Water Pollution

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Outline

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2. Pollution of Lakes & Streams
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1. Types & Sources of Water Pollution

Water pollution *is any chemical, biological, or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.*

- **disease–causing agents**: bacteria, viruses, protozoa, & parasites;
- **oxygen demanding wastes**: organic wastes that can be decomposed by aerobic bacteria;
- **water–soluble inorganic chemicals**: acids, salts, & compounds with heavy metals;
- **organic chemicals**: oil, gasoline, plastics, pesticides, cleaning solvents, detergents, etc.
- **sediment**: suspended matter, insoluble particles of soil & other solids; biggest class of pollution by weight;
- **water–soluble radioactive isotopes**: ionizing radiation sources;
- **genetic pollution**: introduction of non–native species;
- **thermal pollution**: heat added to water.

Point & Nonpoint Sources

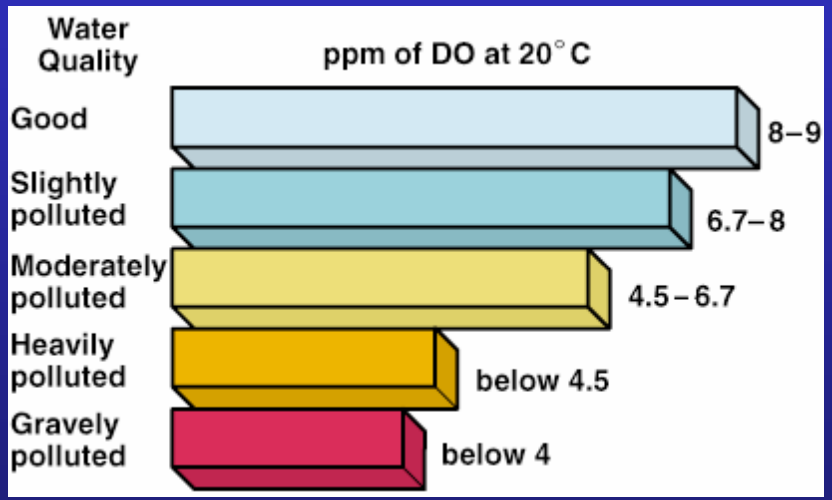
It is easier to control pollution that comes from a distinct source than pollution that does not come from a distinct source.

- **point sources** discharge pollutants at specific locations through pipes, ditches, or sewers (e.g., factories, sewage treatment plants, mines, oil wells, oil tankers);
- **nonpoint sources** cannot be traced to a single site of discharge (e.g., acid deposition, substances picked up in runoff, seepage into groundwater);
- nonpoint source water pollution from agriculture is largest source of water pollution in the U.S. (64% of pollutants into streams & 57% of pollutants entering lakes).

2. Pollution of Lakes & Streams

Large populations of bacteria decomposing **oxygen–demanding wastes** can degrade water quality by depleting dissolved oxygen.

- **dissolved oxygen (DO)** is an indicator of water quality; Fig. 20–3



- **biological oxygen demand (BOD)**: the amount of dissolved oxygen needed by aerobic decomposers to break down organic materials in a certain volume over a 5–day incubation period at 20° C.

Flowing streams, including rivers, can recover rapidly from degradable, oxygen–demanding wastes by dilution & bacterial decay.

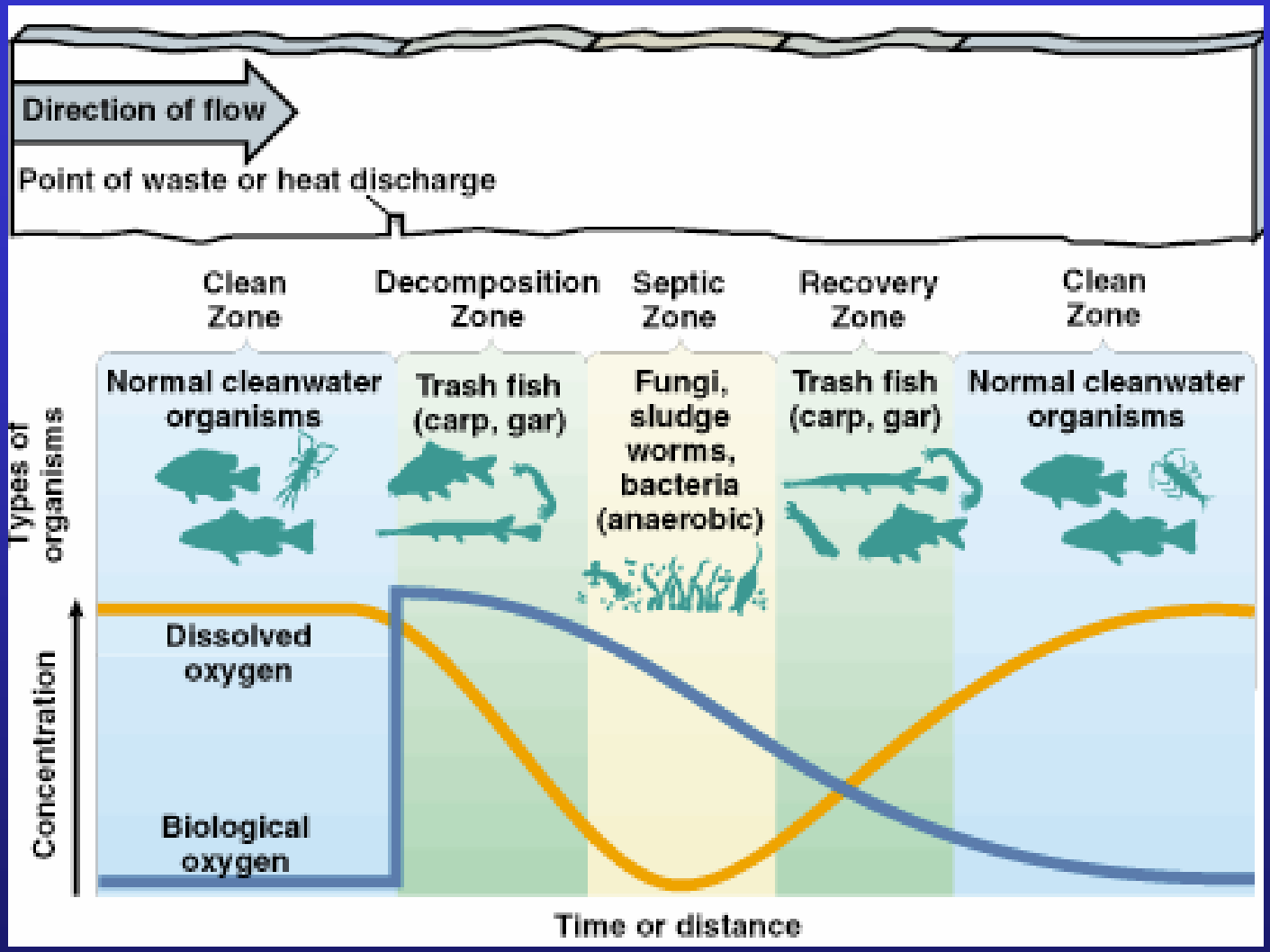


Fig. 20–4

Pollution of Lakes & Streams

Water pollution control laws enacted in the 1970s have greatly increased the number & quality of wastewater treatment plants in the U.S.

- similar improvements in Canada, Japan, & most western European countries;
- large fish kill & contamination of drinking water still occur, especially in developing countries;
- lakes, reservoirs & ponds are more vulnerable to contamination than streams because of less mixing & aeration.

Pollution of Lakes

Natural nutrient enrichment of lakes is called ***eutrophication.***

Cultural eutrophication *results when human activities accelerate the input of nutrients to a lake.*

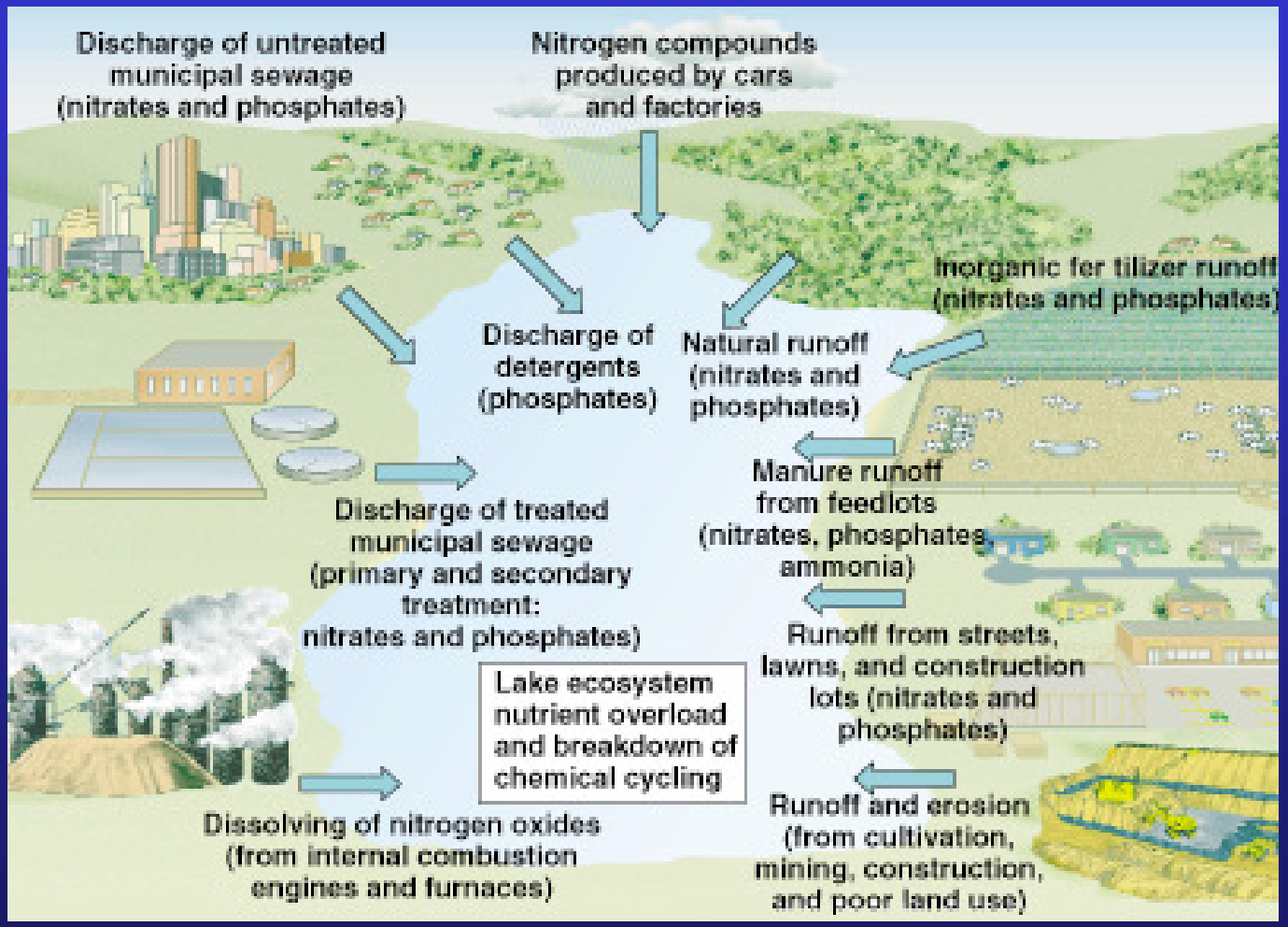


Fig. 20–6

Case Study: Great Lakes

The Great Lakes basin contains at least 95% of the fresh surface water in the U.S. & 20% of the world's fresh surface water. In the 1960s many areas of the Great Lakes (in particular Lake Erie) suffered severe cultural eutrophication. Since 1972, a $20 billion pollution–control program improved water quality.

Video: http://video.nationalgeographic.com/video/player/environment/environmental-threats-environment/water-pollution/great-lakes-cleanup.html

3. Ocean Pollution

Coastal areas – especially wetlands & estuaries, coral reefs, & mangrove swamps – bear the brunt of enormous inputs of wastes into the ocean.

- half of the world's population lives within 100 km (60 miles) of the ocean & 14 of the 15 largest metropolitan areas are near coastal waters;
- in the U.S. about 35% of municipal sewage ends up virtually untreated in marine waters;
- the ocean is the ultimate repository of waste, since surface waters flow into the ocean;
- dumping of industrial waste directly into the ocean off U.S. coasts has stopped, but many countries still dump large quantities of toxic substances.

Case Study: Chesapeake Bay

Chesapeake Bay, the largest estuary in the United States, is severely degraded as the result of water pollution from point & non–point sources in six states, & from deposition of air pollutants.

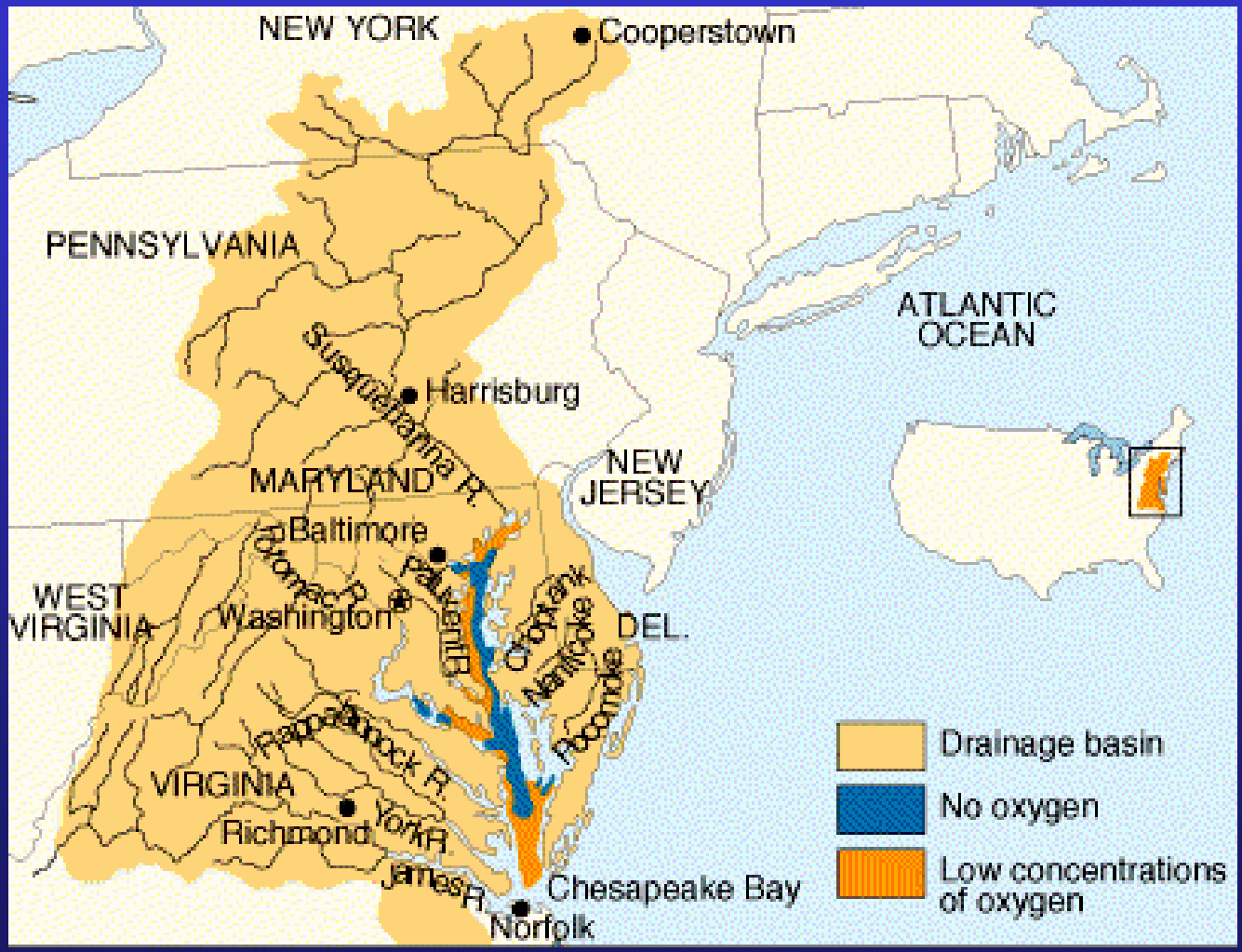


Fig. 20–8

Oil Spills

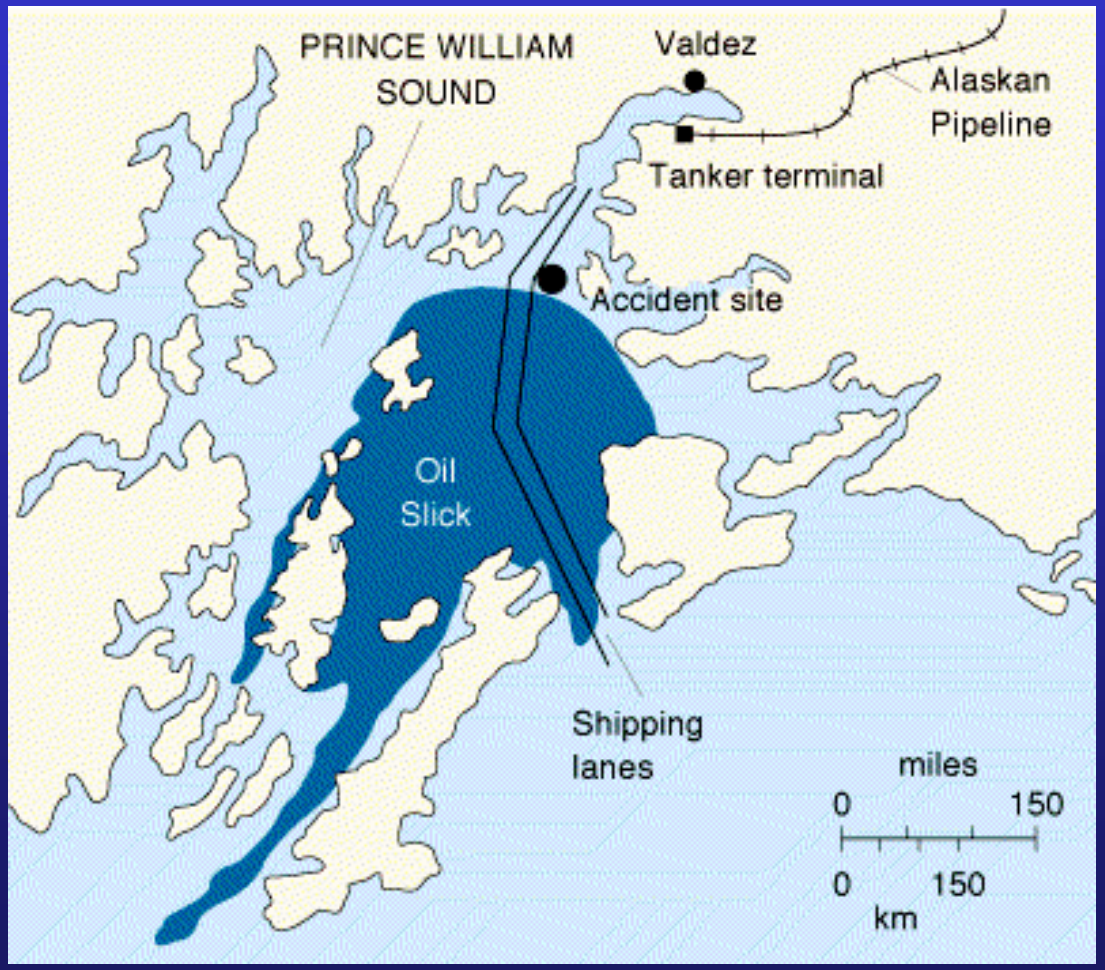
Crude & refined petroleum are accidentally & deliberately released into the environment from various sources.

- most oil is released in normal operation of offshore wells, from washing tankers, & pipeline/storage tank leaks;
- tanker & offshore drilling rig accidents can release large amounts of oil in a short period of time;
- some effects of oil on marine ecosystems:
  - volatile organics immediately kill of many aquatic organisms (especially plankton & larvae), as well as contaminate fish;
  - floating oil coats birds & marine mammal, destroying natural insulation & buoyancy, & causing deaths;
  - heavy oil sinks to ocean bottom & washes into estuaries where it contaminates crabs, oysters, mussels, clams, etc.
  - oil slicks on beaches harm intertidal life & cause economic losses to tourism & fishing industries.

Case Study: Exxon Valdez Oil Spill

On March 24, 1989, the Exxon Valdez tanker went off course, hit submerged rocks in Prince William Sound, Alaska, & created the worst oil spill in U.S. waters.

- coated 1,600 of shoreline, killed wildlife, & caused serious contamination;
- Exxon spent $2.2 billion on direct cleanup + $1 billion fines & damages; another $5 billion damages being appealed.



Video: http://www.history.com/media.do?action=clip&id=tdih_0403

4. Dealing with Water Pollution

Means for preventing, reducing, & cleanup of water pollution include both legal & technological approaches.

- **legislation: Clean Water Act** (1972, amended 1977) & **Water Quality Act** (1983) form basis of water pollution legislation in U.S.;
  - main goals of Clean Water Act were to make U.S. surface waters safe for fishing & swimming by 1983 & to restore the chemical, physical & biological integrity of waters;
  - progress has been made, but goals not met;
- **technology:** installation of septic tanks, sewage treatment plants can greatly decrease water pollution;
- legal & technological approaches are most effective for nonpoint pollution sources.

Dealing with Water Pollution

Septic tank systems *are used to dispose of sewage & wastewater in rural & suburban areas. This system traps greases & large solids & discharges the remaining wastes over a large drainage field.*

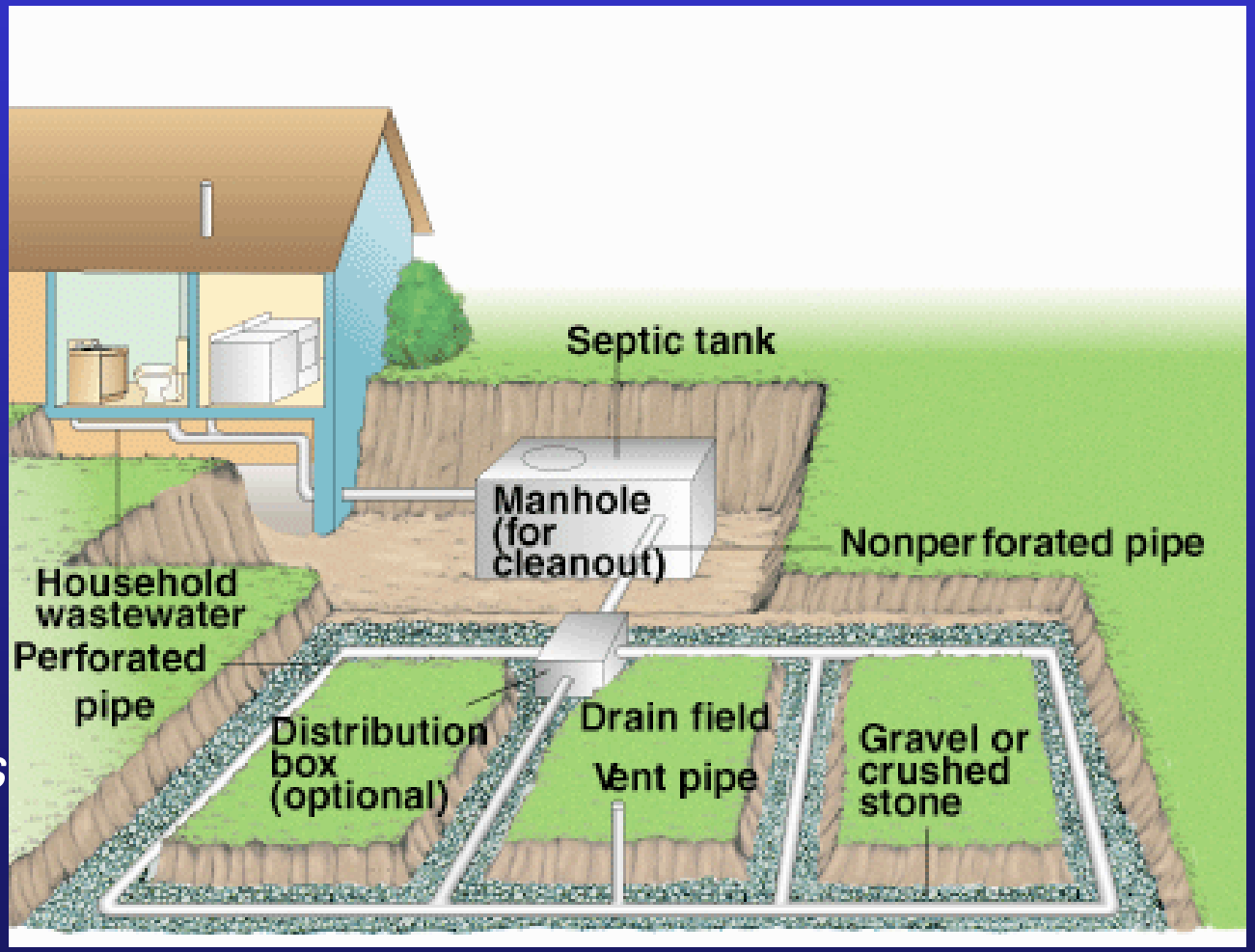


Fig. 20–10

Dealing with Water Pollution

Primary sewage treatment *involves screens & settling tanks to remove solids from sewage.*

Secondary sewage treatment *uses biological processes to break down biodegradable, oxygen–demanding wastes.*

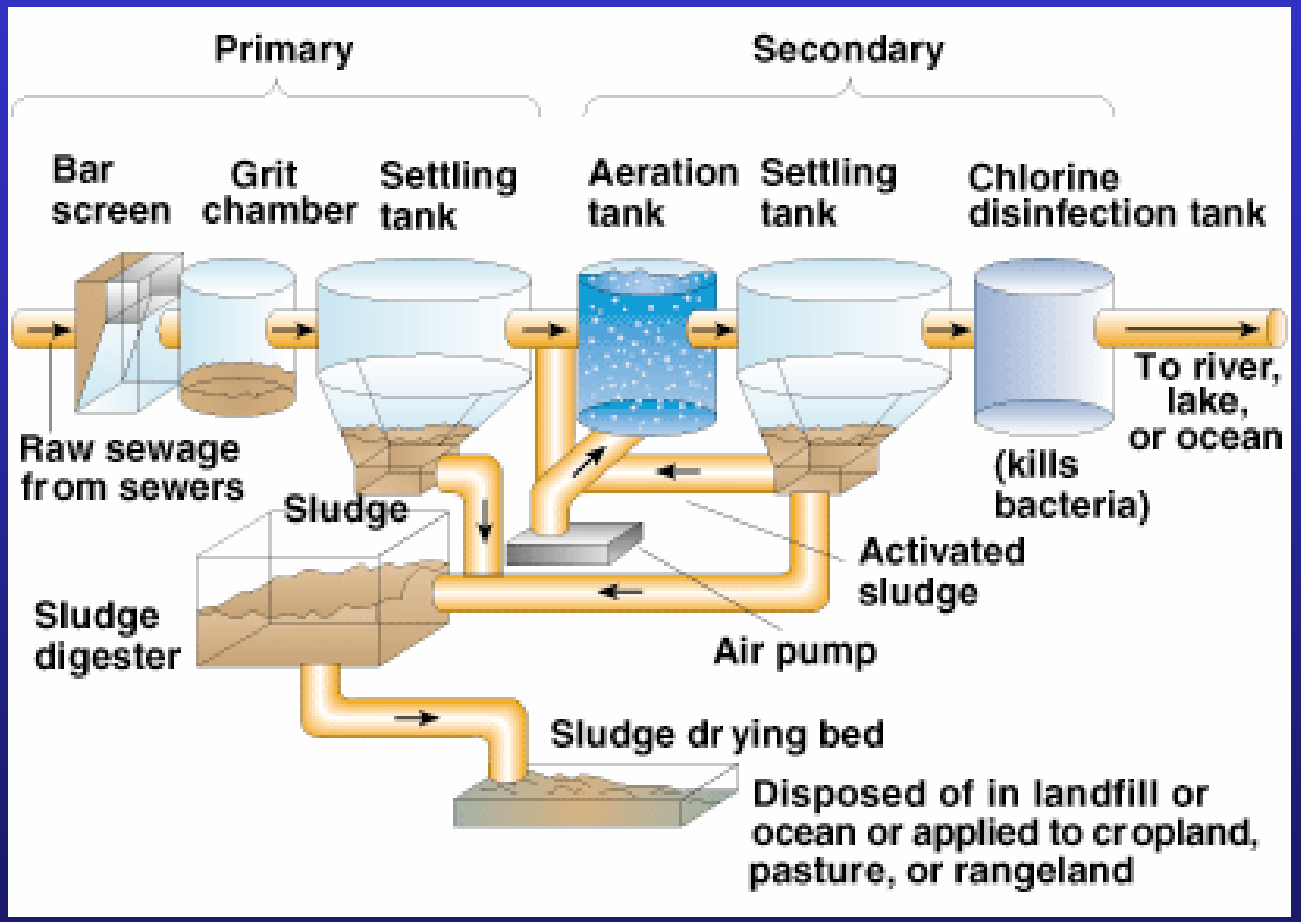


Fig. 20–11

Dealing with Water Pollution

Advanced sewage treatment *uses one or more processes to remove specific pollutants from sewage.*

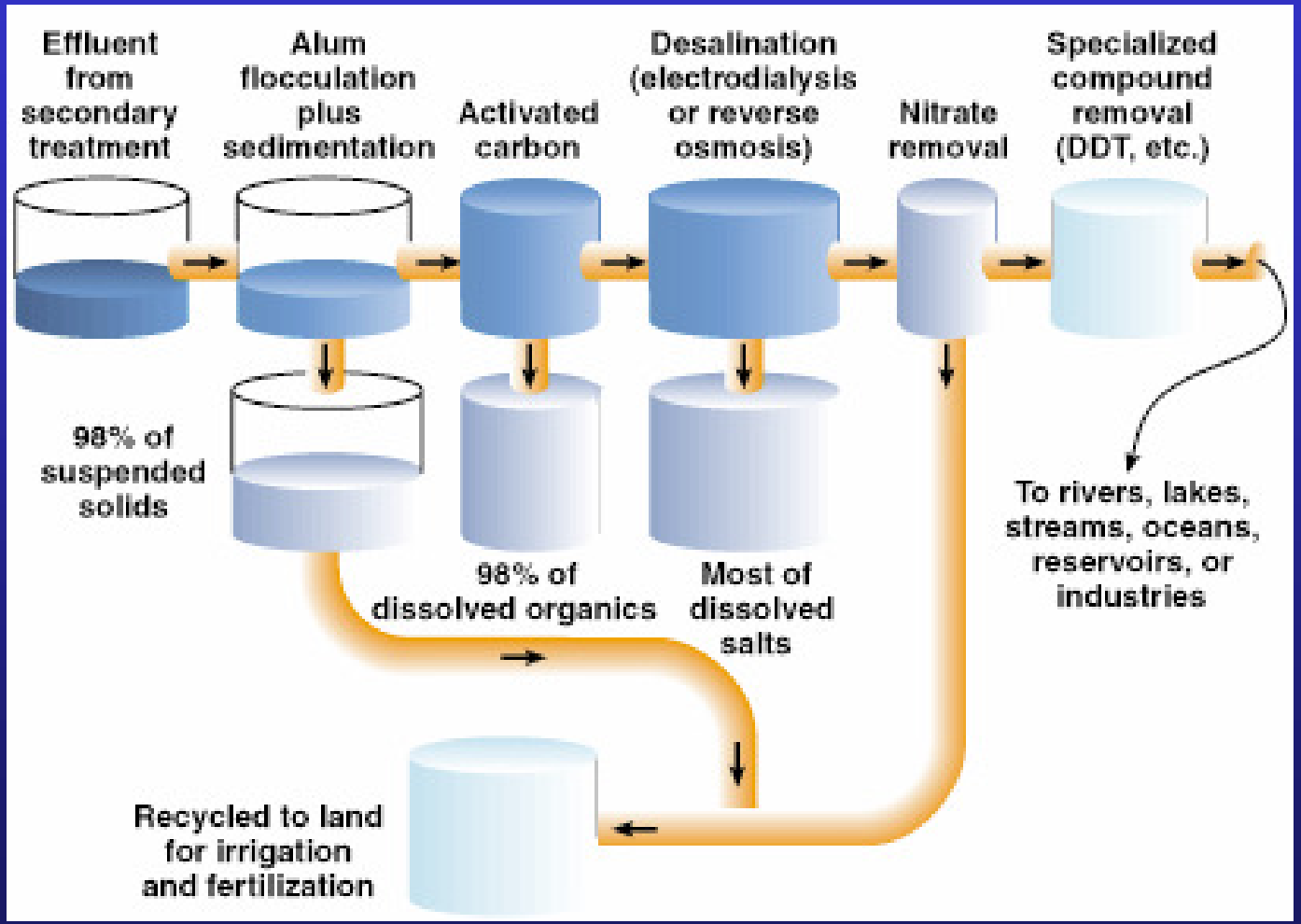


Fig. 20–12

Dealing with Water Pollution

What can we do about water pollution from nonpoint sources?

- agriculture is main nonpoint source of water pollution;
- reducing nonpoint water pollution requires changing farming practices to reduce runoff from fertilizer, pesticides, & livestock, as well as to reduce soil erosion;
- non–farm use of fertilizers & pesticides (golf course, lawns, & public lands) are another major nonpoint source, & can be similarly controlled.

5. Groundwater Pollution

Out–of–sight pollution of groundwater is a greater threat to humans than much of the more visible surface water pollution.

- much of groundwater is renewed slowly, such that pollution lingers for long periods of time;
- crude estimates indicate that up to 25% of usable groundwater in the United States is contaminated;
- extremely difficult to cleanup contaminated groundwater; prevention of contamination more effective;
- pumping groundwater to the surface, purifying the water, & returning it to the aquifer is main approach, but costs are very high.

Groundwater Pollution

Principal sources of groundwater contamination in the United States.

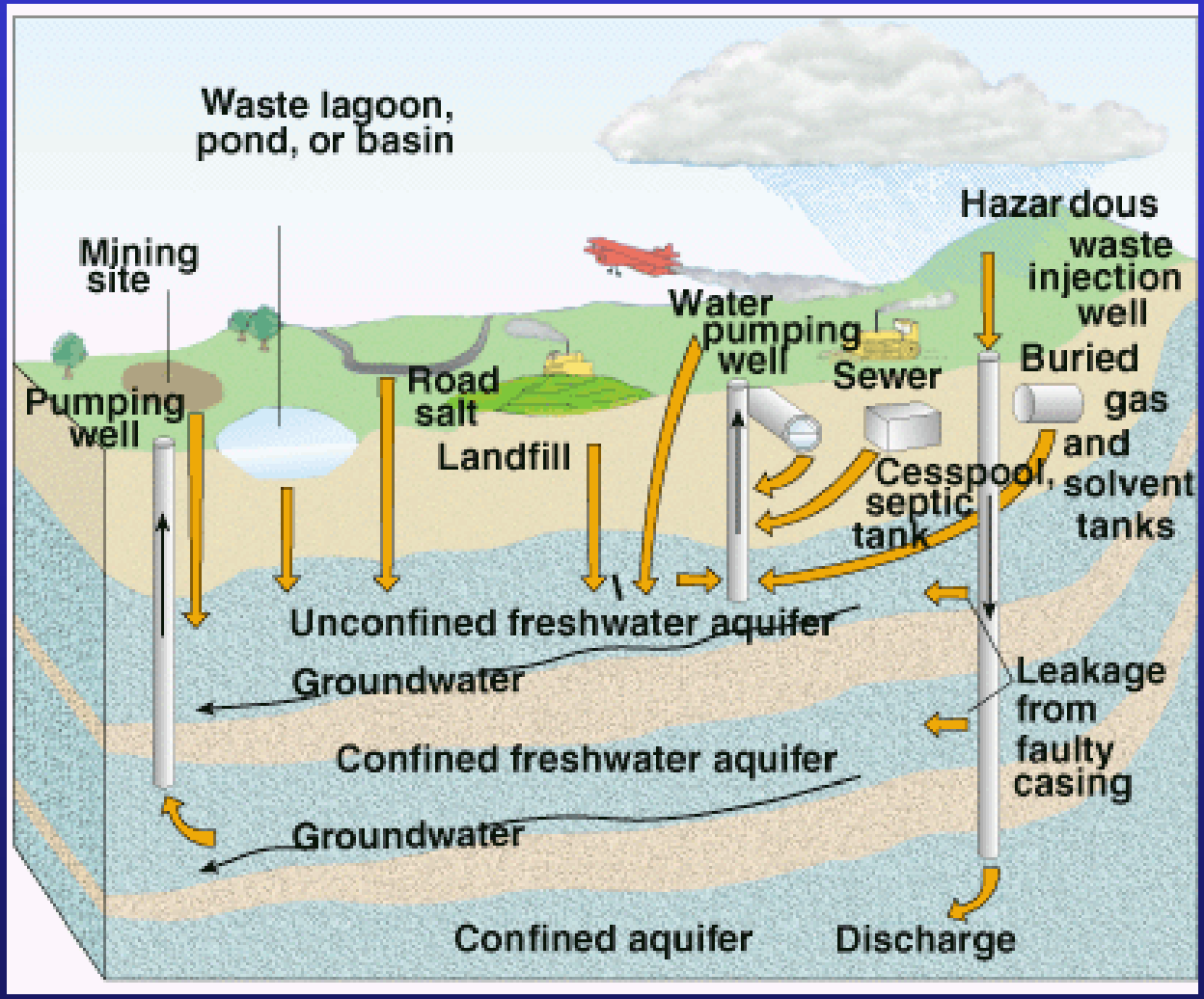


Fig. 20–13

Groundwater Pollution

Ways to prevent contamination of groundwater include the following:

- in general, reduce sources of water pollution that feed into the aquifer;
- monitor aquifers near landfills & underground storage tanks;
- require leak detection systems & liability insurance for existing & new underground tanks that store hazardous liquids;
- ban or more strictly regulate disposal of hazardous wastes in deep injection wells & landfills;
- store hazardous liquids aboveground with more safeguards;

6. Drinking Water Quality

Much of the world's drinking water is contaminated & poses serious health threats.

- currently most drinking water is purified by storage in a reservoir, where suspended matter settles out, & then treated by sand filters, activated charcoal, & addition of chlorine; (See http://thefutureschannel.com/dockets/hands-on_math/water_supply)
- **U.S. Safe Drinking Water Act of 1974** requires EPA to establish national drinking water standards; currently efforts by industry to weaken the standards;
- many individuals turning to bottled water & home filters; bottled water is often more contaminated than tap water. (See http://www.pbs.org/pov/borders/2004/water/water_bottle.html)