Lecture #6

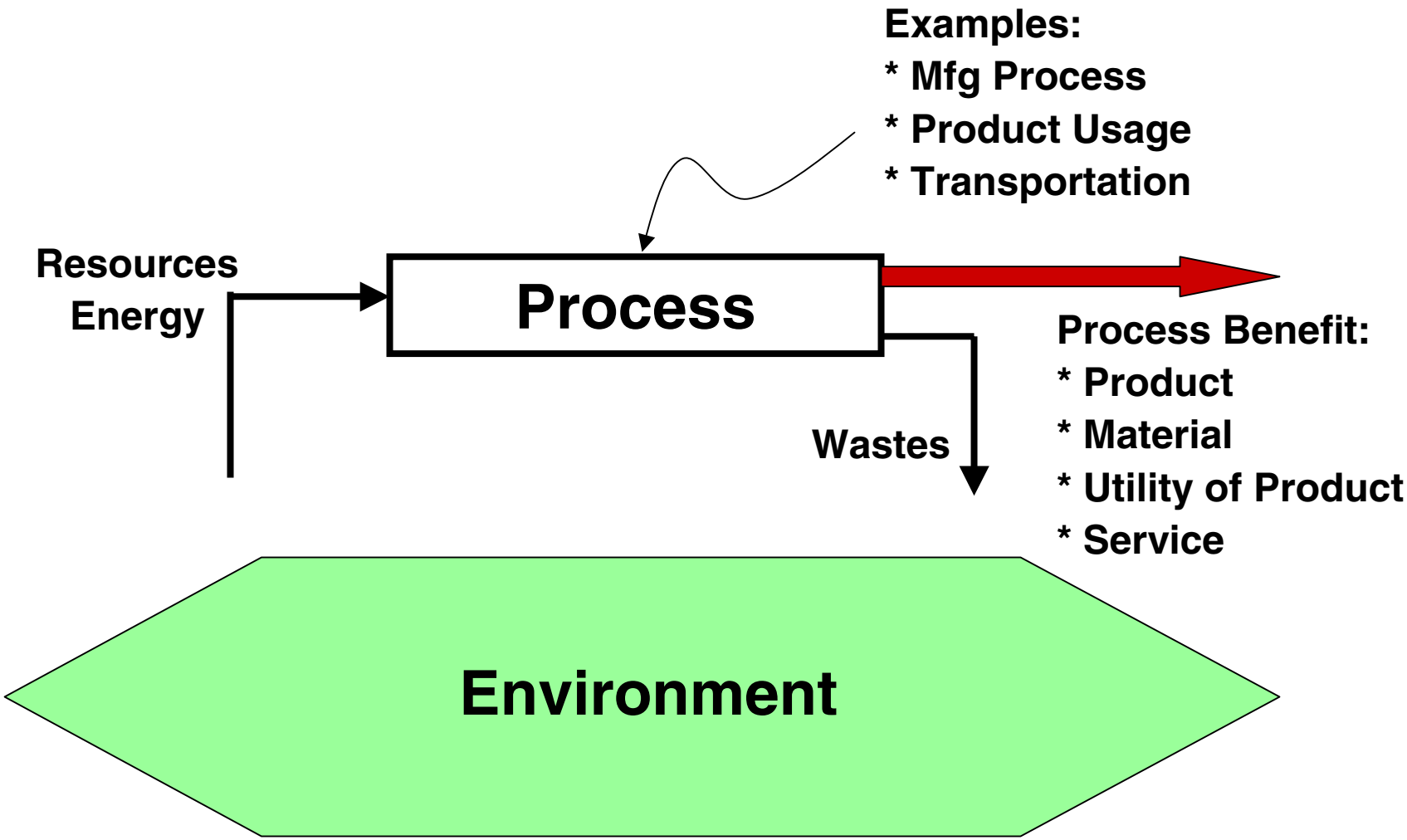
Environmentally Responsible Design and Manufacturing

Prof. John W. Sutherland

Jan. 23, 2004

© *John W. Sutherland*

Recapping

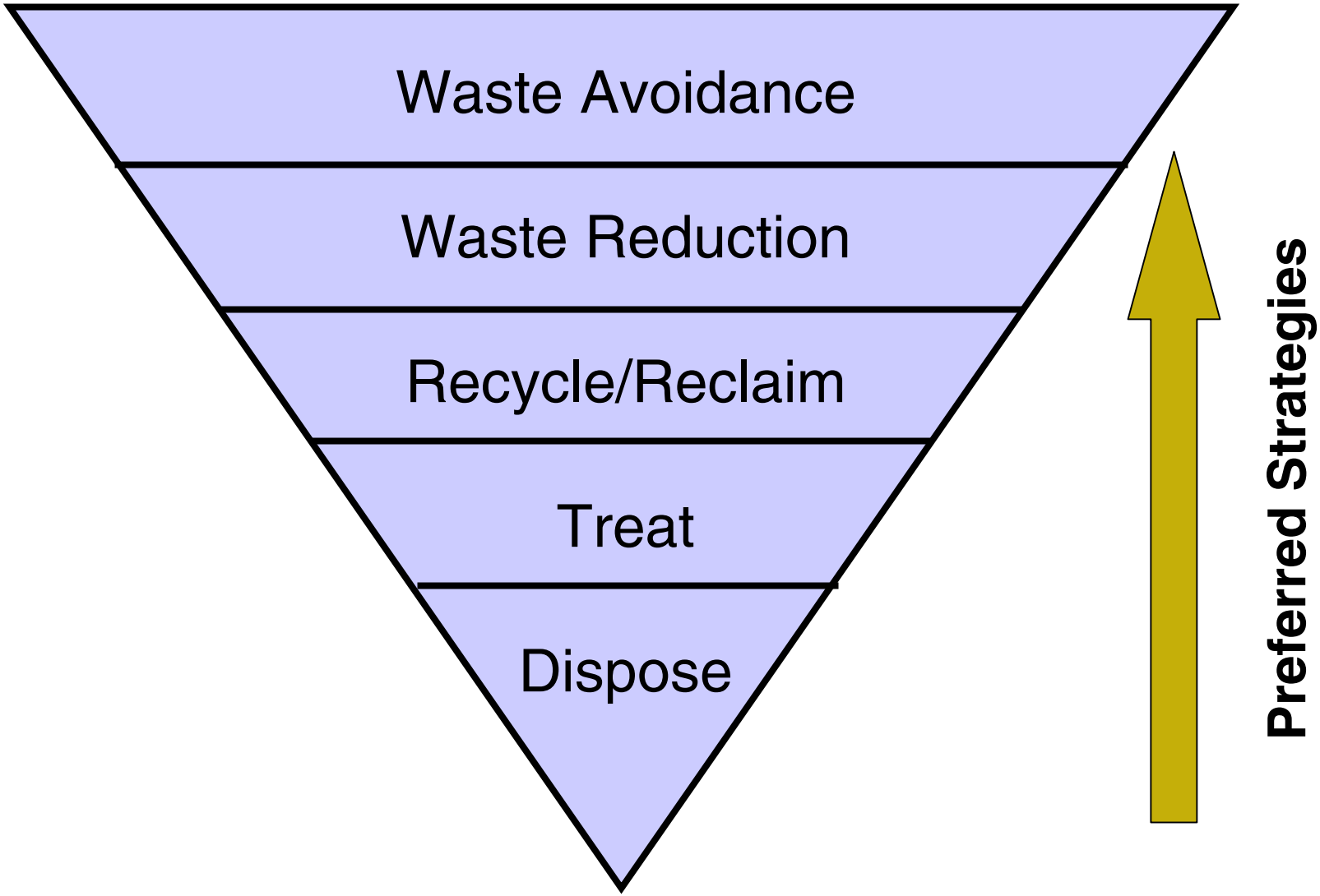

Examples:
* Mfg Process
* Product Usage
* Transportation
Resources
Energy
Process
Process Benefit:
* Product
* Material
* Utility of Product
* Service
Wastes
Environment

Lecture Objectives

- While it is not the preferred approach, we must study pollution control.

- To summarize important classes of pollution control technology

Pollution Prevention Hierarchy



Pollution Based on Form

- Airborne pollution
  - Combustion products (stationary, mobile)
  - Volatile chemicals (stationary, mobile)
- Waterborne pollution
  - Point sources (municipalities, industrial plants)
  - Non-point sources (urban runoff, agricultural runoff)
- Solid wastes

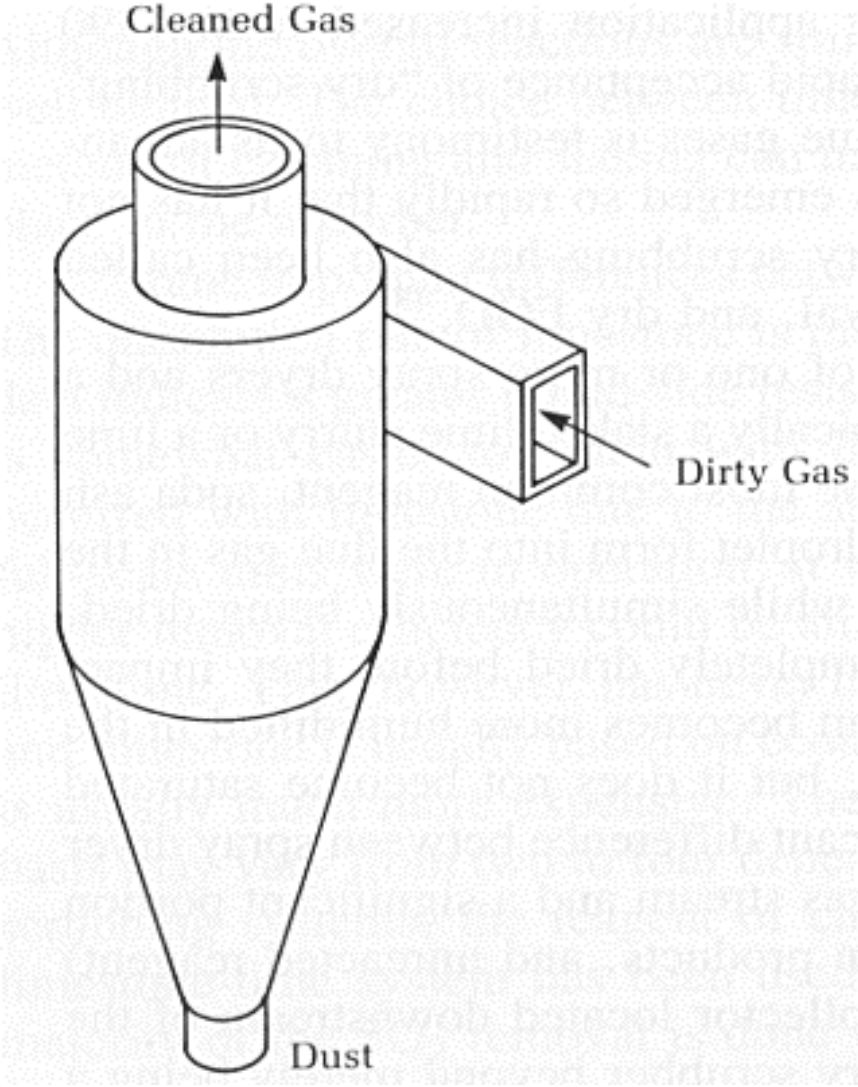
Criteria Air Pollutants

- Carbon monoxide (CO)
- Sulfur dioxide (SO2)
- Oxides of nitrogen (NOx)
- Volatile Organic Compounds (VOC)
- Photochemical Oxidants (O3, Smog)
- Lead (Pb)
- Particulates

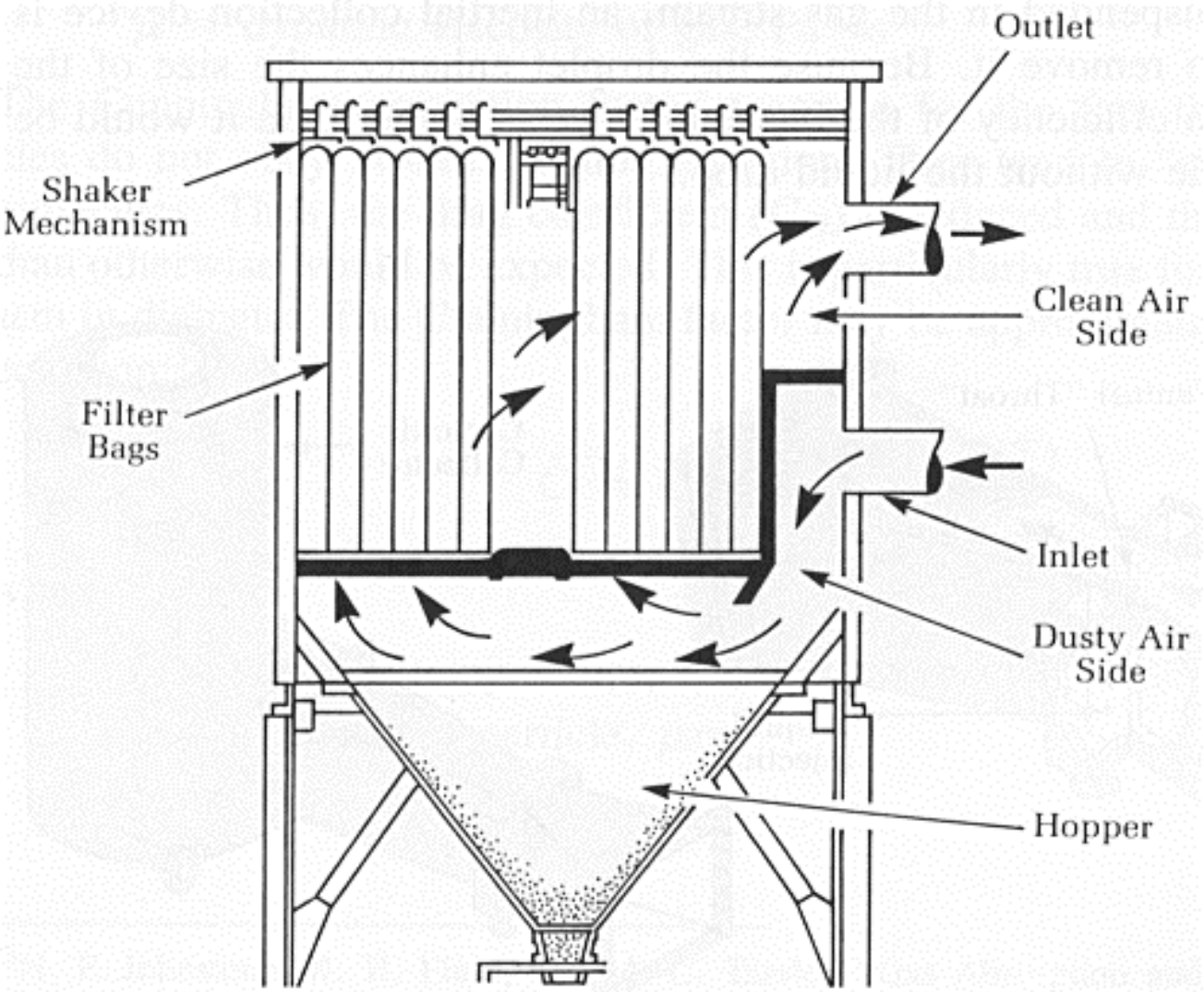
Particulate Removal

- Settling chambers
- Cyclones
- Filters (e.g., baghouse)
- Scrubbers
- Electrostatic precipitators

Cyclone separator



Baghouse Collector



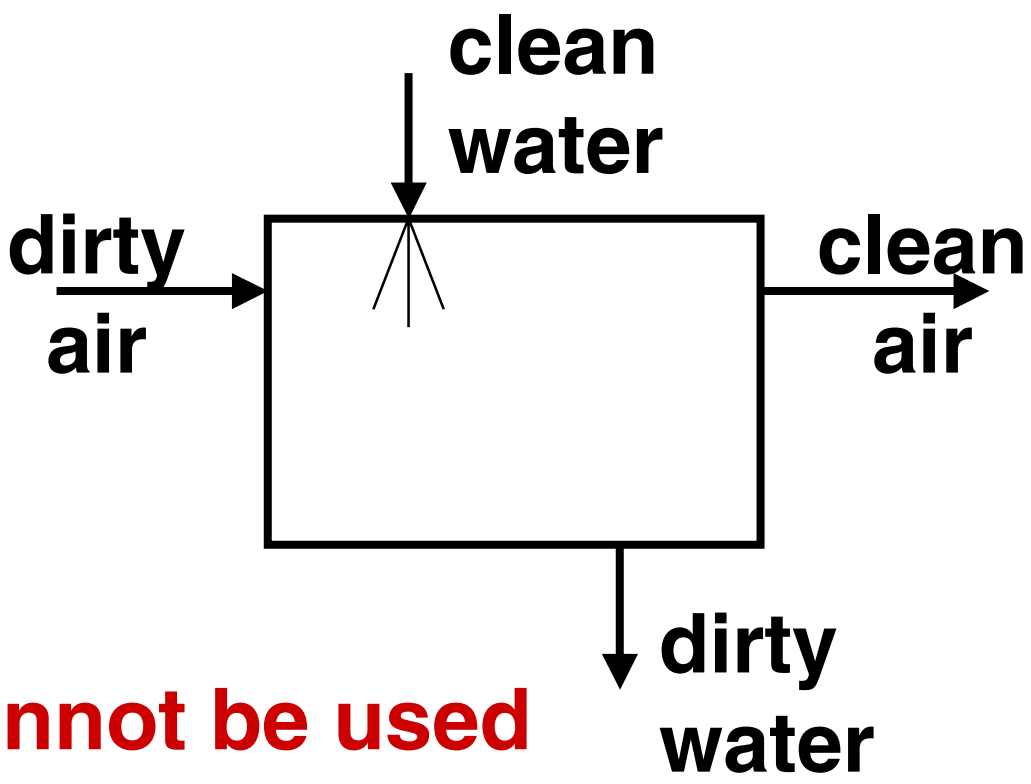
© John W. Sutherland

Gas Removal

- wet scrubbers
  - dissolve gas in water
- adsorption systems
  - gas molecules attach to surface
- incineration
  - gas molecules are oxidized to H2O, CO2, and other oxides

Air Scrubber

- used where
  - air is wet
  - corrosive
  - hot
  - baghouses cannot be used
  - in combination with cyclone



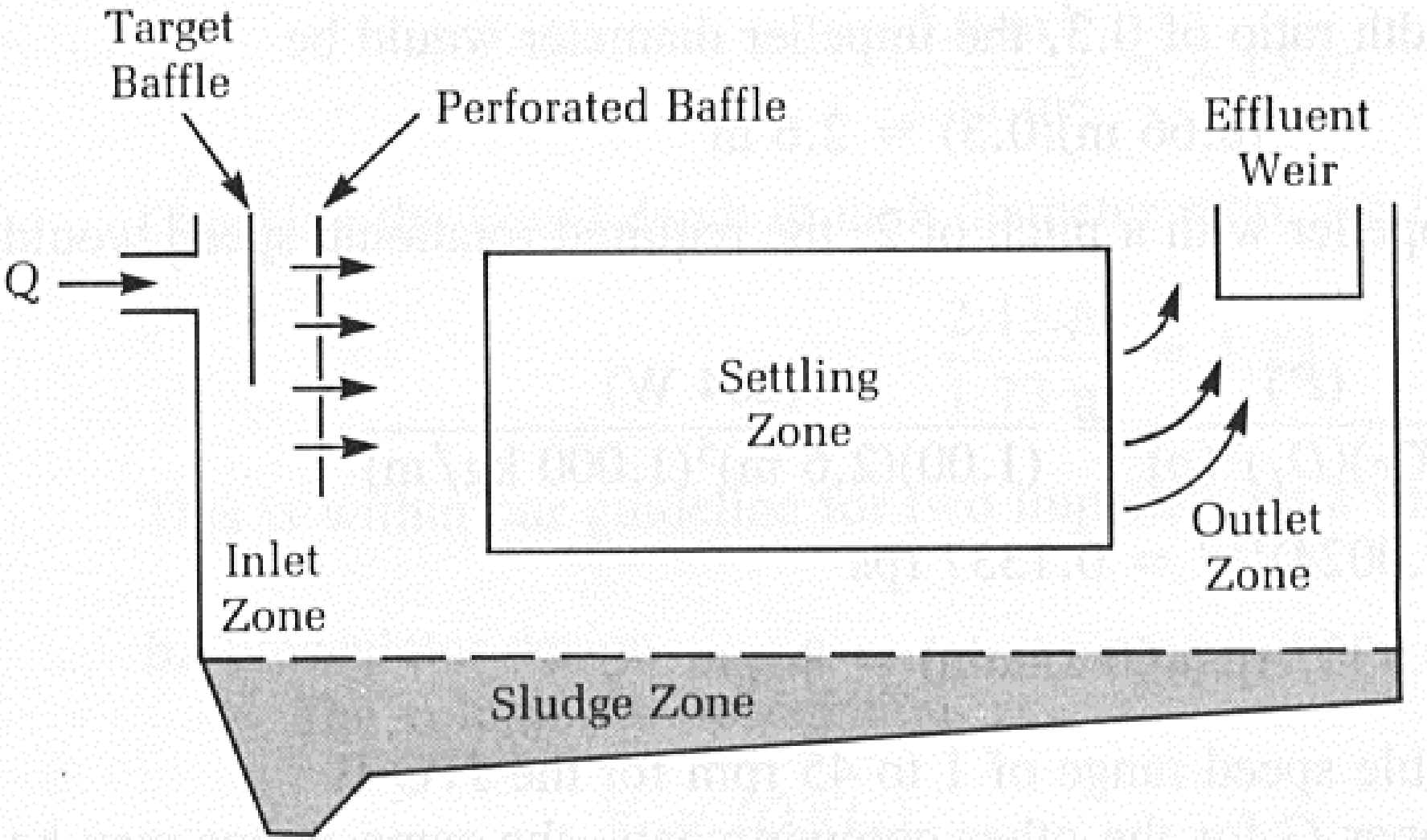
Typical Water Pollutants

- Suspended solids, particles
- Heavy metals (e.g., Hg, Cd, Cr)
- Dissolved organic compounds (e.g., pesticides, solvents, gasoline)
- Plant nutrients (e.g., N, P)
- Pathogens (e.g., bacteria, viruses)

Particle Removal

- Settling tanks, flotation units
- Chemical addition, coagulation, flocculation, and settling
- Filters

Settling Tank



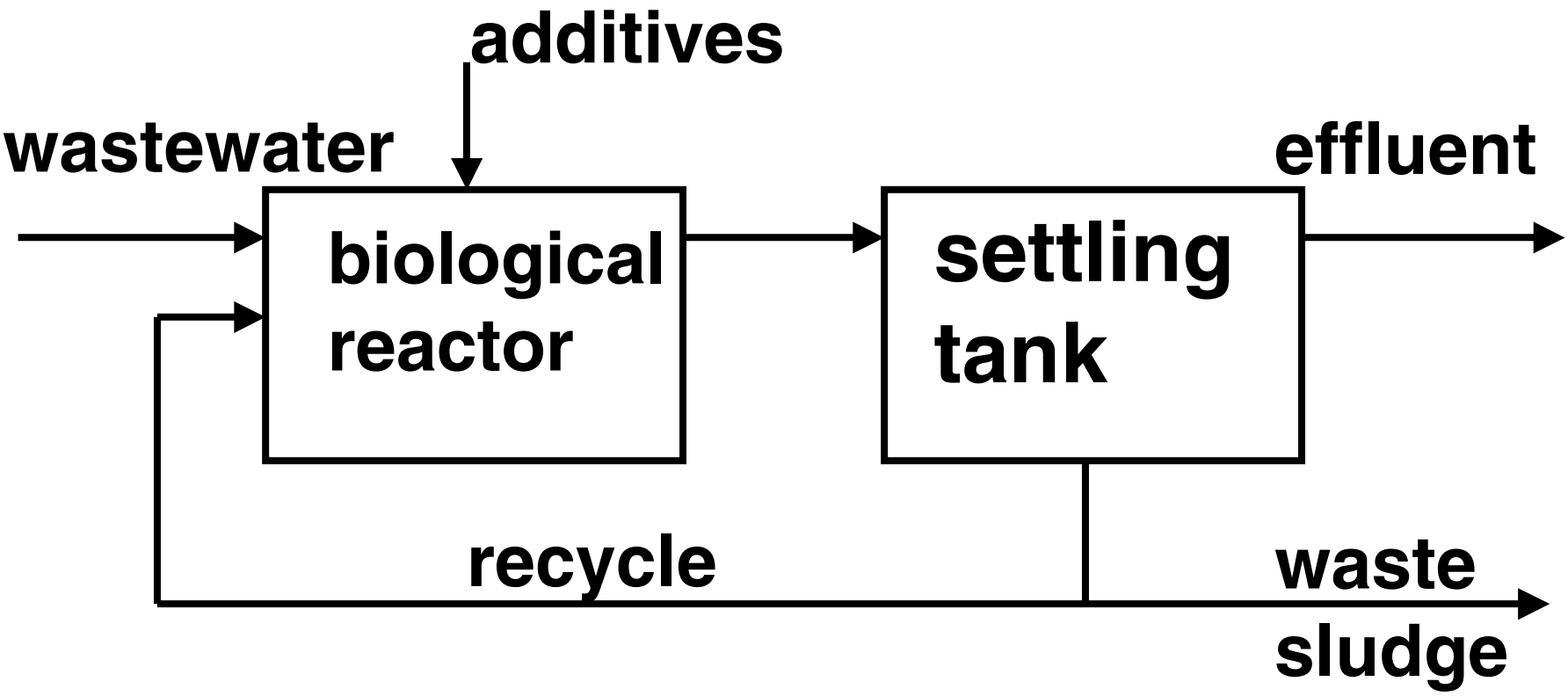
Heavy Metal Removal

- Chemical addition, precipitation, settling tank
- Ion exchange
- Oxidation, precipitation

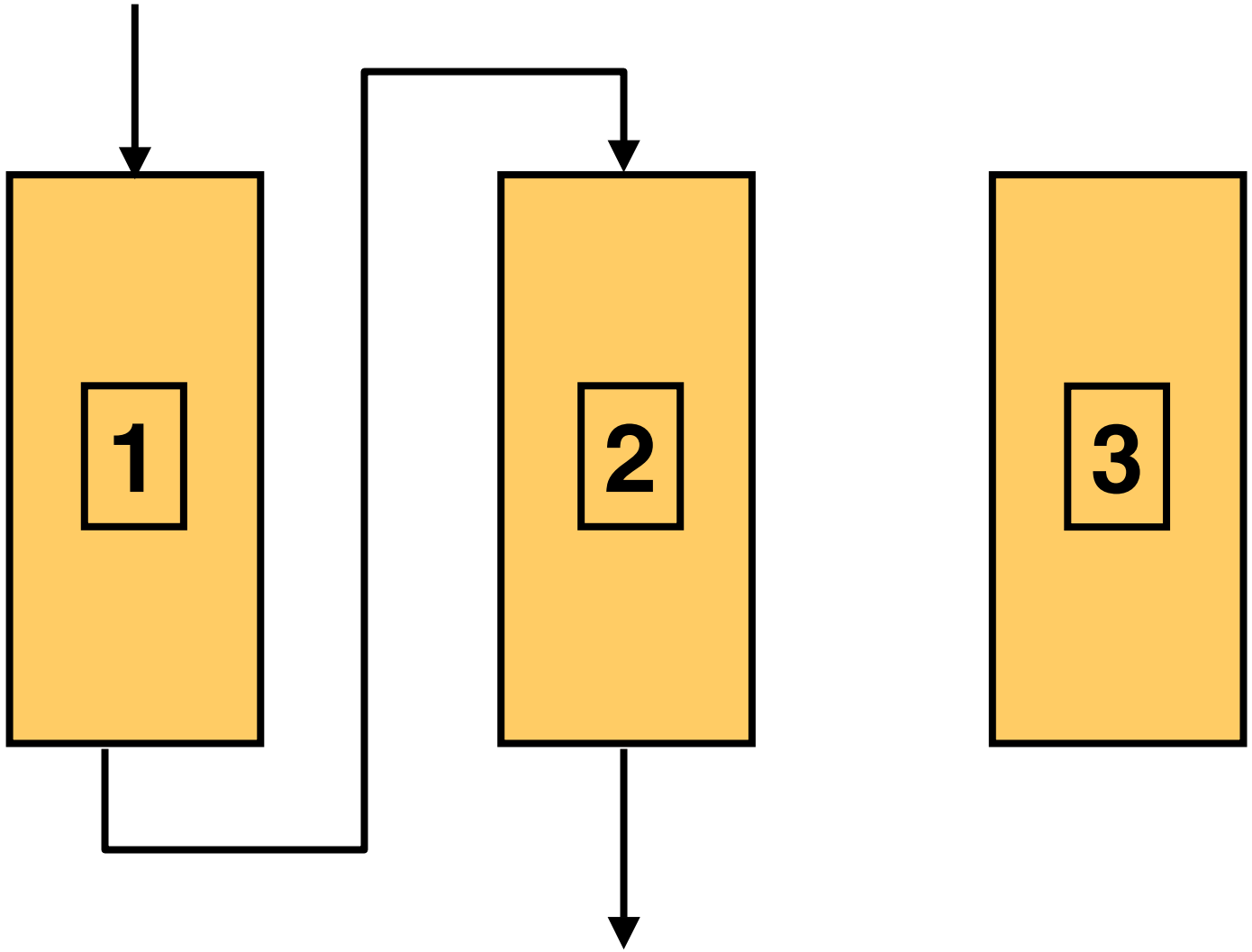
Organic Compound Removal

- Some removed as particulates
- Biological waste treatment
  - assimilation
  - metabolism
- Activated carbon adsorption

Biological Treatment System



Carbon Adsorption System



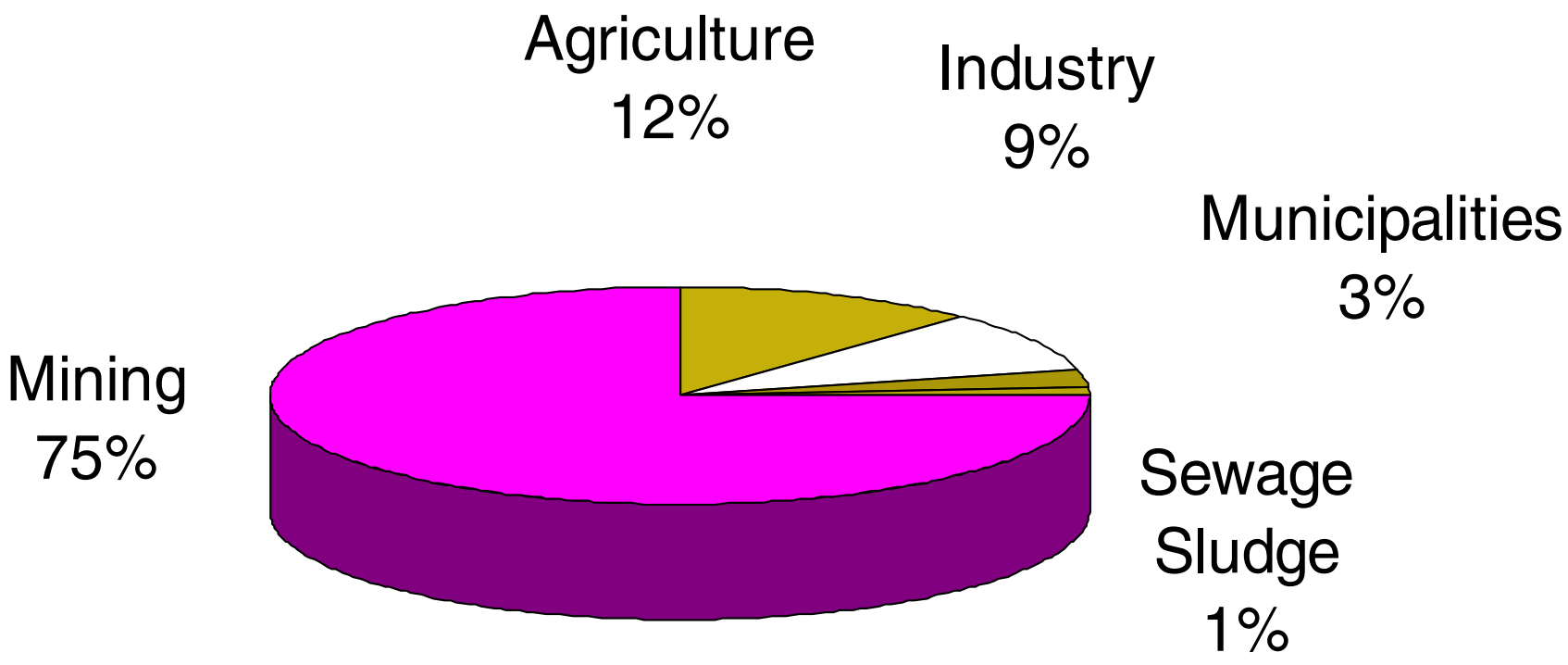
Nutrient Removal

- Biological waste treatment
- Chemical addition

Solid Waste Management

- Collection
- Transport/transfer
- Treatment
- Disposal

Major Sources of Solid Waste



Incineration

- Burns waste, though usually not completely
- Residual is about 10-20% of original material and is landfilled
- Can cause odors, soot, and other air pollutants
- May emit dioxin, which is highly toxic ("Love Canal")
- Can be used to produce energy

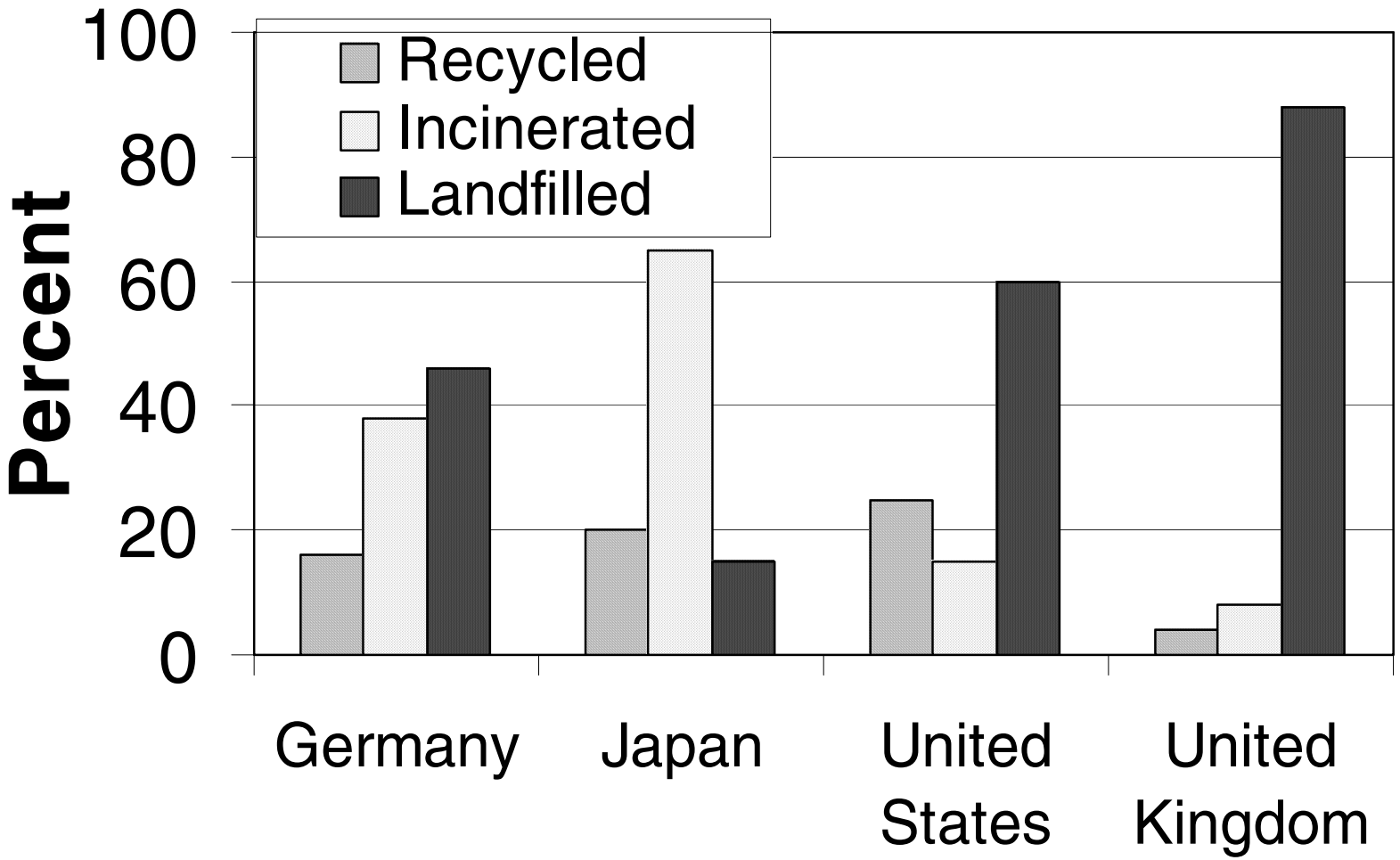
Sanitary Landfills

- Approximately 61% of solid wastes go to sanitary landfills
- sanitary landfills are not open dumps, but are engineered systems
- waste is deposited in compacted layers and covered with earth daily
- have impermeable liner, leachate, and gas collection systems

Resource Recovery

- Can involve
  - fairly simple methods like manual sorting
  - very complex automated material sorting and recovery facilities
  - reduces amount of disposable waste to about 1/3

Fate of Solid Wastes



Summary

- Almost every industrial production facility generates wastes – airborne, waterborne, solid – usually all forms
- Technology exists to deal with most wastes, some can be expensive
- Best to not to generate waste in the first place