



# Chapter 16

## Waste Generation and Waste Disposal

# **Paper or Styrofoam; Which is Better?!?!?**

**Use Text book pg. 437 to help you  
decide and support your claim.**

**Think environmentally,  
ecologically, economically and  
socially.**

# Paper vs. Styrofoam

## (Life-cycle Analysis)

- Decomposes (landfill – produce of methane gas)
- Uses renewable material
- Could be recycled or composted

- Cannot hold without cardboard band for hot liquids (environmental conseq.- more waste)
- Uses 2x as much energy, more water to make
- Heavier, requires more energy to transport (air pollution)
- Used once, throw away
- Bleach used to make, may cause harm to aquatic life (disposal process)
- Small amt. of energy yield (incineration – air pollution)

- Minimizes temp. changes
- Lighter, insulates better, less expensive
- Potentially capable of using more than once (typically used once)

- Does not decompose (landfill)
- Uses non-renewable material
- Polystyrene cup might leach chemicals from plastic to hot liquid (health risk – social conseq)
- Small amt. of energy yield (incineration – air pollution)
- Workers exposed to toxic emissions

# Inputs vs. Outputs vs. Internal Changes in a Ecological System

- In an **Ecological System**, *plant material, nutrients, water, & energy* are the **INPUTS** (Human inputs are similar but can be manufactured goods as well)
- **OUTPUTS** include *anything not useful or consumed, and non-useful products* are called **Waste**
  - **Waste is a component of a human-dominated system in which the products are manufactured, used, and eventually disposed of** (waste of one system may be the input of the next system Ex. fertilizer)



Since the early 1950's with the upcoming of paper & plastic products (disposal diapers) we are known as the **"throw-away society"** ....referred to as **planned obsolescence** – *goods become obsolete and require replacing*

# Municipal Solid Waste (MSW)

-Waste collected by municipalities from households, small businesses, and institutions such as schools, prisons, municipal buildings & hospitals.

- EPA estimates 60% of MSW comes from residents and 40% from commercial & institutional facilities

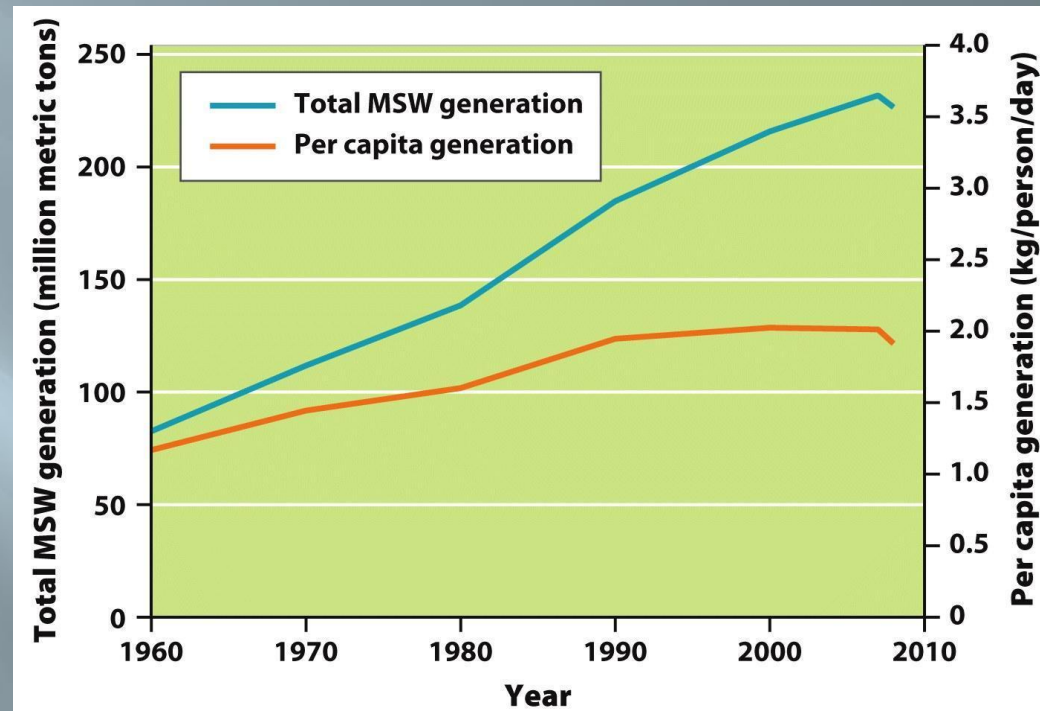
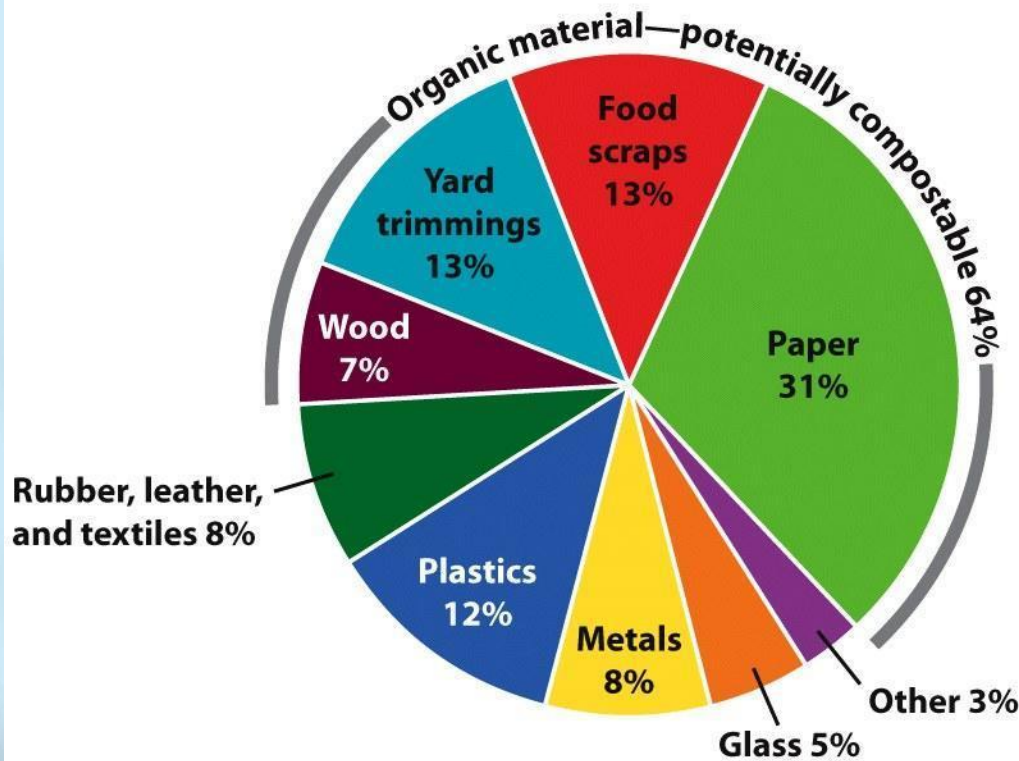
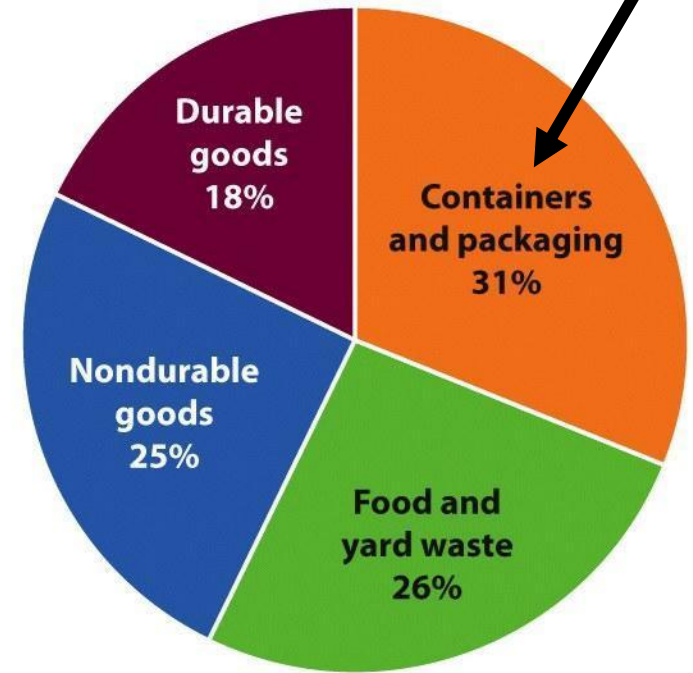


Figure 16.3  
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**Waste Stream-** the flow of solid waste that is recycled, incinerated, or placed in landfill (or disposed in a different way).



(a) Breakdown of MSW by composition



(b) Breakdown of MSW by source

Figure 16.5  
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## Composition of Municipal Solid Waste

Waste generation varies by season of the year, socioeconomic (more \$\$, more waste), geographic location with the country.

Agricultural waste, mining waste, industrial waste (average 4.5lbs/person in U.S, developed nations range from 1.8-4.8lbs/person, Japan 2.4lbs each day)

# E-Waste

- **Electronic waste** (E-waste) televisions, computers, cell phones that **contain toxic metals such as Hg & Cd** (roughly 2% of waste stream but growing, environmental effect is greater)

Incentive to recycle these products; however, cost more to recycle than put in landfill.

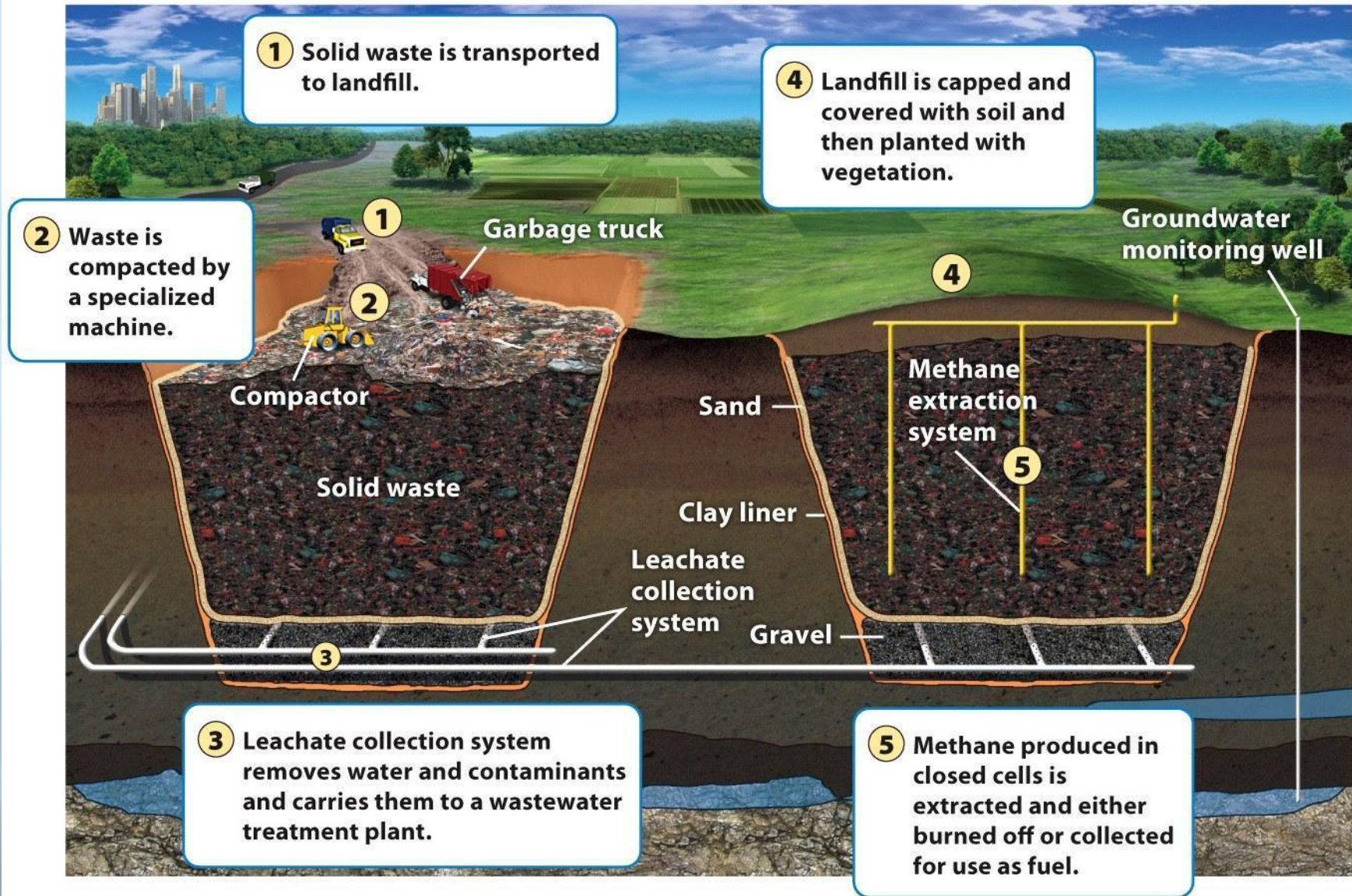


**Figure 16.6**  
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# Landfills

- **Sanitary landfills-** **engineered ground facilities** (holes lined with clay (impede water flow) designed to **hold MSW** with as little contamination of the surrounding environment as possible.
- **Leachate-** the **water that leaches through the solid waste** and removes various chemical compounds with which it comes into contact.
  - Leach into aquifers, rivers, streams, drinking water supplies & human habitation.
  - System of pipes is constructed below the landfill to collect leachate
  - Cover of soil & clay (cap) is installed when landfill reaches capacity.





**Most important component is controlling inputs...materials destined for a landfill are those with least likely to cause environmental damage through leaching.**

# Consequences of Landfills:

- Take up **space** (locations – adjacent waterways)  
**Proximity to neighborhoods...most ignored factor!!!!**
- **Organic material is unstable** – absence of oxygen, anaerobic bacteria produces *methane gas* (much more potent greenhouse gas than CO<sub>2</sub>, *can be extracted to be burned off or used as fuel*) proper ventilation piping (no trapped gases, highly explosive), not enough moisture can reduce decomposition; **remains the same size after capped**
- Improper lining and layering can lead into **leaching**...groundwater contamination
- **Toxic material**, such as household cleaners, oil-based paints, anything containing substantial quantities of metals (Al, Cu), automotive additives (batteries, antifreeze, motor oil...etc) should not be in landfills...leaching

**Alternative from landfills are the three R's and composting...**

# Reduce, Reuse, Recycle (3 R's)

- **Reduce**- (most desirable); *waste minimization* or prevention
  - **Input reduced=output reduced** (fewer resources are being expended, source reduction provides economic benefits)
- **Reuse**- (next desirable); *reusing* something like a disposable cup more than once.
  - allow the material to cycle w/in the system w/o additional energy or resources
- **Recycle**- (more efficient) materials are collected and *converted into raw materials* and then used to produce new objects
  - **Greatest problem** is there is not always a market for recycled goods

**Benzene and other petroleum raw materials**



**Carpet fibers**



**Collection and recycling**



**Carpet**

**Closed-loop recycling**

**Recycle product into same product, some additional energy and raw material is needed.**

**(ex. Al cans)**

Figure 16.8a  
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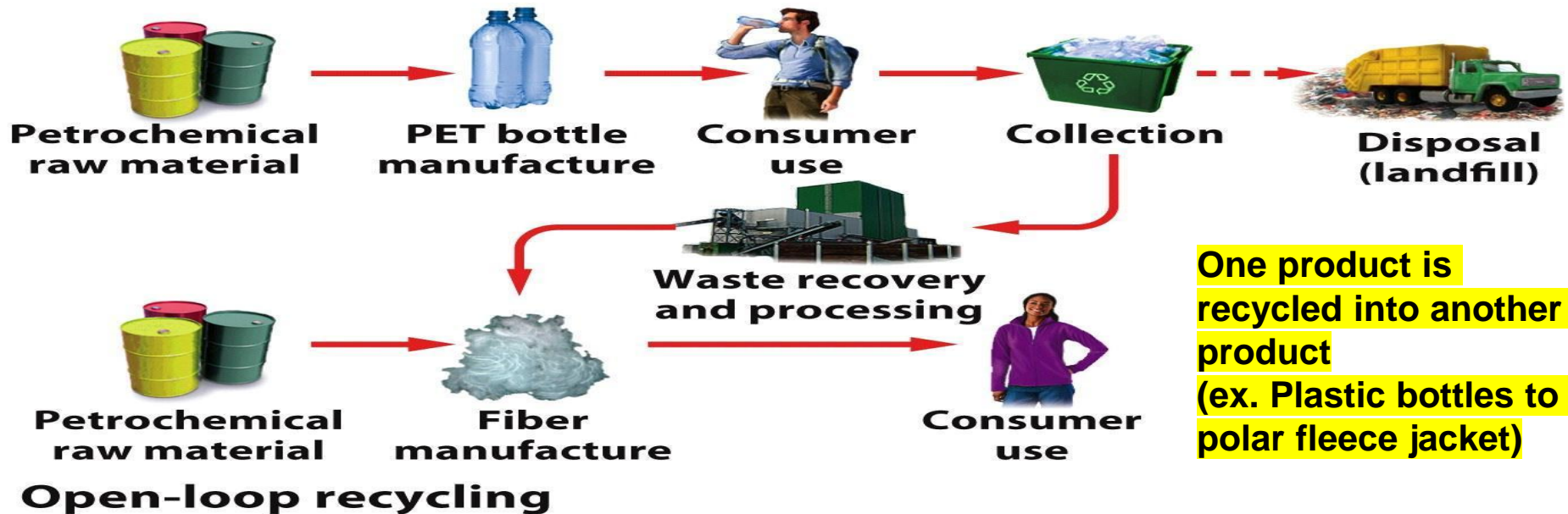


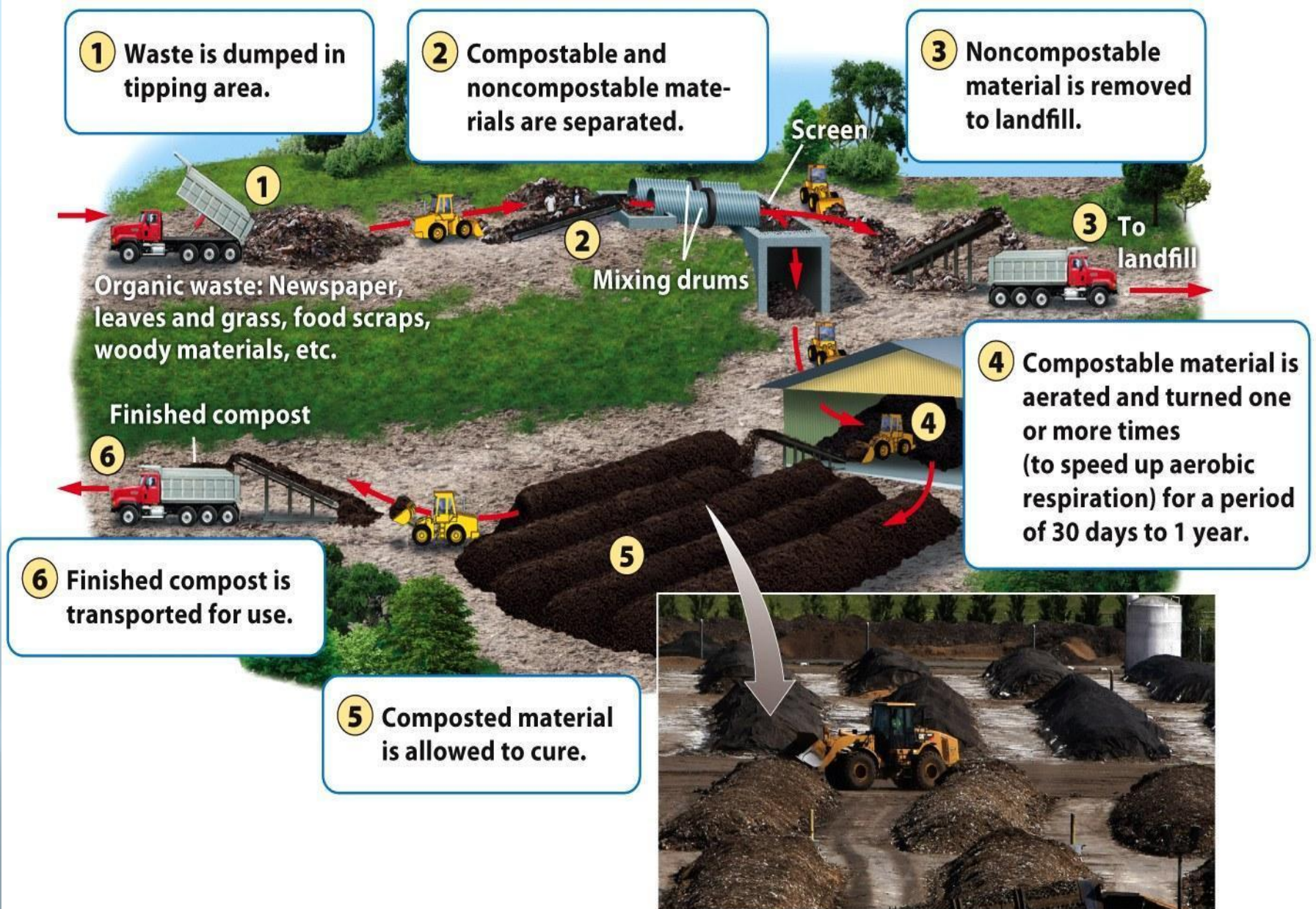
Figure 16.8b

# Composting

**Compost**- **organic material** (vegetation paper fibers, feces etc) that has **decomposed under controlled conditions** to produce an organic-rich material that **enhances soil structure, cation exchange capacity & fertility** (*no meat & dairy products, do not decompose easily, smell foul*).



Figure 16.11  
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**Figure 16.12**

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# Incineration

Incineration- the process of **burning waste materials** to reduce its volume and mass (75%-90%) & sometimes to generate electricity and heat (byproduct ash & air pollution in the form of particular matter and gas emissions).

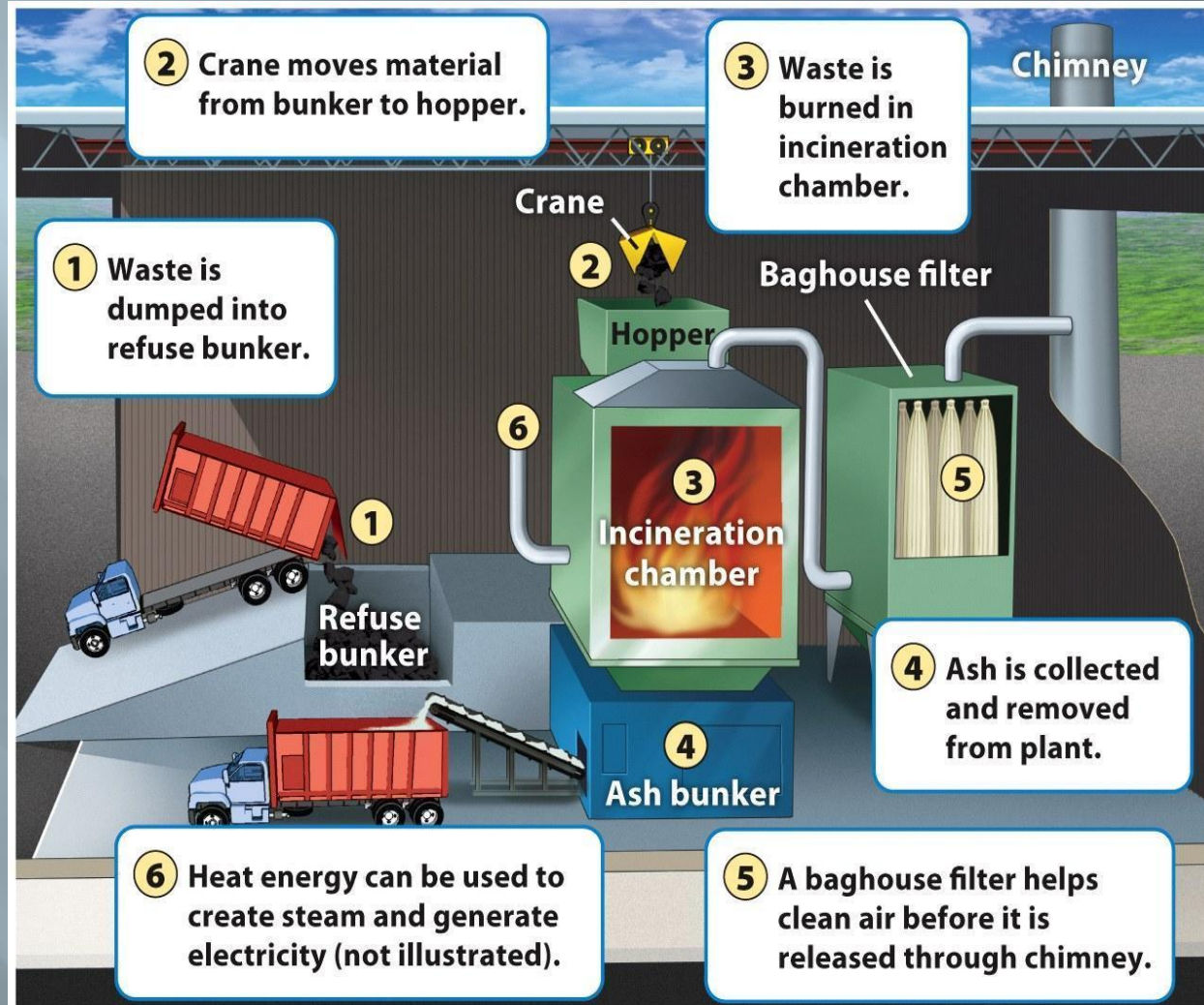


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# Incineration Consequences

- Construction, operation, maintained **costs** (higher costs than landfills)
- **Release air pollution & particular matter** (ash – more concentrated thus more toxic, requires special landfill)
- Difficult to burn all the waste deposited...**uniform burn**

Best choice is **the production of less material** for either the landfill or the incinerator



# Hazardous Waste

- **Hazardous waste**- liquid, solid, gaseous, or sludge waste material that is **harmful to humans or ecosystems**.
- **Collection sites** for hazardous waste **must be staffed** with specially trained personnel (*most communities do not have regular collection sites for hazardous waste, have to hold onto until periodic collections are held*)
- **Hazardous waste must be treated** before disposal (*making it less environmentally harmful*)
- Treatment & disposal of **hazardous waste is more expensive** and more difficult than ordinary MSW.

# Laws

- *Resource Conservation and Recovery Act (RCRA)*- designed to protect human health & the natural environment by **reducing or eliminating hazardous waste**.
  - Also know as “*cradle-to-grave*” tracking.
- RCRA ensures that hazardous waste is tracked and properly disposed of.
- In 1984, RCRA was modified to federal *Hazardous & Solid Waste Amendments (HSWA)*- encourages **waste minimization** & phased out of the disposal of hazardous wastes on land.
  - Increased law enforcement and punish violators

# Laws

- *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-*
  - Also know as “*Superfund Act*”.
- Puts a tax on the chemical and petroleum industries (*Superfund money*). This revenue is used to cleanup abandoned and nonoperating hazardous waste sites where a responsible party cannot be found (highest risk to public health).
- Requires the federal government (enforcement) to respond directly to the release of substance that may pose a threat to human health or the environment
  - EPA maintains the National Priorities list (NPL), contaminated sites (need to be rehabilitated before livable, Love Canal) that are eligible for cleanup funds

# Brownfields Program

- EPA created the *Brownfields* Program to assist state and local government in cleaning up contaminated industrial & commercial land that did not achieve Superfund category.
- Contaminated industrial or commercial sites that may require environmental cleanup before they can be redeveloped or expanded.
  - Old factories, industrial areas and waterfronts, dry cleaners, gas stations, landfills, and rail yards are some examples.
- Brownfield program lacks legal liability controls to compel polluters to rehabilitate their properties (no enforcement/consequences).

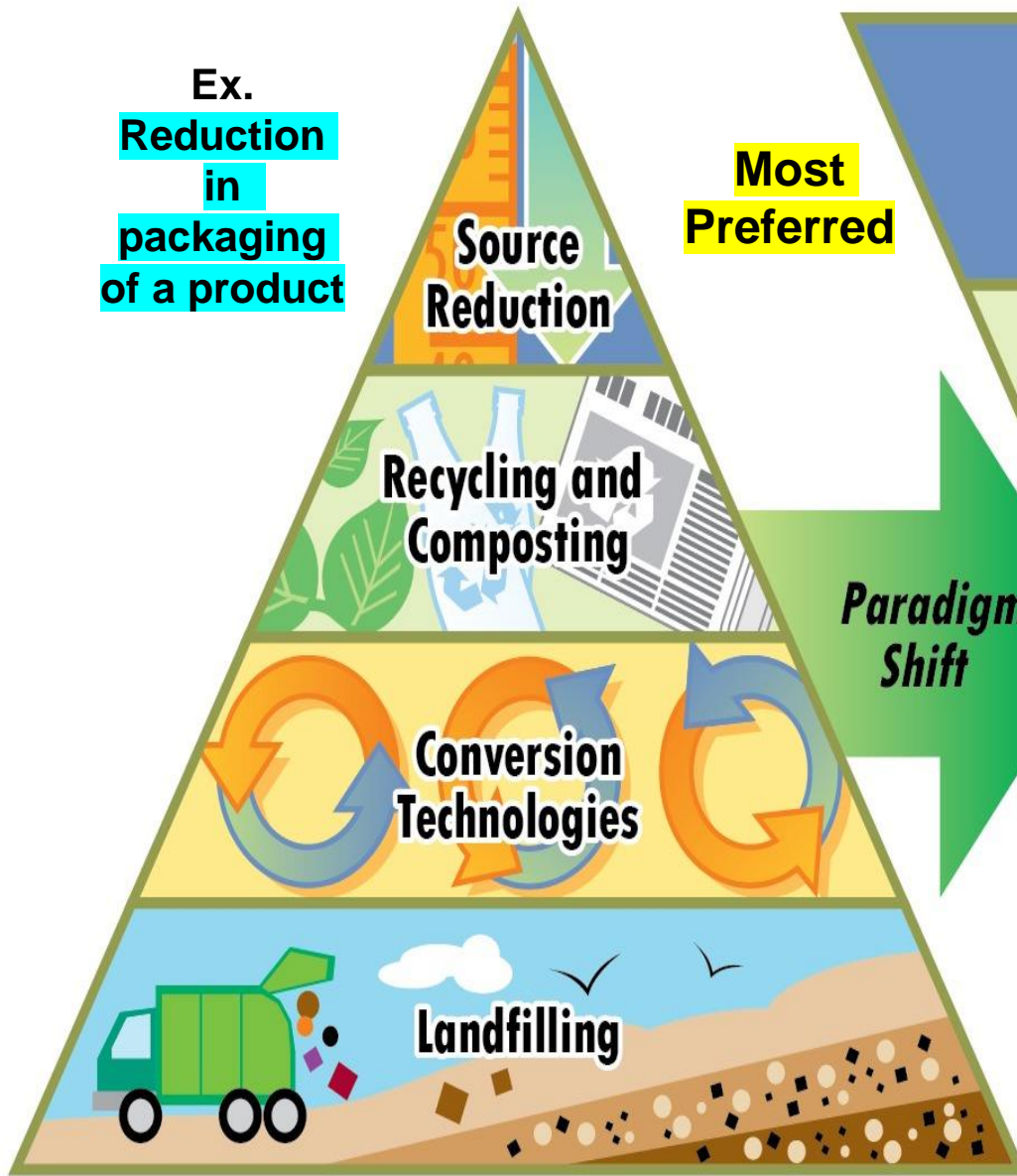
# Integrated Waste Management

- A method that seeks to develop as many options as possible, to reduce environmental harm and cost in a more holistic approach.  
(possibilities/solutions are endless)

## Some ways IWM is utilized:

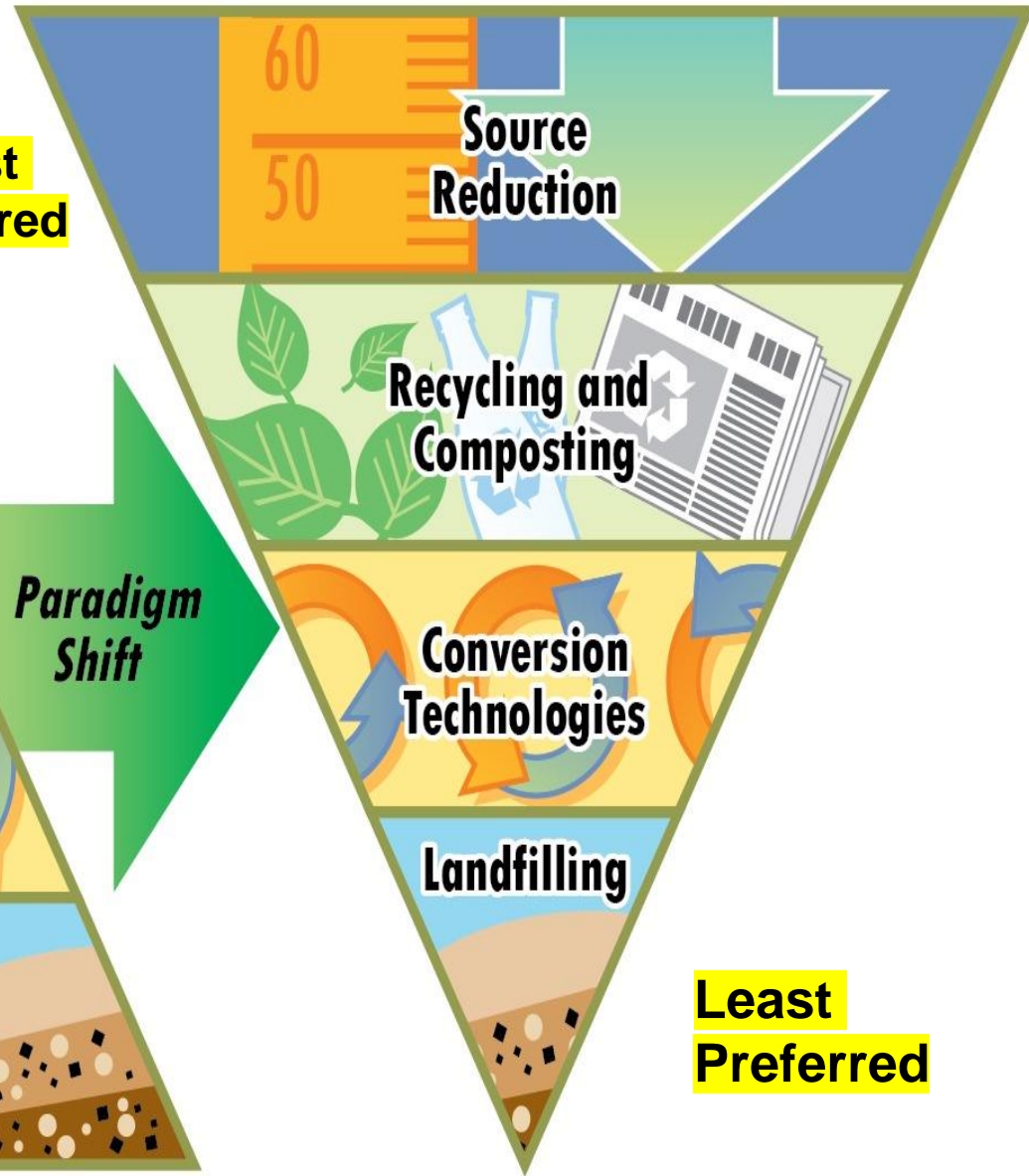
1. Reduction
2. Composting
3. Recycling
4. *Landfills (last resort)*
5. *Incineration (last resort)*

Ex.  
Reduction  
in  
packaging  
of a product



**Most Preferred**

**Paradigm Shift**



**Hierarchy of Preferred  
Solid Waste Management Strategies**

**Paradigm Shift  
for the 21st Century**