

GS 106 Notes - Water Pollution

- I. Water as a Natural Resource
 - A. Near-Surface Components of Hydrologic Cycle
 1. Oceans
 2. Rivers
 3. Groundwater
 - B. Water as a Resource (Important Uses)
 1. Required for Life: Plants, Animals
 2. Human Consumption
 3. Irrigation / Agricultural Production
 4. Industrial Processing
 5. Domestic Wastewater Management (sewage)
 - C. Water Use in the United States
 1. Basic Budget (approximate)
 - a. U.S. Rainfall = 4200 billion gal/day (input)
 - b. Evapotranspiration = 2750 billion gal/day (output)
 - c. Streamflow+Groundwater = 1400 billion gal/day
 2. Human Consumption of Water
 - a. average human needs 1 gal/day for internal consumption
 - b. U.S. daily consumption = 400 billion gallons per day
 - c. Actual Use = 1800 gal/person/day
 - (1) consumption, cooking, washing, industrial, agricultural
 3. Water Resource Problems
 - a. Water use does not match population / needs
 - b. water pollution reduces effective amount available for use
 4. Water Supplies in U.S.
 - a. Surface Water vs. Groundwater
 - (1) surface water important in humid regions
 - (2) groundwater important in arid regions
 - (a) largest reservoir of unfrozen fresh water
 - b. Seasonal Variation in Water supply
 - (1) droughts
 - (2) seasonal rainfall changes
 - c. Dams and Water Reservoirs
 - d. Highest Water Use
 - (1) Urban Areas
 - (2) SW U.S.
 - (a) irrigation
 - (b) high population growth
 - (c) arid conditions

II. Water Pollution Issues

A. Introduction

1. water is a good solvent, commonly associated with dissolved chemical constituents
2. "pollution" - contamination of water with unwanted or hazardous chemical constituents
3. common pollution sources
 - a. industry
 - b. agriculture
 - c. domestic sewage

B. Natural Geochemical Cycles

1. water dissolving elemental constituents from rock and sediment material
2. Commonly dissolved weathering products from rock material
 - a. calcium, iron, sulfur, sodium, chloride, magnesium

C. Residence Time - duration with which water resides in Earth reservoir systems

1. > residence time > opportunity for dissolution and addition of dissolved chemical constituents
2. residence time of dissolved ions - the length of time that individual ionic species are present in a dissolved state before they are removed by natural "attenuation" processes

D. Pollution Sources

1. Point vs. Nonpoint Sources
 - a. point pollution - pollutants are released at a discrete point of discharge
 - (1) e.g. a sewer outlet
 - b. nonpoint pollution - pollutants are released as diffuse contaminants from across the landscape
 - (1) e.g. fertilizer runoff from farmland
 - (2) petroleum-based runoff from parking lots
2. Industrial Pollution - 10's of thousands of chemicals are created each year by industrial and pharmaceutical chemists, industry forms a primary source of water pollution
 - a. Inorganic Pollutants - Metals
 - (1) e.g. mercury
 - (a) naturally occurring in rocks, thermometers, equipment
 - (b) very toxic, affects nervous system
 - (c) propagates easily through the food chain (e.g. seafood)
 - (2) Other metals - all toxic to system
 - (a) chromium - common in metals manufacturing
 - (b) lead - common in mining, batteries
 - (c) cadmium
 - (d) iodine
 - b. Other Inorganic Pollutants
 - (1) industrial acids
 - (2) acid mine drainage

- (a) common in coal and sulfide mining districts
- (3) asbestos - carcinogenic

c. Organic Pollutants

- (1) organic chemicals - carbon-based compounds
- (2) 1000's of naturally occurring and synthetic organic compounds exist
- (3) some organic chemicals are extremely carcinogenic or toxic to humans and animals
- (4) examples
 - (a) oil spills
 - (b) leaking gas storage tanks
 - (c) PCB's - polychlorinated biphenyls - common as coolant in electrical equipment

d. Thermal Pollution of Water

- (1) hot water pollution
- (2) destructive of cold water fisheries and other organisms
- (3) sources of thermal pollution
 - (a) power plants (cooling water)
 - (b) industrial cooling processes

e. Microorganisms

- (1) sewage discharge - source of viruses and bacteria
- (2) excess nutrient discharge - nitrogen
 - (a) nitrogen is important fertilizer source for plants
 - (b) algal blooms, excessive algal growth
- (3) eutrophication - excessive algal and plant growth with deposition of organic matter to bottom of surface water bodies
 - (a) result: organic infilling of water bodies and oxygen deficient environments

f. Agricultural Pollution

- (1) Fertilizers - nitrogen and phosphorous
 - (a) fertilizer runoff in streams and lakes
 - (b) excessive plant growth / eutrophication
 - (c) nitrate contamination - "blue baby syndrome"
- (2) Sediment Pollution - erosion and surface runoff
- (3) Herbicides and Pesticides

E. Pollution Prevention and Remediation

- 1. pollution prevention devices
- 2. ground and surface water remediation
 - a. chemical treatment strategies

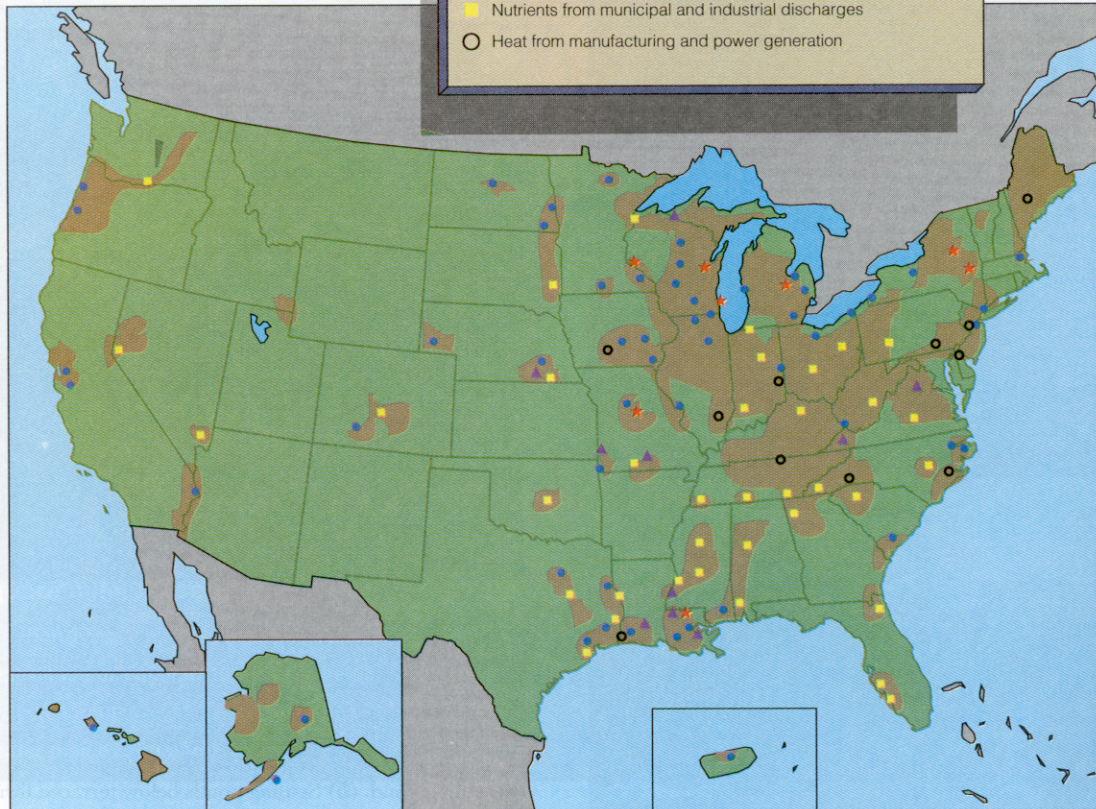
Explanation

Area problem

- Area in which significant surface-water pollution from point sources is occurring

Specific types of point-source pollutants

- Coliform bacteria from municipal waste or feedlot drainage
- ★ PCB (polychlorinated biphenyl), PBB (polybromated biphenyl), PVC (polyvinyl chloride), and related industrial chemicals
- ▲ Heavy metals (e.g., mercury, zinc, copper, cadmium, lead)
- Nutrients from municipal and industrial discharges
- Heat from manufacturing and power generation



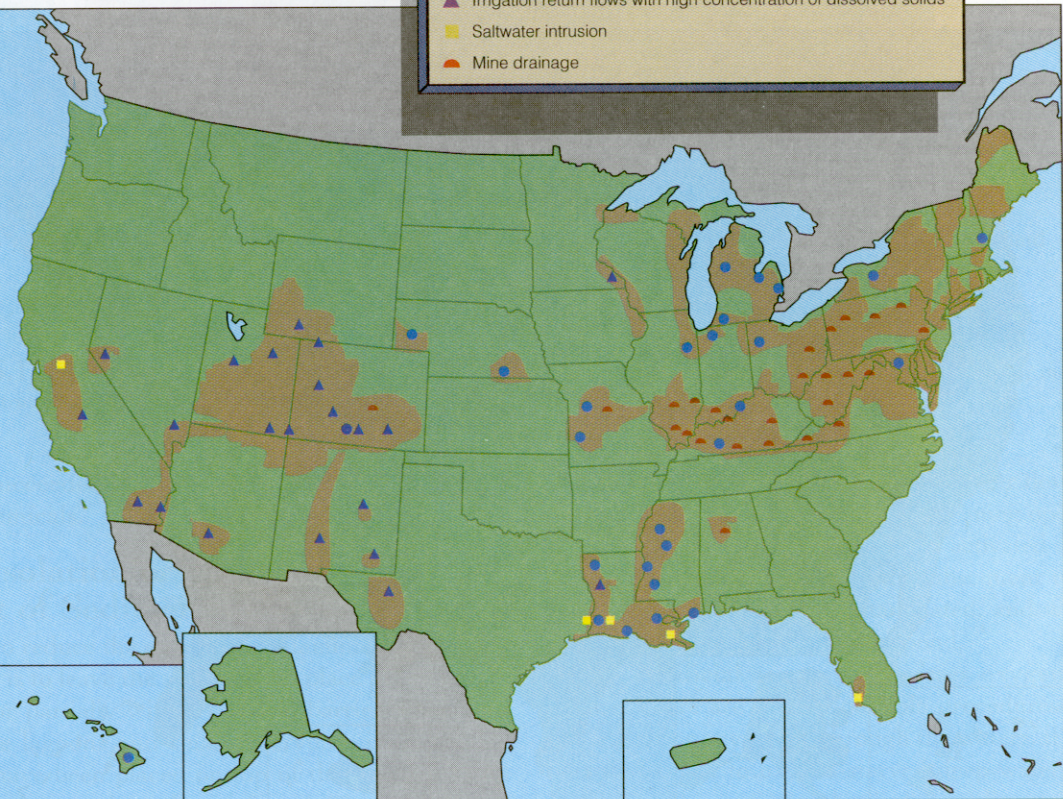
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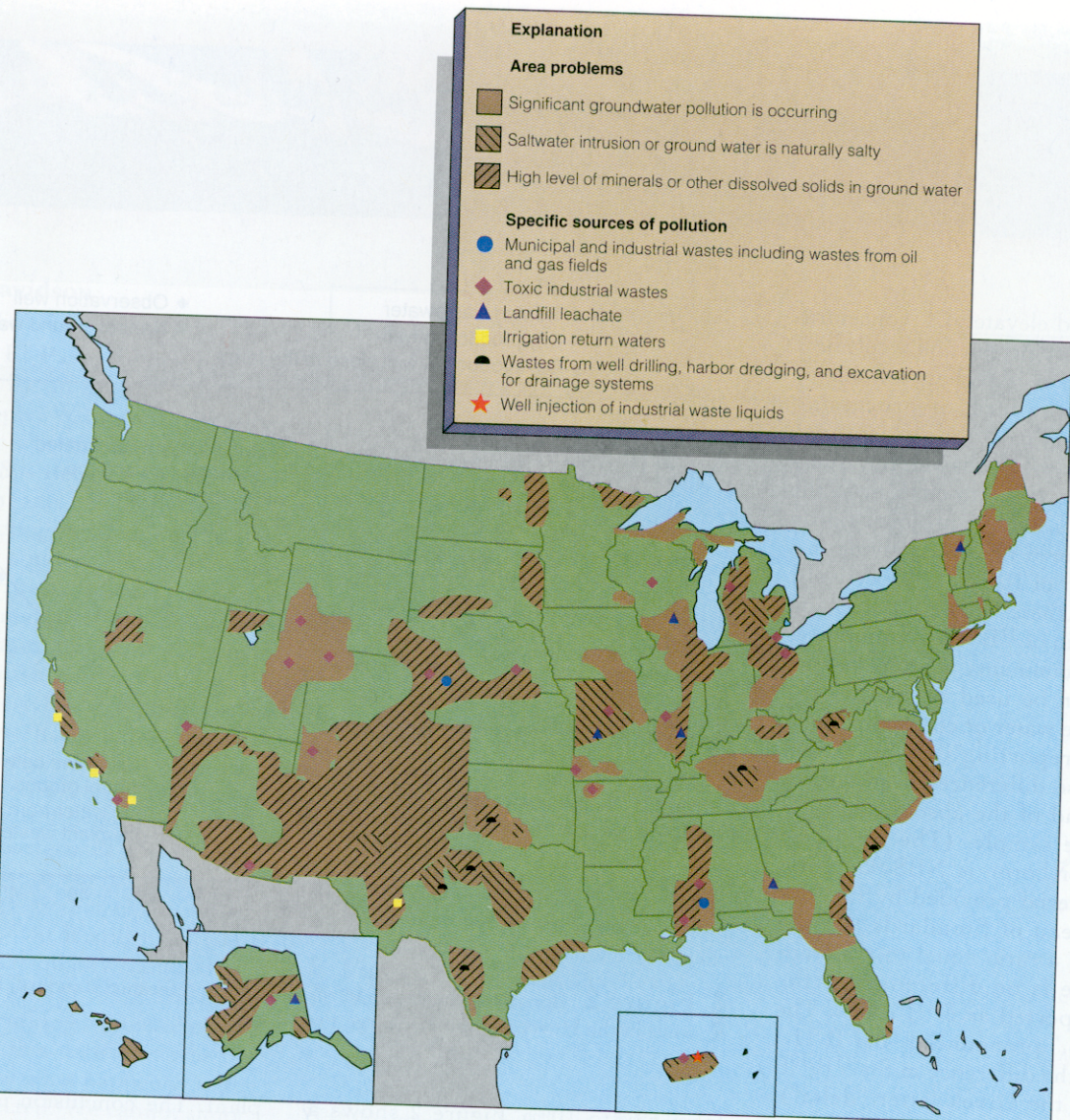
Area problem

■ Area in which significant surface-water pollution from nonpoint sources is occurring

Specific types of nonpoint-source pollutants

- Herbicides, pesticides, and other agricultural chemicals
- ▲ Irrigation return flows with high concentration of dissolved solids
- Saltwater intrusion
- ▲ Mine drainage





16 Groundwater pollution problems. Source: Modified from U.S. Water Resources Council, *The Nation's Water Resources*