Hazardous waste management I

Today's lecture

- Introduction to hazardous wastes
- Hazardous waste regulation in the US
- Soil and groundwater remediation techniques
  - Pump and treat systems
  - Soil vapor extraction & air sparging

Hazardous waste

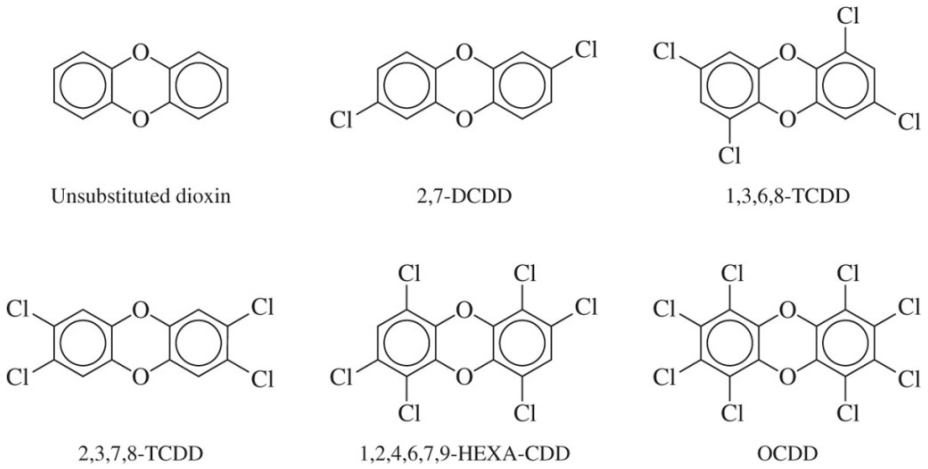
- Any waste or combination of wastes that poses a substantial danger, now or in the future, to human, plant, or animal life
- Must be handled or disposed of with special precautions

Hazardous waste

- Consequences of failure to manage hazardous wastes

Some examples of hazardous wastes

- Dioxins
  - Refers to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), or to the family of a chemical group called polychlorinated dibenzo-*p*-dioxins (PCDDs)
  - By-product that may be generated during the manufacture and burning of chlorophenols, 2,4,5-T, etc.



Examples of PCDDs

Some examples of hazardous wastes

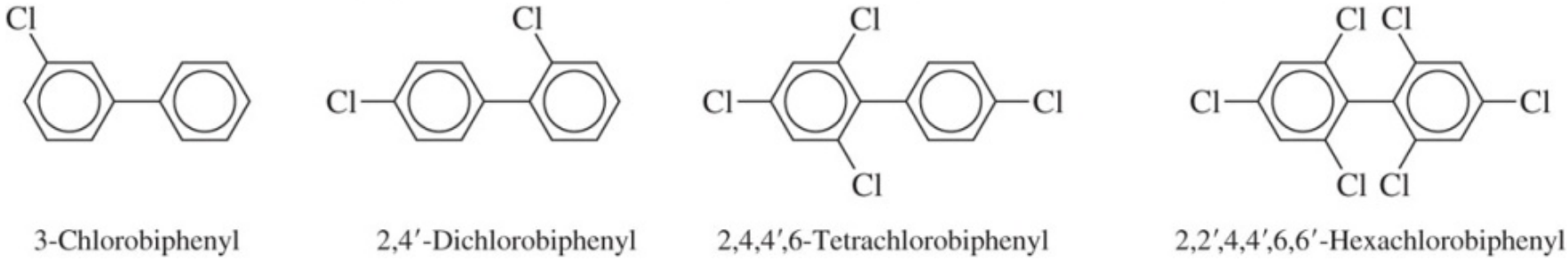
- Dioxins
  - 2,3,7,8-TCDD is probably the most poisonous of all synthetic chemicals
  - 2,3,7,8-TCDD is a “known” human carcinogen, and other dioxins are “likely” human carcinogens

Table. Approximate acute LD_{50}s of some chemical agents

Agent	**LD_{50} (mg/kg)**	**Agent**	**LD_{50} (mg/kg)**
Ethyl alcohol	10000	Hemicholinium-3	0.2
Sodium chloride	4000	Tetrodotoxin	0.1
Morphine sulfate	1500	2,3,7,8-TCDD	0.001
Nicotine	1	Botulinum toxin	0.00001

Some examples of hazardous wastes

- Polychlorinated biphenyls
  - A class of organic chemicals produced by the chlorination of a biphenyl molecule
  - 209 “congeners” exist



Examples of PCBs

Some examples of hazardous wastes

- Polychlorinated biphenyls
  - Used as coolants, lubricants, and coating materials until the 1970s
  - PCB manufacture and use were banned in the 1970s in developed countries
  - Chronic exposure could result in hazards to human health and the environment (PCBs are “likely” human carcinogen and endocrine disrupting compound)

Regulation for hazardous wastes (US)

- Resource Conservation and Recovery Act (RCRA)
  - Passed Congress in 1976
  - Amended in 1984 by the Hazardous and Solid Waste Amendments (HSWA)
  - A cradle-to-grave system for the management of hazardous waste: tracks whole life cycle (generation, transportation, treatment, storage, and disposal)
  - Requires permits for the treatment, storage, or disposal
  - Applies mainly to **active facilities** but not for abandoned or closed waste disposal sites or spills

Regulation for hazardous wastes (US)

- Comprehensive Environmental Response, Compensation, and Liability Act (1980)
  - Enacted in 1980
  - Commonly referred to as “Superfund” act
  - Addresses inactive or abandoned hazardous waste disposal sites
  - Extended in 1986 by the Superfund Amendments and Reauthorization Act (SARA)

Regulation for hazardous wastes (US)

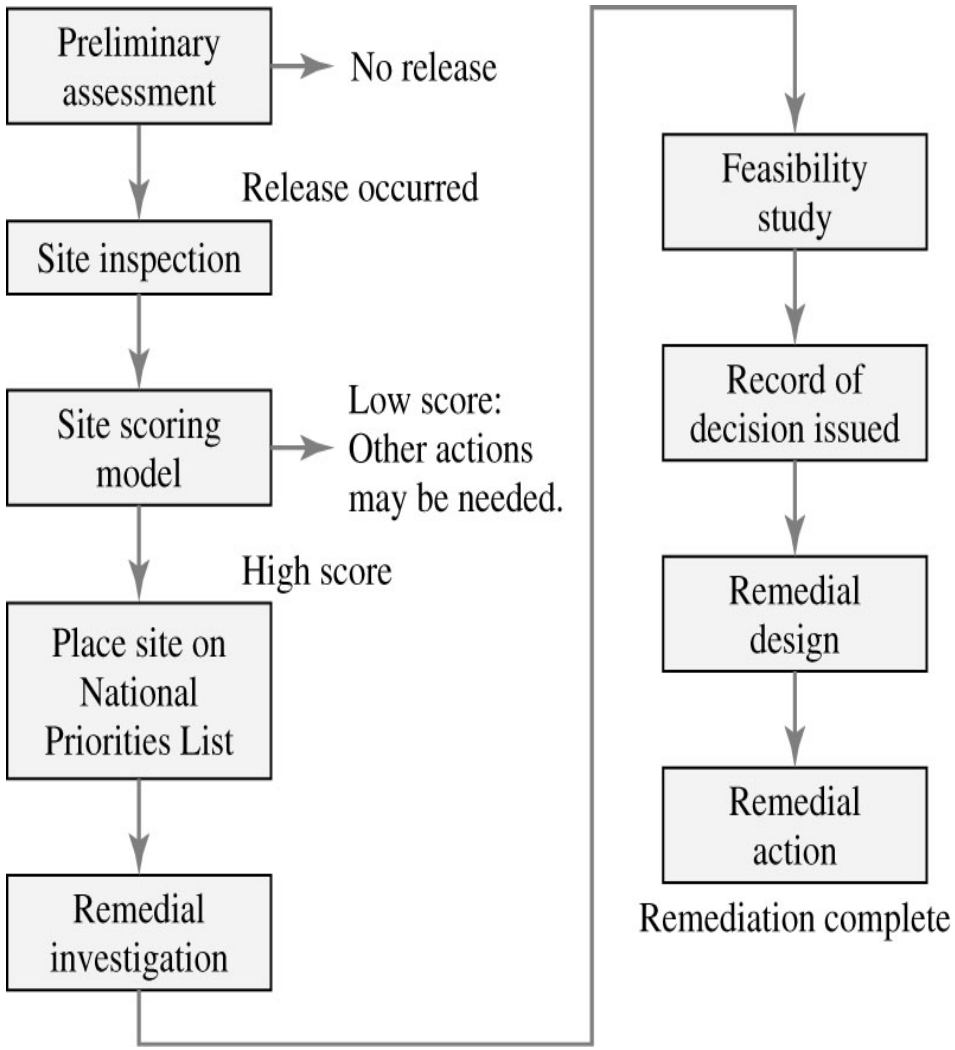
- Comprehensive Environmental Response, Compensation, and Liability Act (1980)
  - Major provisions
    - Generate a fund (the “Superfund”) to pay for investigations and remediation at sites where the responsive people cannot be found or will not voluntarily pay
    - A priority list of abandoned or inactive hazardous waste sites for cleanup (“the National Priority List”)
    - The mechanism for action at abandoned or inactive sites (the “National Contingency Plan”)
    - Liability for those responsible for cleaning up

Regulation for hazardous wastes (US)

- Comprehensive Environmental Response, Compensation, and Liability Act (1980)
  - National Priority List (NPL)
    - Identify sites that appear to present a significant risk to public health or the environment
    - To wisely use the Superfund money
    - Use “Hazard Ranking System (HRS)” to estimate the potential hazard to a score (added to the list if HRS score ≥ 28.50)
    - Updated three times a year: new sites are added to the list and sites are deleted from the list when remediation is completed
    - 1322 sites in the list in October 2014

Regulation for hazardous wastes (US)

- Superfund cleanup process Summary

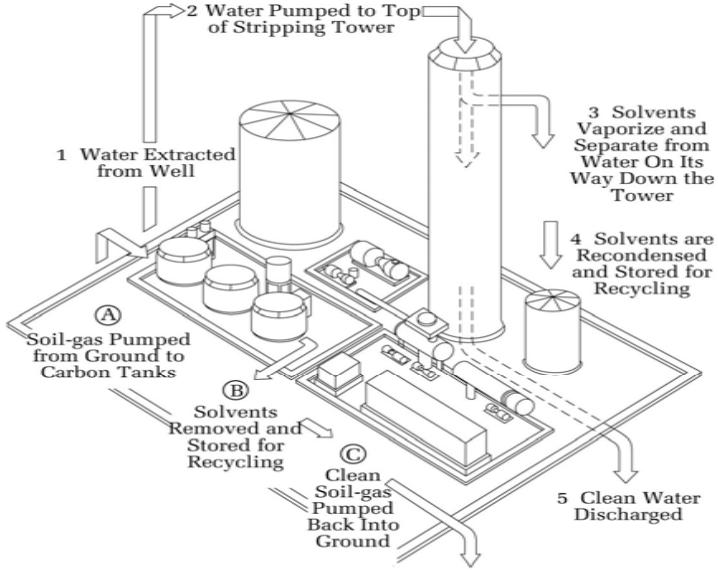


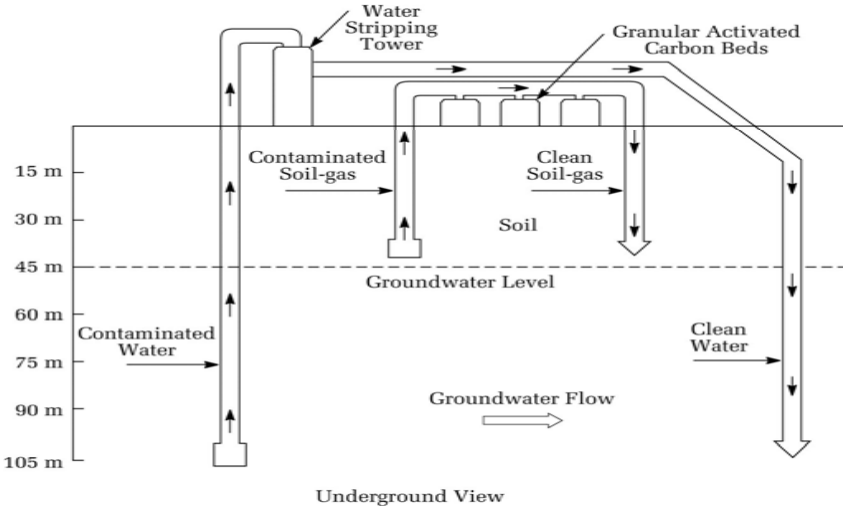
Soil and groundwater remediation techniques

- Pump-and-treat systems
  1) pump contaminated groundwater to the surface
  2) remove the contaminants
  3) either recharge the treated water back into the ground or discharge it to a surface water body or municipal wastewater treatment plant

Soil and groundwater remediation techniques

- Example of pump-and-treat systems





Soil and groundwater remediation techniques

- Soil vapor extraction (unsaturated zone)
  1) Install vertical extraction wells or horizontal extraction pipes at the contaminated site
  2) Apply vacuum
  3) Collect volatilized contaminants
  4) Treat the air containing contaminants above ground

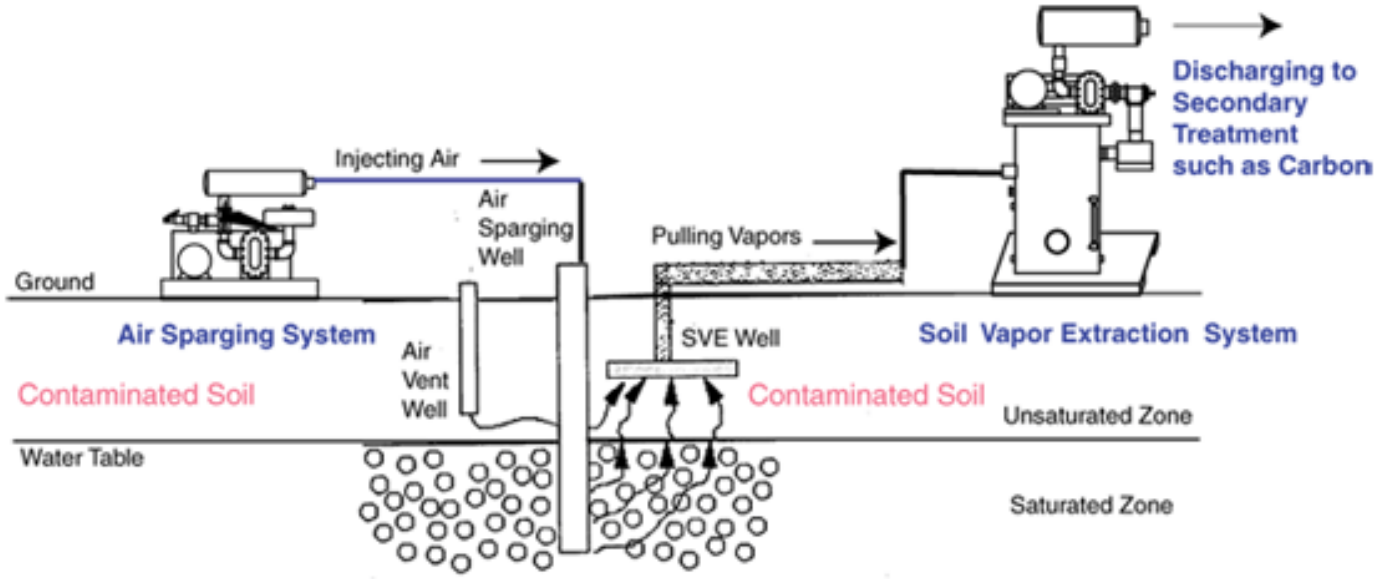
Soil and groundwater remediation techniques

- Air sparging (saturated zone)
  - Usually applied together with soil vapor extraction technique
  - Inject contaminant-free air into the saturated zone to convert dissolved contaminants into vapors
  - The contaminant vapor moved to the unsaturated zone is collected by the vapor extraction system

- Limitations of soil vapor extraction and air sparging: applicable to volatile compounds in high-permeability zones

Soil and groundwater remediation techniques

- Soil vapor extraction and air sparging



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