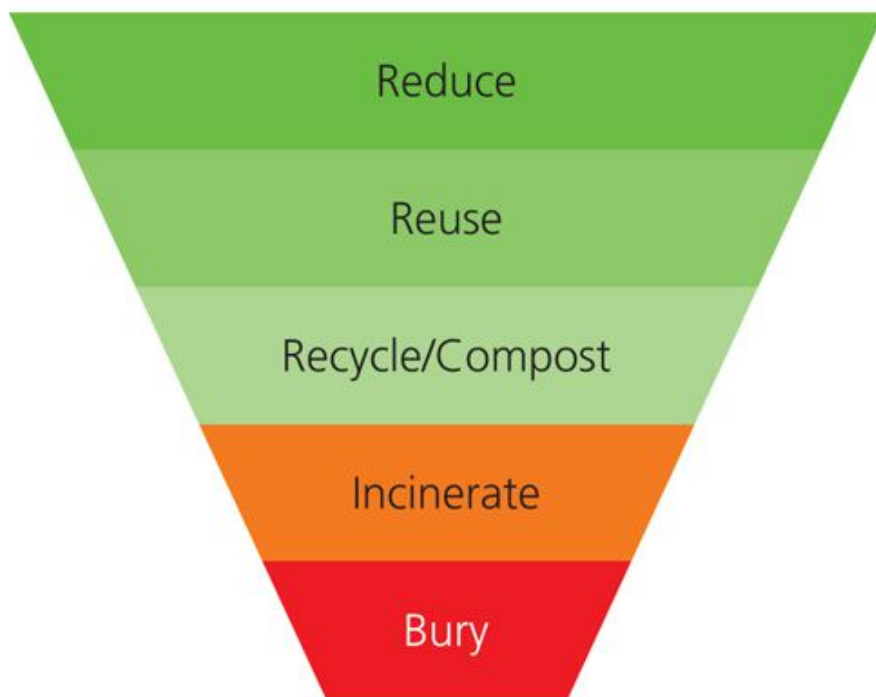
- Input, or waste prevention:
 - Refuse: Don't use it
 - Reduce: Use less
 - Reuse: Use it over and over
 - Recycle: Convert used resources to useful items/buy products made from recycled materials
 - Composting: using bacteria to treat biodegradable waste

Six Industrial/Community Strategies To Reduce Resource Use/Waste/Pollution

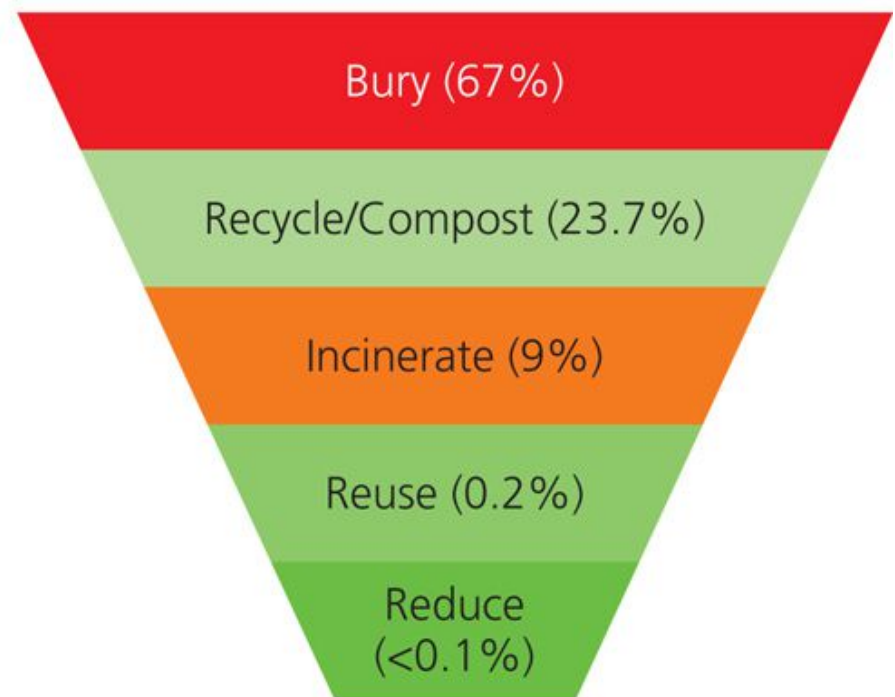
- Change industrial processes to eliminate/reduce use of harmful chemicals
- Redesign manufacturing processes and products to use less material and energy
- Develop products that are easy to repair, reuse, remanufacture, compost or recycle
- Eliminate/reduce unnecessary packaging
- Use fee-per-bag waste collection systems
- Pass laws

Recommendations For Dealing With Municipal and Solid Waste

What We Should Do



What We Do



Compiled by the authors using data from U.S. Environmental Protection Agency, U.S. National Academy of Sciences, Columbia University, and BioCycle.

16.3 Why Are Refusing, Reducing, Reusing, and Recycling So Important?

- If we decrease our consumption of matter and energy resources by refusing and reducing resource use, by reusing and recycling what we use – we will reduce pollution, decrease natural capital degradation, and save money

There Are Alternatives To the Throwaway Economy

- Applying the four “R”s:
 - Refusing to buy things that have a significant environmental impact
 - Reducing: buying less, how many do I need?
 - Reuse: clean and reuse items such as refillable coffee cups, dishes, utensils, cloth napkins, etc., to increase their lifespan
 - Recycling and composting: convert used items and materials to other useful forms

How Can Individuals Reuse the Items They Purchase?



© 2016 Cengage Learning

What Can You Do?

Reuse

- Buy beverages in refillable glass containers
- Use reusable lunch containers
- Store refrigerated food in reusable containers
- Use rechargeable batteries and recycle them when their useful life is over
- When eating out, bring your own reusable container for leftovers
- Carry groceries and other items in a reusable basket or cloth bag
- Buy used furniture, cars, and other items, whenever possible

Brenda Carson/Shutterstock.com

How Individual Countries Deal With Throwaway Packaging

- Denmark, Finland and Prince Edward Island (Canada) have banned all beverage containers that cannot be reused
 - In Finland, 95% of all soft drink, beer, wine, and spirits containers are refillable
- Denmark, Ireland, Taiwan, and the Netherlands tax single-use plastic shopping bags
 - In 2014, Hawaii became the first U.S. State to ban the use of these shopping bags

There Is Great Potential For Recycling

- Recyclable workplace/household materials: paper products, glass, aluminum, steel, and some plastics
- The life cycle of new items:
 - Primary/closed loop recycling – existing aluminum cans become new aluminum cans
 - Secondary recycling – waste materials are converted to new and different products
 - Three steps: material collection, conversion to new products, and new commercial sales

Composting

- Another form of recycling – bacteria are used to decompose yard trimmings, vegetable food scraps, and other biodegradable organic waste
 - Benefits: enriches nutrients in soil, reduces erosion, retains water, improves crop yields
 - In Canada and in European Union countries, many cities collect and compost 85% or more of their biodegradable waste in centralized facilities

Recycling Arguments – Pro and Con

- Critics argue costs/taxes add to the taxpayer burden, only making economic sense for paper/cardboard/steel/aluminum
- Proponents feel the economic, health, and environmental benefits far outweigh costs
- Some cities profit by recycling:
 - Single-pickup systems
 - Pay-as-you-throw approach
 - Recycling/reuse/composting creates jobs

Recycling Tradeoffs

Trade-Offs

Recycling

Advantages

Reduces energy and mineral use and air and water pollution

Reduces greenhouse gas emissions

Reduces solid waste



Disadvantages

Can cost more than burying in areas with ample landfill space

Reduces profits for landfill and incinerator owners

Inconvenient for some

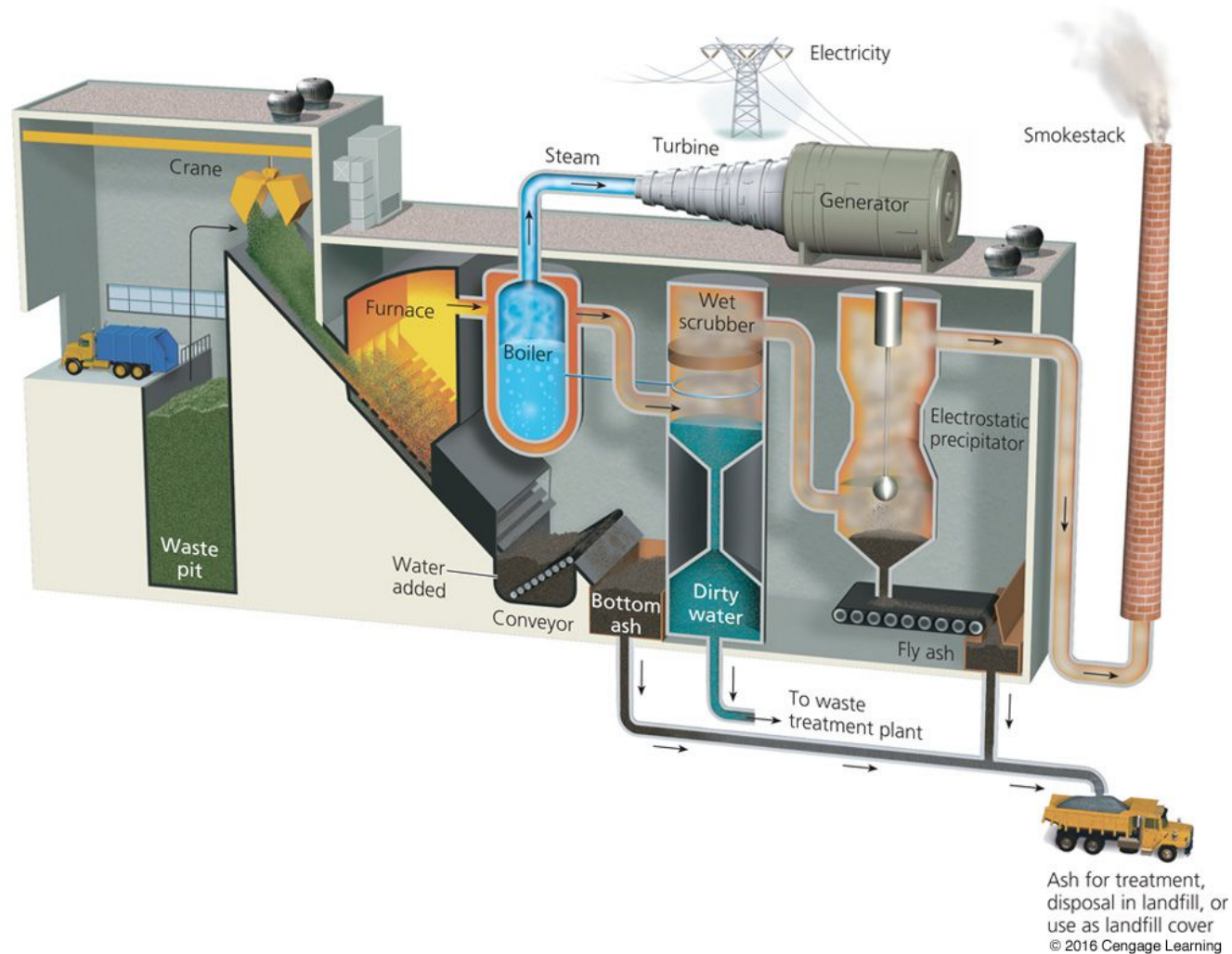
16.4 Advantages and Disadvantages of Burning and Burying Solid Waste

- Technologies for burning and burying have advanced, but both still have disadvantages
 - Burning contributes to air and water pollution, and the emission of greenhouse gases
 - Buried wastes contribute to water pollution

The Pros and Cons of Burning Solid Waste

- Highly polluting/poorly regulated incinerators are a thing of the past
 - Today, large waste-to-energy incinerators use their heat to boil water, make steam to produce electricity or heat buildings
 - Ash produced from burning can contain toxic chemicals and must be stored somewhere
 - Must compete with abundant low-cost landfills
 - Local government/scientists oppose this – as it undermines efforts to reuse and recycle

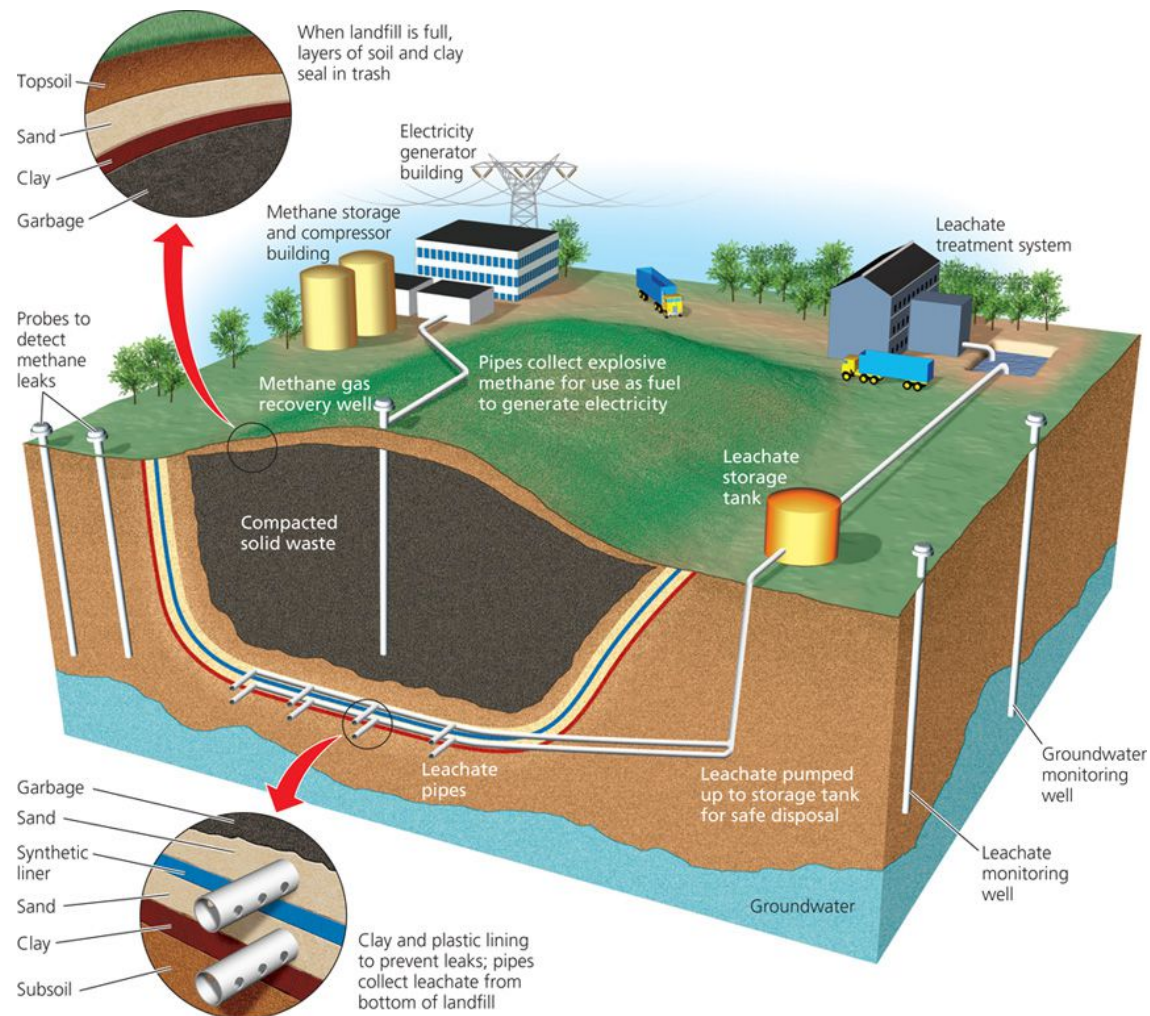
A Waste-To-Energy Incinerator



Burying Solid Waste

- Typically, in two types of landfills:
 - Sanitary landfills: solid wastes are spread out in thin layers, compacted, and covered daily with a fresh layer of clay or plastic foam
 - Keeps materials dry, reduces leakage of contaminated water, lessens fire risk, decreases odors, and limits accessibility from vermin
 - Open dump: a large field or pit where garbage is deposited and sometimes burned
 - Rare in more developed countries – China uses open dumps and poorly regulated landfills

A State-of-the-Art Sanitary Landfill



© 2016 Cengage Learning

16.5 How Should We Deal With Hazardous Waste?

- The best way to deal with hazardous waste is to prevent it – existing waste should be reused, recycled, and converted to less hazardous materials, and the remainder should be stored safely

We Can Use Integrated Management of Hazardous Waste

- Three management levels for dealing with the problem:
 - Produce less
 - Convert as much of it as possible to less hazardous substances
 - Put the rest in long-term safe storage
- Top priority should be given to prevention/waste reduction and the finding of substitutes for hazardous materials

Integrated Hazardous Waste Management

Produce Less Hazardous Waste

- Change industrial processes to reduce or eliminate hazardous waste production
- Recycle and reuse hazardous waste

Convert to Less Hazardous or Nonhazardous Substances

- Natural decomposition
- Incineration
- Thermal treatment
- Chemical, physical, and biological treatment
- Dilution in air or water

Put in Perpetual Storage

- Landfill
- Underground injection wells
- Surface impoundments
- Underground salt formations

© 2016 Cengage Learning

We Can Detoxify Hazardous Waste

- Physical methods: use charcoal/resin to filter; distill liquid waste; encapsulate and store deadly waste safely and securely
- Chemical methods: convert to less harmful/harmless chemicals
- Bioremediation: use bacteria/enzymes to destroy/convert toxic/hazardous substances

Other Ways to Detoxify Hazardous Waste

- Phytoremediation: natural and genetically engineered plants absorb/ filter/remove contaminants from soil/water
 - “Pollution sponges”
- Plasma gasification: electrically produced high temperatures vaporize trash in the absence of oxygen
 - Produces synthetic gaseous fuel and encapsulates toxics in glassy lumps of rock

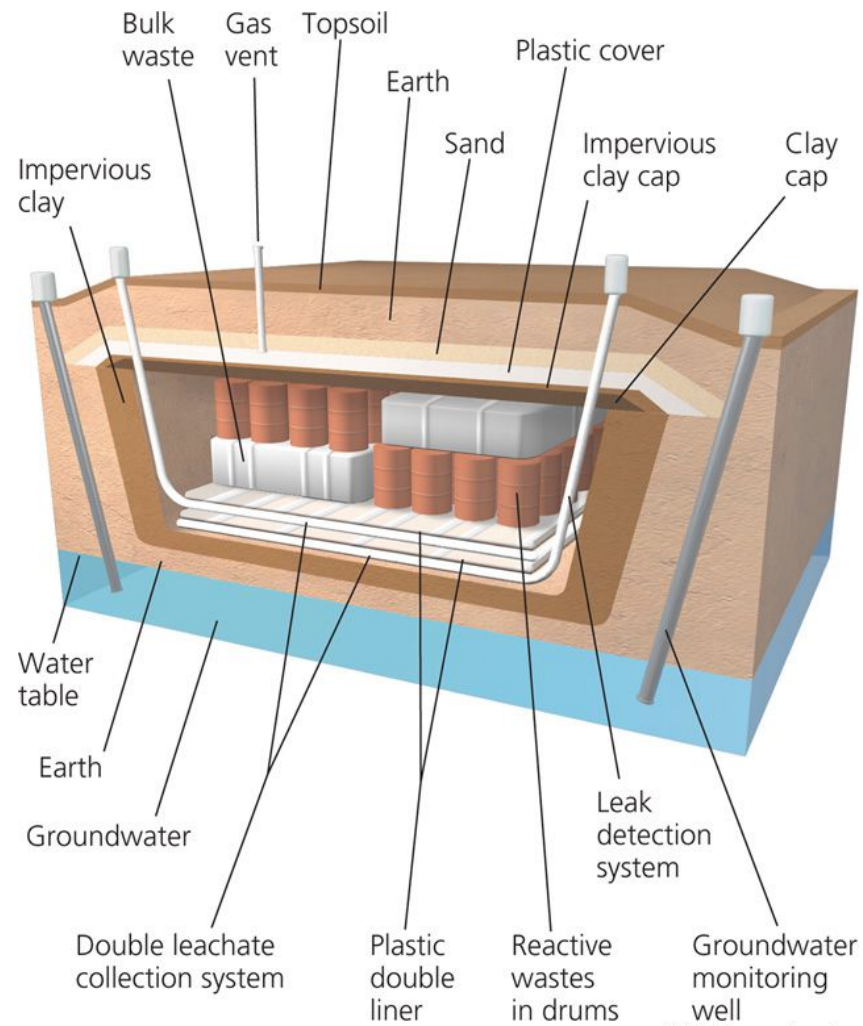
We Can Store Some Forms of Hazardous Waste

- Last resort: burial on land/long-term storage in secure vaults
 - Deep-well disposal – liquid waste pumped under high pressure through pipes into dry, porous formations beneath aquifers
 - Pros and cons: leakage from below into aquifers used for drinking water – inexpensive and waste can be retrieved if problems develop
 - Limited number of such sites and limited space within each

More Ways To Store Hazardous Waste

- Surface impoundment – storage in lined ponds, pits or lagoons
 - Some have no liner, liners can leak or overflow during storms, and both can cause waste to percolate into groundwater
- Secure hazardous waste landfills: containment of both liquid/solid hazardous waste in drums/other containers and buried in landfills (expensive)

Hazardous Waste Storage



© 2016 Cengage Learning

16.6 How Can We Make the Transition To a More Sustainable Low-Waste Economy?

- Individuals and businesses will need to reduce resource use and to reuse and recycle both solid and hazardous waste at all levels (local, national, global)

Factors That Hinder Reuse and Recycling

- Artificially low prices – most products do not include harmful environmental/health costs associated with production/disposal
- Uneven economic playing fields – reuse and recycling industries do not receive the tax breaks/subsidies given to extraction industries
- The demand and pricing for recycled materials fluctuates

Reduction of Hazardous Waste Through Government Channels

- Basel Convention Treaty (1992) – bans participating countries from shipping hazardous waste to or through countries without their permission
- Stockholm Convention on Persistent Organic Pollutants (POPs) – regulates 12 most widely used organic pollutants (dirty dozen); strengthened in 2014 to ban or phase out these chemicals

More on Treaties and Laws

- US has signed, but not ratified, the Basel Convention Treaty (179 countries have)
 - A ban on transferring hazardous wastes from industrialized countries to less-developed countries still awaits ratification
- In 2000, the Swedish Parliament passed a law requiring industries to perform chemicals risk assessment – the burden of proof to show safety is now with industry

Additional Case Study: How Most of Europe Deals With the 4 R's

- Stena, a Scandinavian based European reuse/recycling company
 - Recycles electronics, plastics, and other solid and hazardous waste
 - Created x-ray glass and blasting abrasives from old picture tubes
 - Recycled plastics – which due to moisture and other contaminants stored in plastic containers, can only be recycled about 10 times

Additional Case Study: How Most of Europe Deals With the Four Rs

- To see the environmental impact of recycling, check out Stena's interactive Climate Wheel
 - Select an item and quantity of it for recycling – a calculation is performed and you can see the amount of CO₂ conserved
- Stena says “To us, waste is what is left when imagination runs out”

Additional Case Study: How Most of Europe Deals With the 4 Rs

- How does Stena handle hazardous wastes?
- How much CO₂ is saved by recycling 1000 cell phones?
- Do you think if people were more aware of the environmental and economic savings illustrated by the Climate Wheel, they would recycle more?
- Would you consider using their services?

Stena Innovative Recycling and the Three Big Ideas

- Stena is following sustainability priorities by collecting/reusing and recycling as much waste as possible
 - Working with all major treatment facilities in northern Europe, Stena offers secure recyclable/non-recyclable hazardous waste services
- Stena, approved by the European Union, is a good example of a company viewing solid waste as an economic resource