Water Pollution

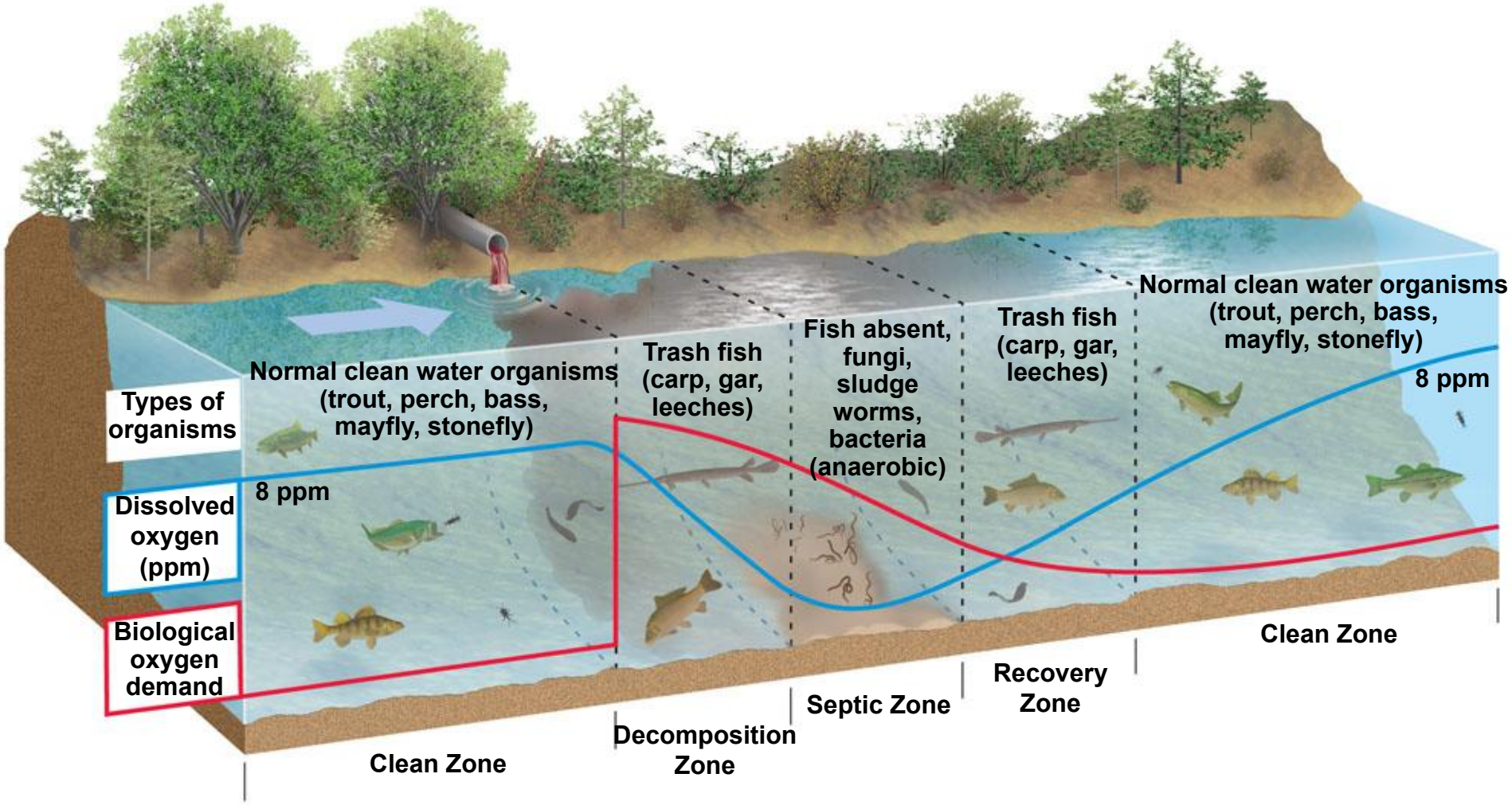
Water Pollution: Types, Effects, and Sources

- What is water pollution?
- Major types of pollutants, sources and effects
- Point and nonpoint sources
- Is the water safe to drink?

Major Categories of Water Pollutants

- Infectious Agents
  - Bacteria, Viruses, Protozoa, Parasitic Worms
  - Source: Human and animal waste
- Oxygen-Demanding Waste
  - Organic debris & waste + aerobic bacteria
  - Source: Sewage, feedlots, paper-mills, food processing
- Inorganic Chemicals
  - Acids, Metals, Salts
  - Sources: Surface runoff, Industrial effluent, household cleansers
- Radioactive Materials
  - Iodine, radon, uranium, cesium, thorium
  - Source: Coal & Nuclear Power plants, mining, weapons production, natural
- Plant Nutrients
  - Nitrates, Phosphates,
  - Source: Sewage, manure, agricultural and landscaping runoff
- Organic Chemicals
  - Oil, Gasoline, Plastics, Pesticides, Solvents, detergents
  - Sources: Industrial effluent, Household cleansers, runoff from farms and yards
- Eroded Sediment
  - Soil, Silt
- Heat/Thermal Pollution
  - Source: Power plants, Industrial

Pollution in Streams



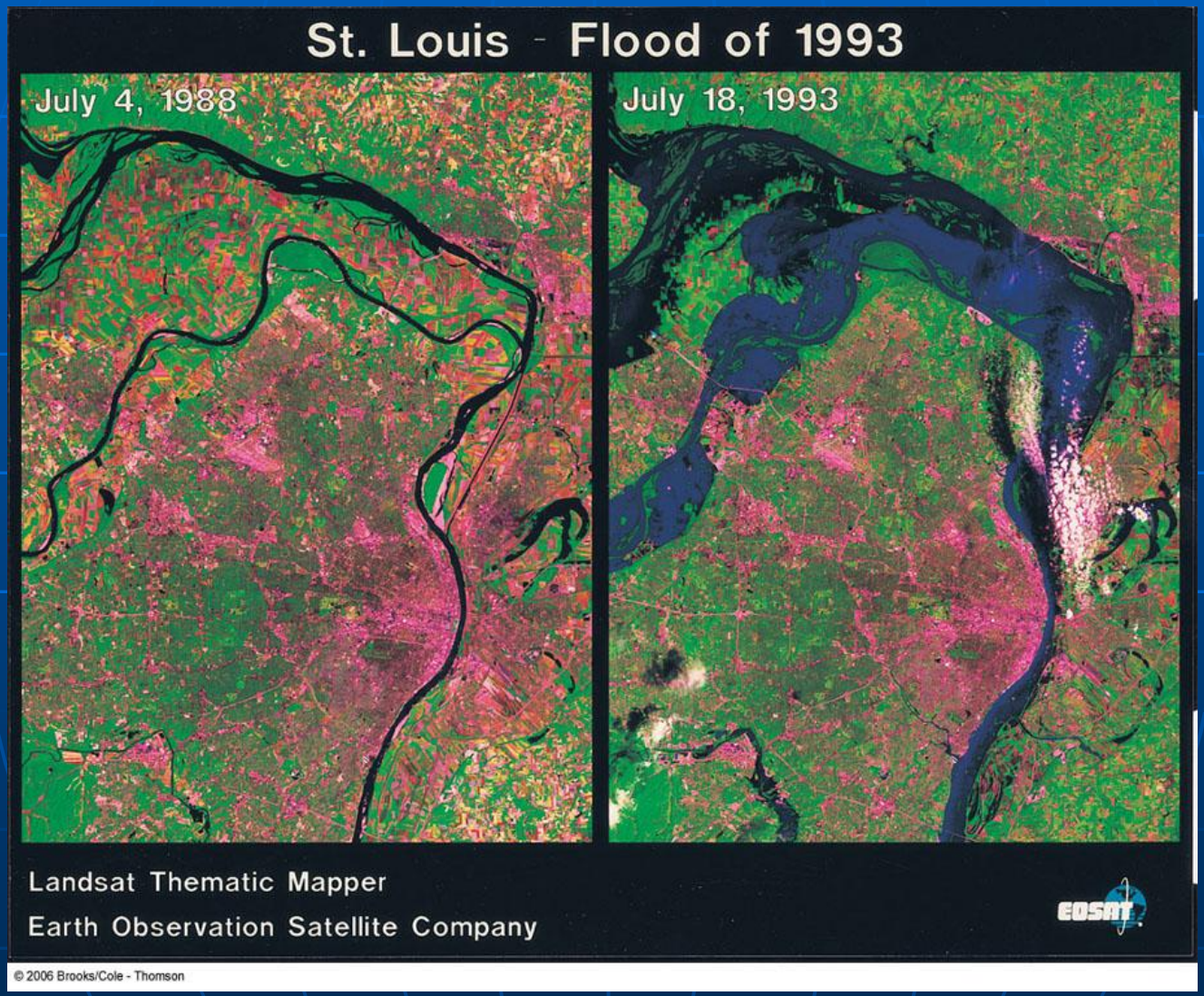
Benefits of Floodplains

- Highly productive wetlands
- Provide natural flood and erosion control
- Maintain high water quality
- Recharge groundwater
- Fertile soils
- Nearby rivers for use and recreation
- Flatlands for urbanization and farming

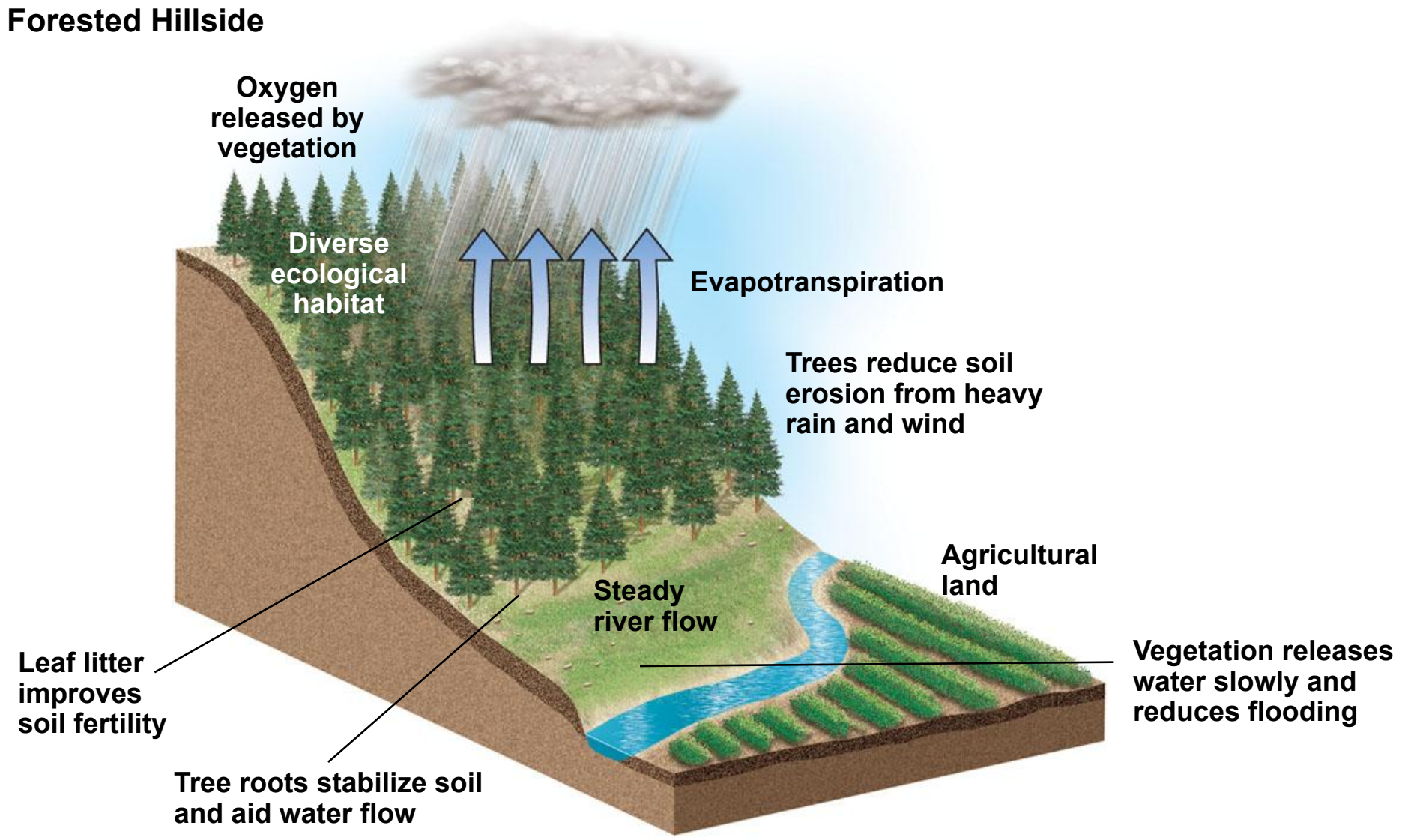
Dangers of Floodplains and Floods

- Deadly and destructive
- Human activities worsen floods
- Failing dams and water diversion
- Bangladesh

Before and During a Flood in St. Louis, Missouri

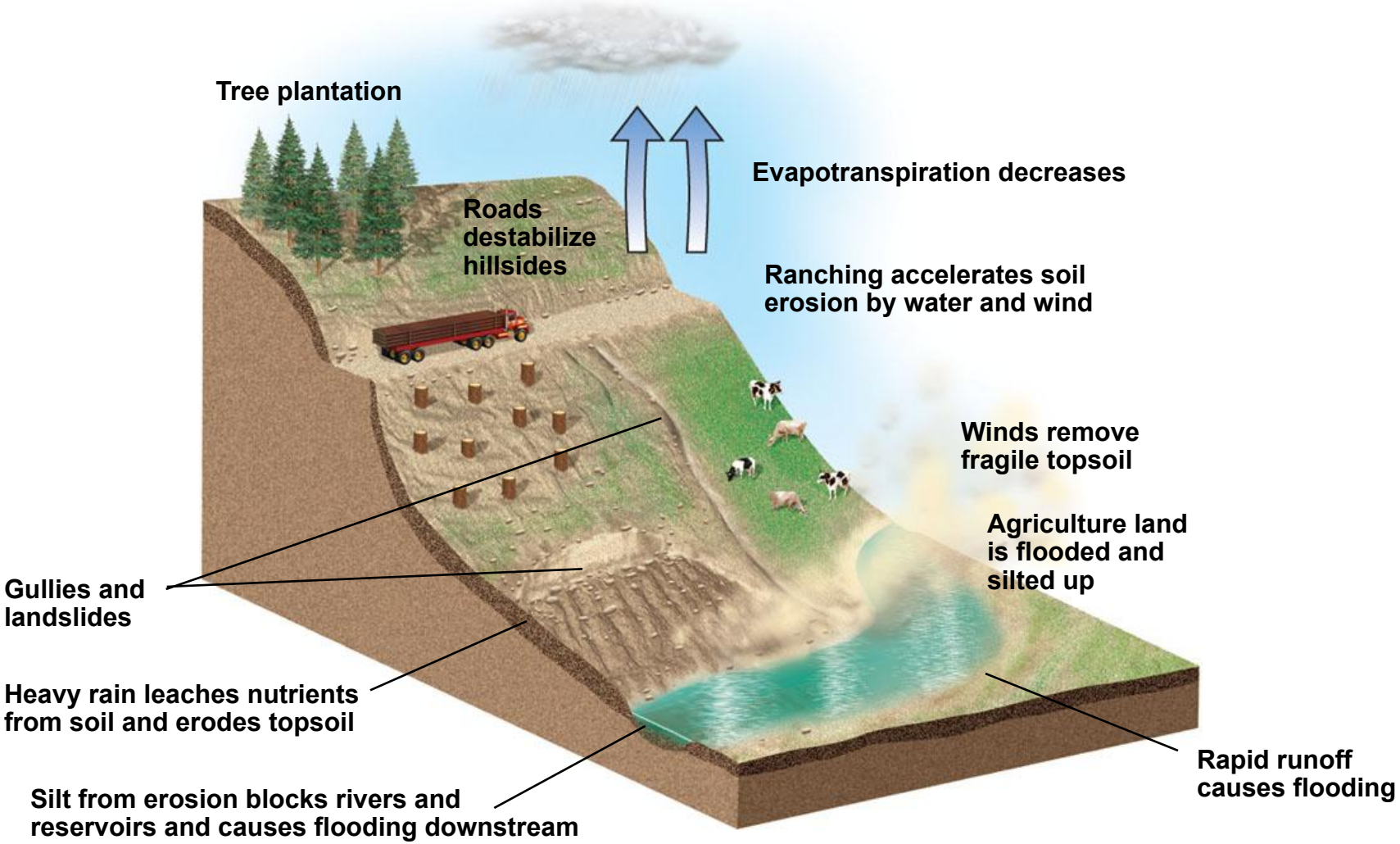


Flooding After Deforestation of a Hillside



Flooding After Deforestation of a Hillside

After Deforestation



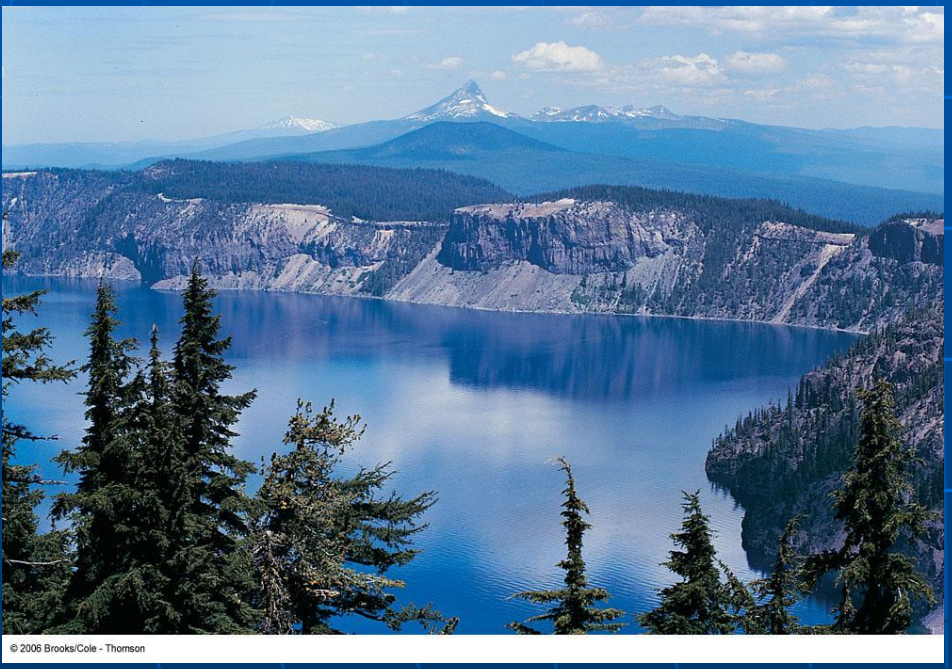
Reducing Flood Risks

- Channelization
- Levees (floodwalls)
- Dams
- Protect and restore wetlands
- Identify and manage flood-prone areas
- Precautionary approach

Lake Pollution

- Dilution less effective than with streams
- Stratification in lakes and relatively little flow hinder rapid dilution of pollutants
- Lakes more vulnerable to pollutants than streams
- How pollutants enter lakes
- Eutrophication: causes and effects
- Oligotrophic and eutrophic lakes
- Cultural eutrophication
- Preventing or removing eutrophication

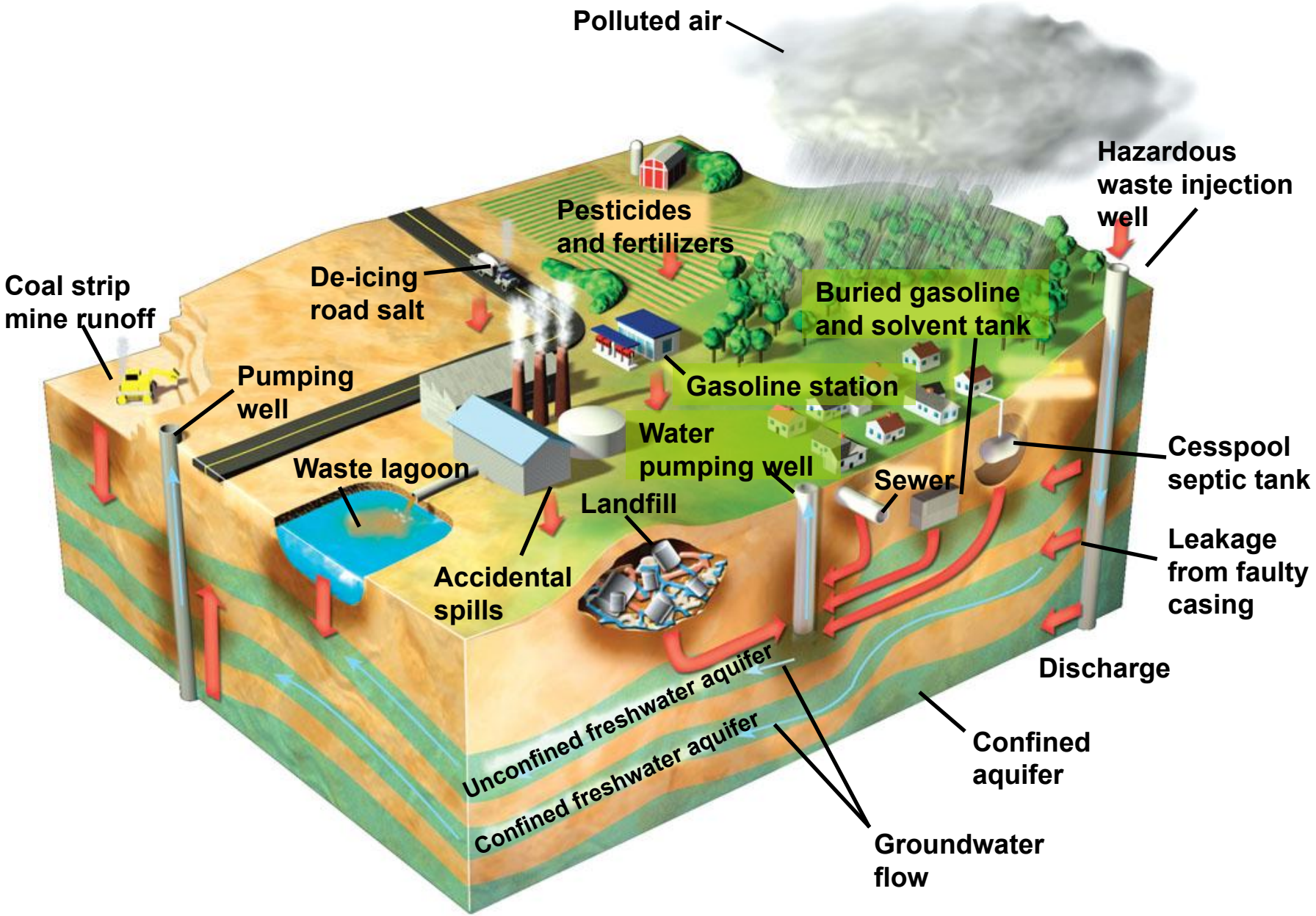
Oligotrophic and Eutrophic Lakes



Groundwater Pollution: Causes and Persistence

- Sources of groundwater pollution
- Slow flowing: slow dilution and dispersion
- Consequences of lower dissolved oxygen
- Fewer bacteria to decompose wastes
- Cooler temperatures: slow down chemical reactions
- “Degradable” and nondegradable wastes in groundwater

Groundwater Pollution



Extent of Groundwater Pollution

- Not much is known about groundwater pollution
- Organic contaminants, including fuel leaks
- Arsenic
- Protecting groundwater: Prevention is best

Preventing and Cleaning Up Pollution in Groundwater

Solutions

Groundwater Pollution

Prevention

Cleanup

Find substitutes for toxic chemicals
Keep toxic chemicals out of the environment

Install monitoring wells near landfills and underground tanks

Require leak detectors on underground tanks

Ban hazardous waste disposal in landfills and injection wells

Store harmful liquids in aboveground tanks with leak detection and collection systems

Pump to surface, clean, and return to aquifer (very expensive)

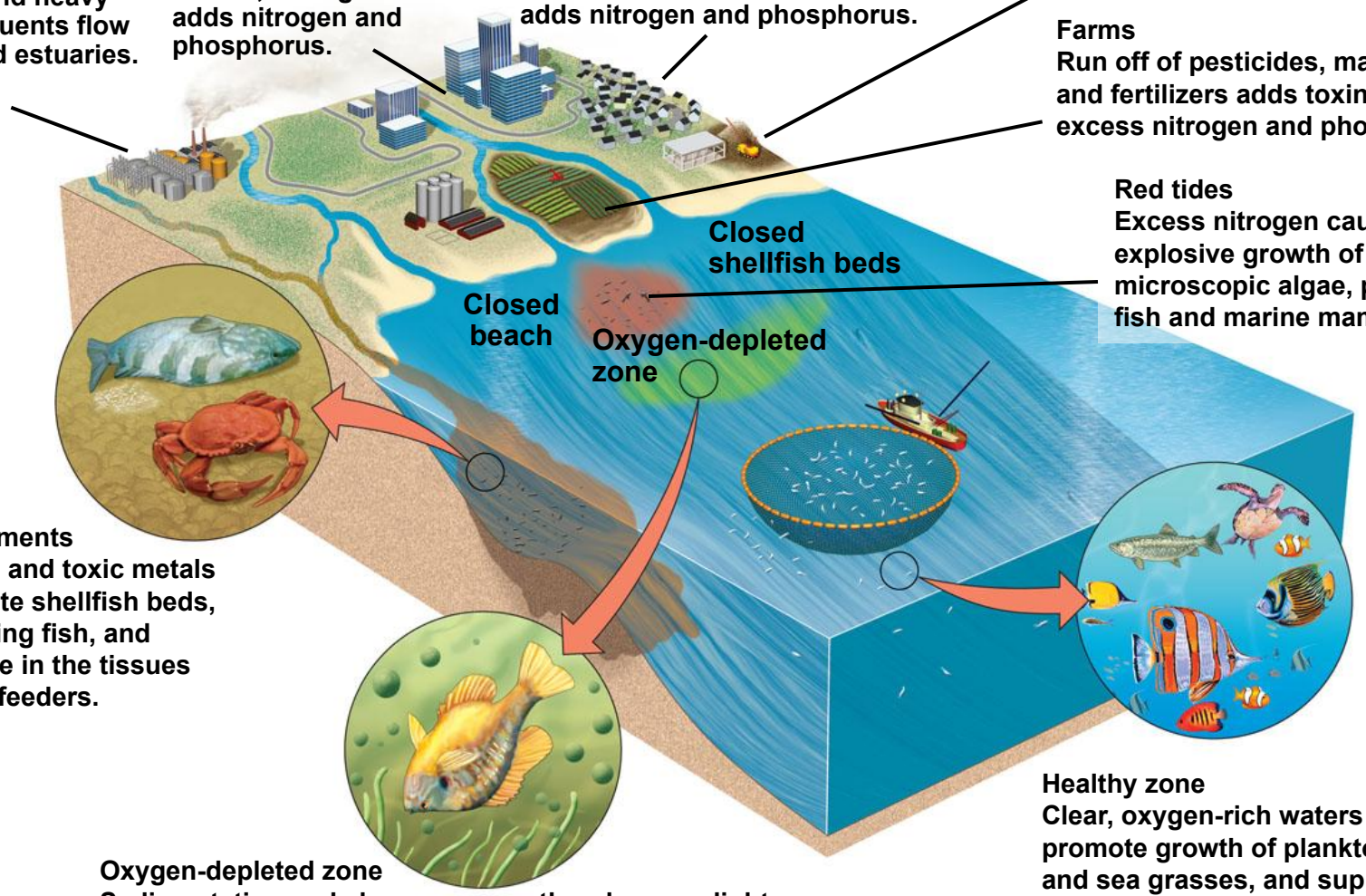
Inject microorganisms to clean up contamination (less expensive but still costly)

Pump nanoparticles of inorganic compounds to remove pollutants (may be the cheapest, easiest, and most effective method but is still being developed)

Ocean Pollution

- How much pollution can oceans tolerate?
- Some pollutants degrade and dilute in oceans
- Ocean dumping controversies

Coastal Water Pollution



Industry
Nitrogen oxides from autos and smokestacks; toxic chemicals, and heavy metals in effluents flow into bays and estuaries.

Cities
Toxic metals and oil from streets and parking lots pollute waters; sewage adds nitrogen and phosphorus.

Urban sprawl
Bacteria and viruses from sewers and septic tanks contaminate shellfish beds and close beaches; runoff of fertilization from lawns adds nitrogen and phosphorus.

Construction sites
Sediments are washed into waterways, choking fish and plants, clouding waters, and blocking sunlight.

Farms
Run off of pesticides, manure, and fertilizers adds toxins and excess nitrogen and phosphorus.

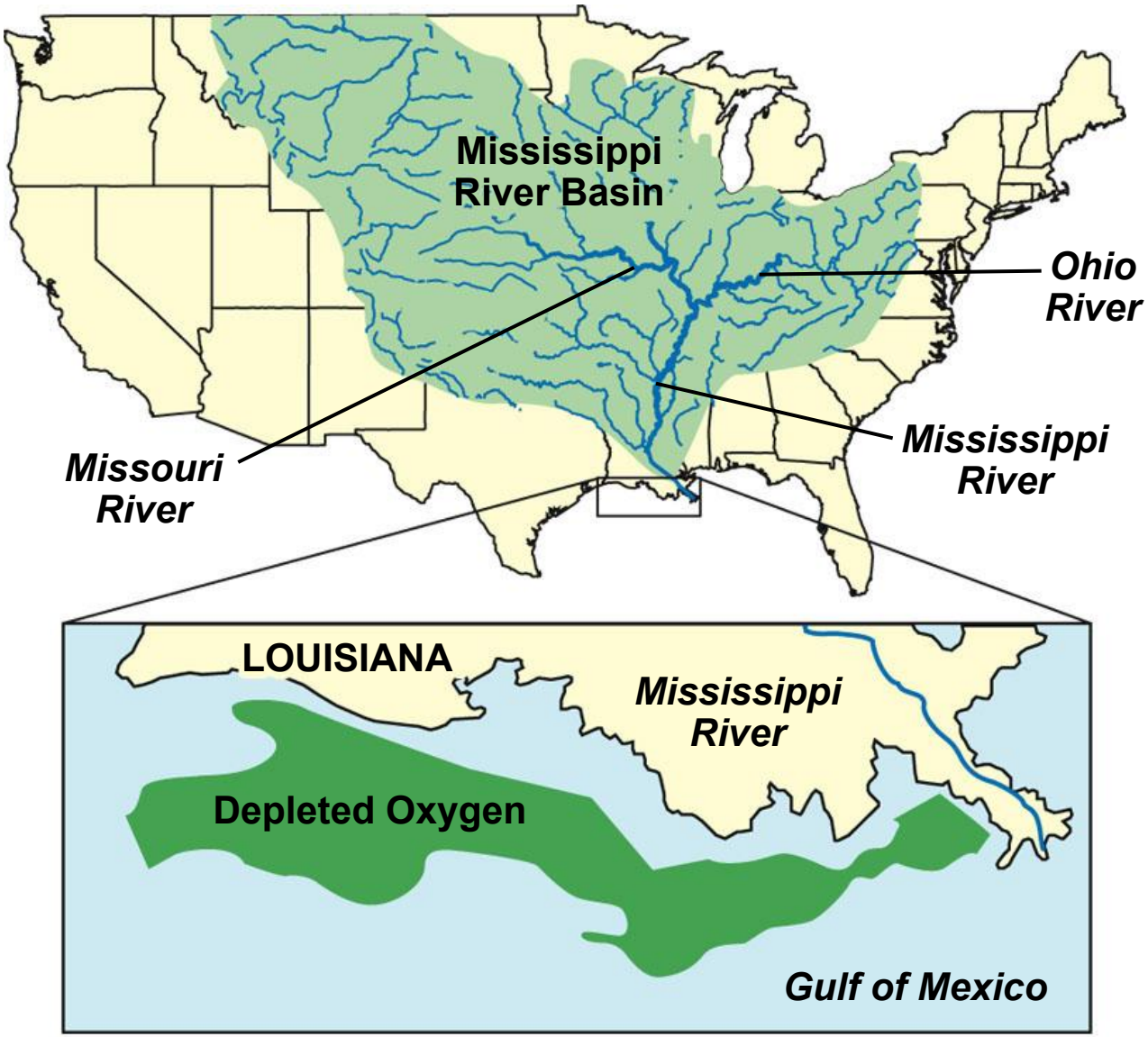
Red tides
Excess nitrogen causes explosive growth of toxic microscopic algae, poisoning fish and marine mammals.

Toxic sediments
Chemicals and toxic metals contaminate shellfish beds, kill spawning fish, and accumulate in the tissues of bottom feeders.

Oxygen-depleted zone
Sedimentation and algae overgrowth reduce sunlight, kill beneficial sea grasses, use up oxygen, and degrade habitat.

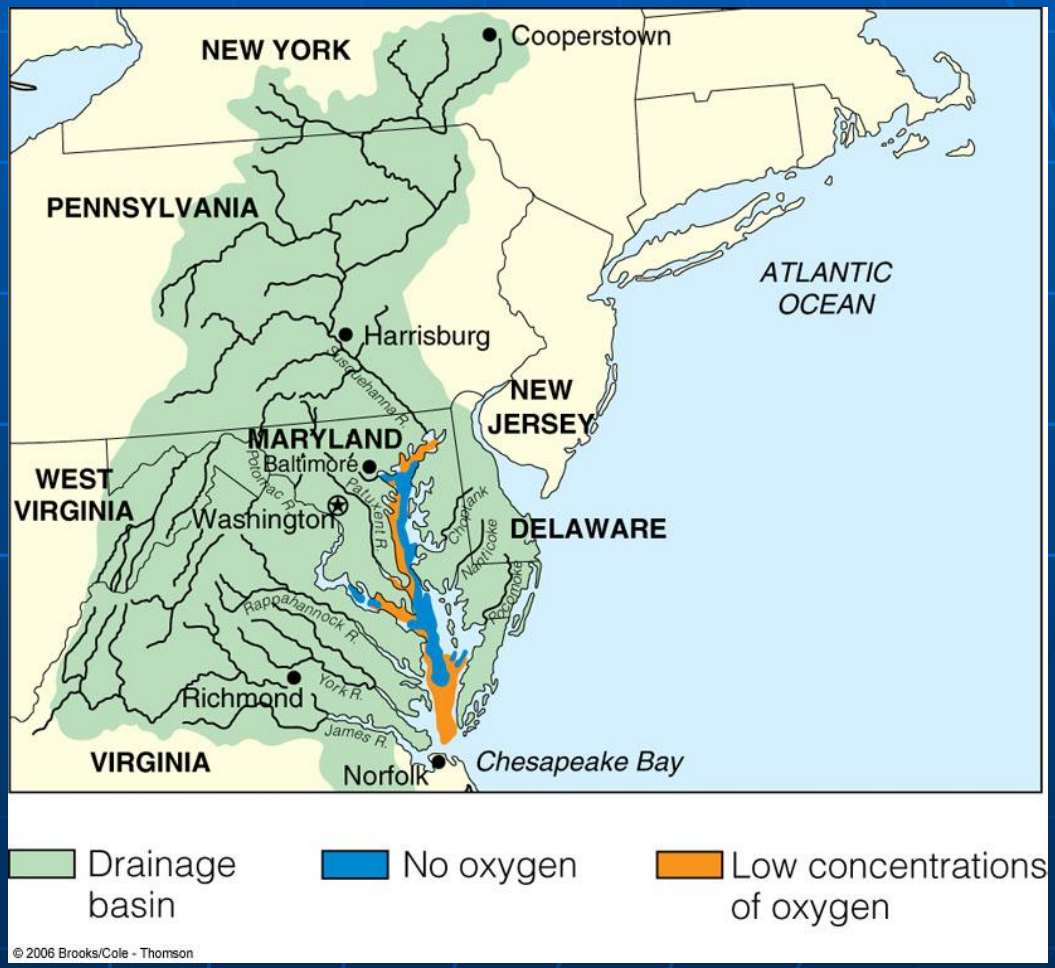
Healthy zone
Clear, oxygen-rich waters promote growth of plankton and sea grasses, and support fish.

Oxygen-depleted Water in the Gulf of Mexico



Chesapeake Bay

- Largest US estuary
- Pollution “sink”
- Oxygen depletion
- Chesapeake Bay Program



Effects of Oil on Ocean Life

- Crude and refined petroleum
- Tanker accidents and blowouts
- *Exxon Valdez*
- Volatile hydrocarbons kill larvae
- Tar-like globs coat birds and marine mammals
- Oil destroys insulation and buoyancy
- Heavy oil sinks and kills bottom organisms
- Coral reefs die

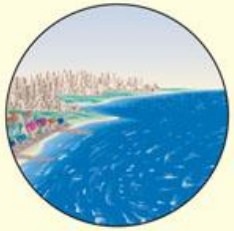
Preventing and Cleaning Up Pollution in Coastal Waters

Solutions

Coastal Water Pollution

Prevention

- Reduce input of toxic pollutants
- Separate sewage and storm lines
- Ban dumping of wastes and sewage by maritime and cruise ships in coastal waters
- Ban ocean dumping of sludge and hazardous dredged material
- Protect sensitive areas from development, oil drilling, and oil shipping
- Regulate coastal development
- Recycle used oil
- Require double hulls for oil tankers



Cleanup

- Improve oil-spill cleanup capabilities
- Sprinkle nanoparticles over an oil or sewage spill to dissolve the oil or sewage without creating harmful byproducts (still under development)
- Require at least secondary treatment of coastal sewage
- Use wetlands, solar-aquatic, or other methods to treat sewage

Preventing Nonpoint Source Pollution

- Mostly agricultural wastes
- Use vegetation to reduce soil erosion
- Reduce fertilizer use
- Use plant buffer zones around fields
- Integrated pest management: Only use pesticides when necessary
- Use plant buffers around animal feedlots
- Keep feedlots away from slopes, surface water and flood zones

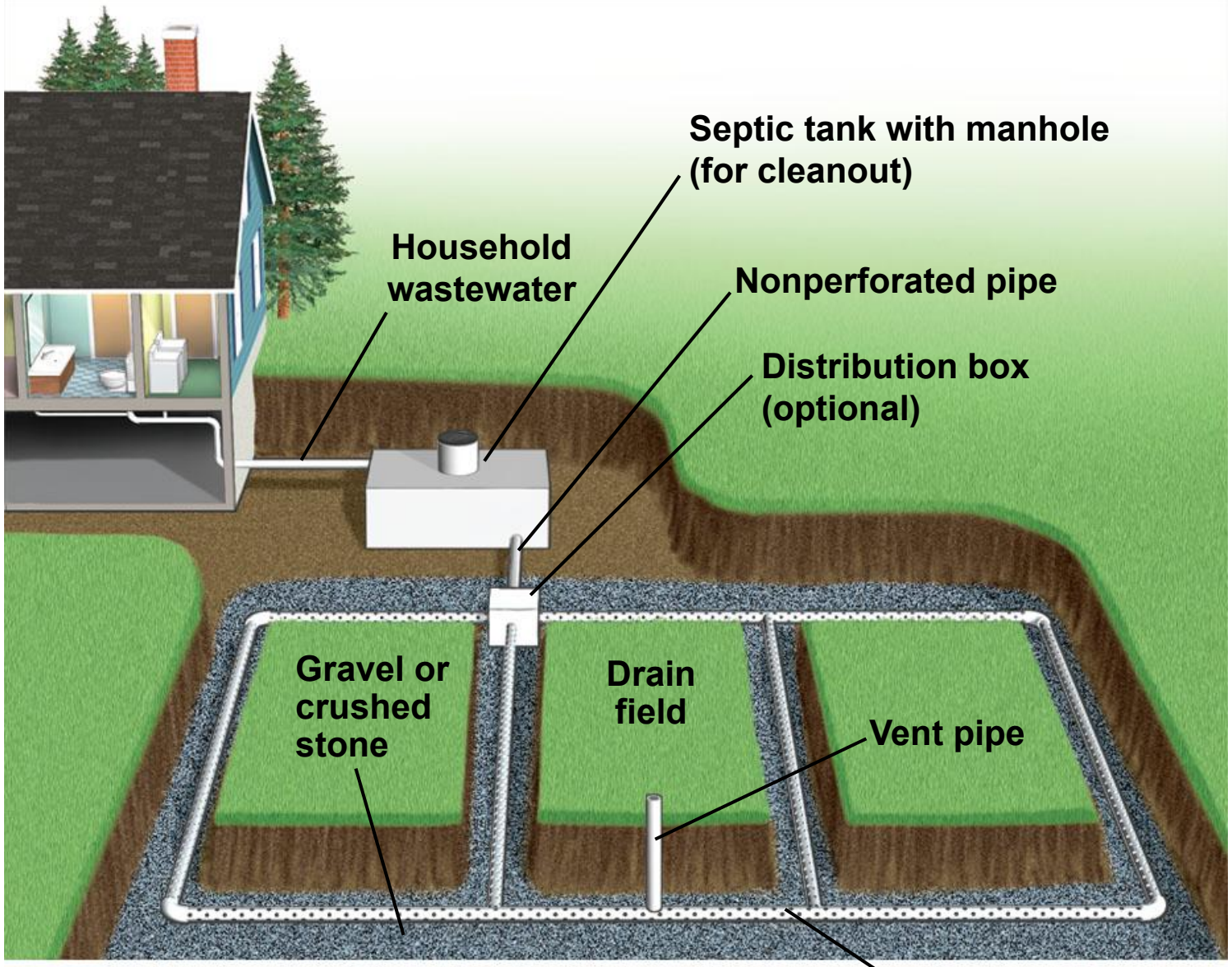
Laws for Reducing Point Source Pollution

- Clean Water Act
- Water Quality Act

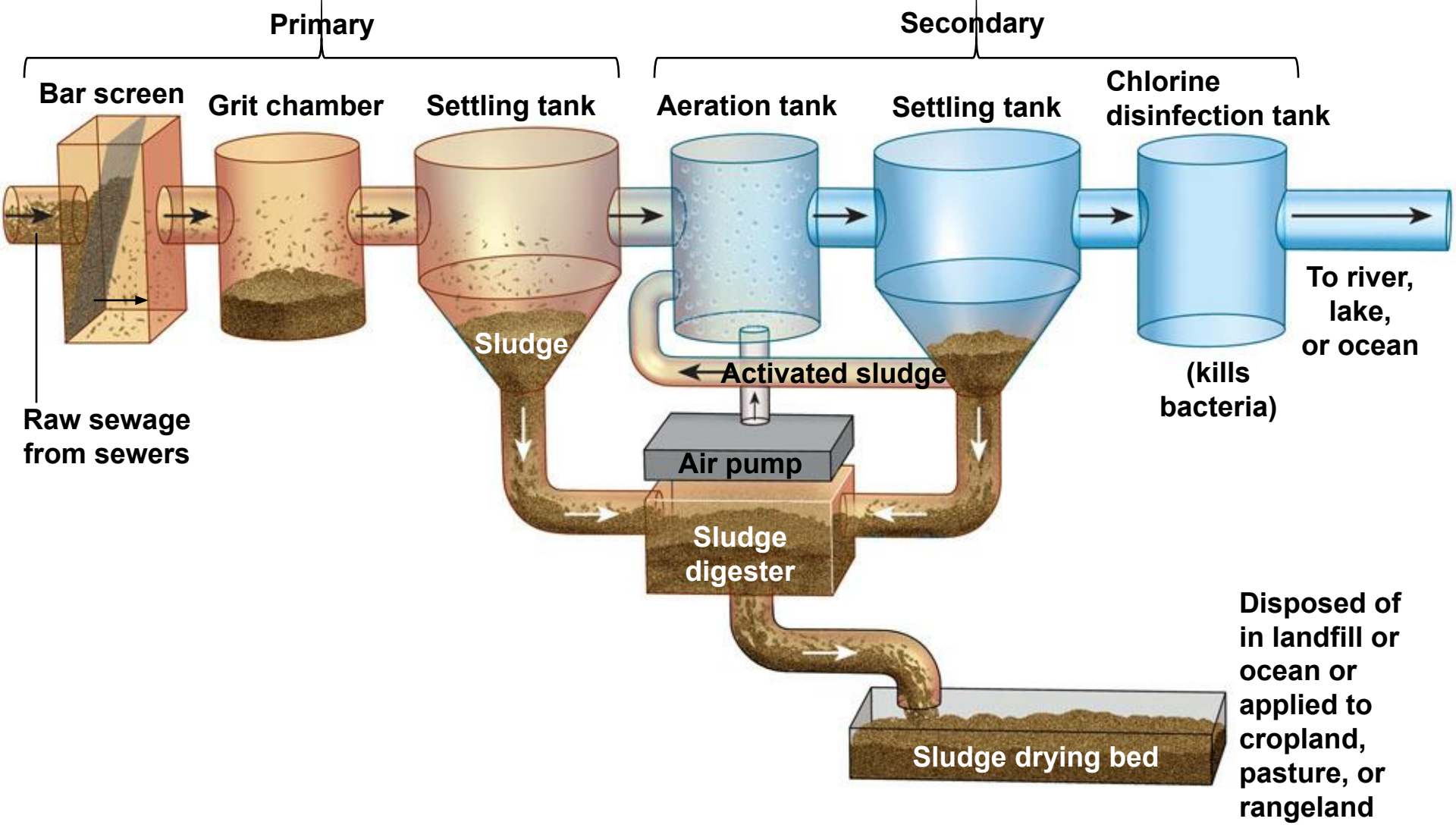
Sewage Treatment Systems

- Sewage treatment in rural and suburban areas
- Septic tanks
- Primary (physical) sewage treatment
- Secondary (biological) sewage treatment
- Urban sewage treatment (Clean Water Act)
- Sewage treatment facilities in many cities fail to meet federal standards
- Bleaching and disinfection
- Disinfectants: chlorine, ozone, and ultraviolet radiation

Typical Septic Tank System



Primary and Secondary Sewage Treatment



Improving Sewage Treatment

- Systems that exclude hazardous wastes
- Non-hazardous substitutes
- Composting toilet systems
- Working with nature to treat sewage
- Using wetlands to treat sewage

Ecological Wastewater Treatment

Burlington, VT
University of Vermont

Should the Clean Water Act be Strengthened?

- Yes: environmentalists

- No: farmers, libertarians, manufacturers, and developers

State and local officials want more discretion

Drinking Water Quality

- Purification of urban drinking water
- Purification of drinking water in developing countries
- Bottled water

Solutions

Water Pollution

- Prevent groundwater contamination
- Greatly reduce nonpoint runoff
- Reuse treated wastewater for irrigation
- Find substitutes for toxic pollutants
- Work with nature to treat sewage
- Practice four R's of resource use (refuse, reduce, recycle, reuse)
- Reduce resource waste
- Reduce air pollution
- Reduce poverty
- Reduce birth rates

What Can You Do?

Water Pollution

- Fertilize your garden and yard plants with manure or compost instead of commercial inorganic fertilizer.
- Minimize your use of pesticides.
- Never apply fertilizer or pesticides near a body of water.
- Grow or buy organic foods.
- Compost your food wastes.
- Do not use water fresheners in toilets.
- Do not flush unwanted medicines down the toilet.
- Do not pour pesticides, paints, solvents, oil, antifreeze, or other products containing harmful chemicals down the drain or onto the ground.