WATER POLLUTION

Environmental Science

The Walker School

Water Pollution

- Water pollution is any chemical, biological, or physical change in water quality that has a harmful effect on living organism or makes water unsuitable for desired uses.
- It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily.

Human and Natural Pollutants

- Water is typically referred to as polluted when it is impaired by anthropogenic contaminants.
- Natural phenomena such as volcanoes, alga blooms, storms, and earthquakes also cause major changes in water quality.

Sources of Water Pollution

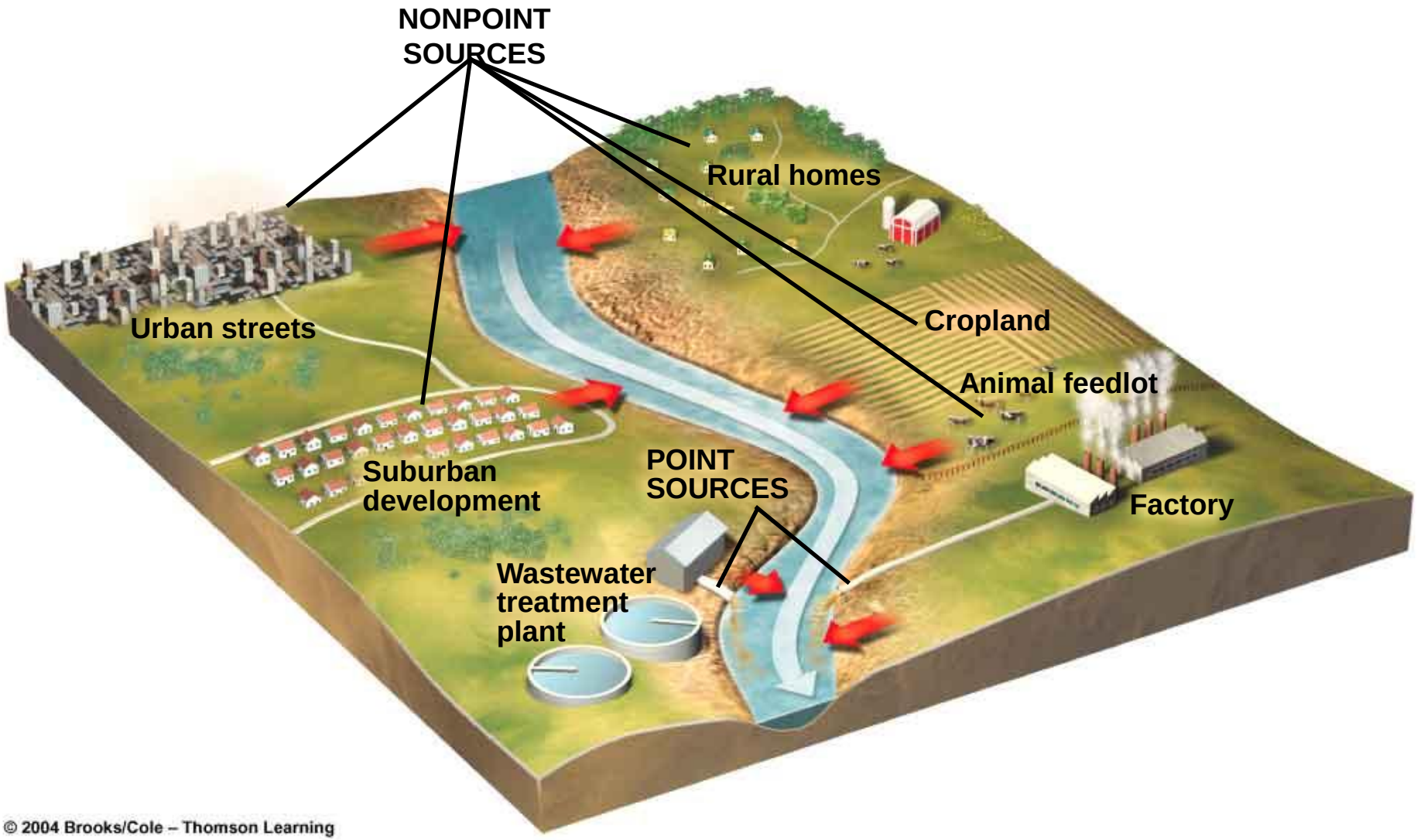


Table 22-1 Major Categories of Water Pollutants

Infectious Agents

Examples: Bacteria, viruses, protozoa, and parasitic worms
Major Human Sources: Human and animal wastes
Harmful Effects: Disease

Oxygen-Demanding Wastes

Examples: Organic waste such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria
Major Human Sources: Sewage, animal feedlots, paper mills, and food processing facilities
Harmful Effects: Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen-consuming aquatic life to die.

Inorganic Chemicals

Examples: Water-soluble (1) acids, (2) compounds of toxic metals such as lead (Pb), arsenic (As), and selenium (Se), and (3) salts such as sodium chloride (NaCl) in ocean water and fluorides (F^-) found in some soils
Major Human Sources: Surface runoff, industrial effluents, and household cleansers
Harmful Effects: Can (1) make fresh water unusable for drinking or irrigation, (2) cause skin cancers and crippling spinal and neck damage (F^-), (3) damage the nervous system, liver, and kidneys (Pb and As), (4) harm fish and other aquatic life, (5) lower crop yields, and (6) accelerate corrosion of metals exposed to such water.

Organic Chemicals

Examples: Oil, gasoline, plastics, pesticides, cleaning solvents, detergents
Major Human Sources: Industrial effluents, household cleansers, surface runoff from farms and yards
Harmful Effects: Can (1) threaten human health by causing nervous system damage (some pesticides), reproductive disorders (some solvents), and some cancers (gasoline, oil, and some solvents) and (2) harm fish and wildlife.

Plant Nutrients

Examples: Water-soluble compounds containing nitrate (NO_3^-), phosphate (PO_4^{3-}), and ammonium (NH_4^+) ions
Major Human Sources: Sewage, manure, and runoff of agricultural and urban fertilizers
Harmful Effects: Can cause excessive growth of algae and other aquatic plants, which die, decay, deplete water of dissolved oxygen, and kill fish. Drinking water with excessive levels of nitrates lowers the oxygen-carrying capacity of the blood and can kill unborn children and infants ("blue-baby syndrome").

Sediment

Examples: Soil, silt
Major Human Sources: Land erosion
Harmful Effects: Can (1) cloud water and reduce photosynthesis, (2) disrupt aquatic food webs, (3) carry pesticides, bacteria, and other harmful substances, (4) settle out and destroy feeding and spawning grounds of fish, and (5) clog and fill lakes, artificial reservoirs, stream channels, and harbors.

Radioactive Materials

Examples: Radioactive isotopes of iodine, radon, uranium, cesium, and thorium
Major Human Sources: Nuclear and coal-burning power plants, mining and processing of uranium and other ores, nuclear weapons production, natural sources
Harmful Effects: Genetic mutations, miscarriages, birth defects, and certain cancers

Heat (Thermal Pollution)

Examples: Excessive heat
Major Human Sources: Water cooling of electric power plants and some types of industrial plants. Almost half of all water withdrawn in the United States each year is for cooling electric power plants.
Harmful Effects: Lowers dissolved oxygen levels and makes aquatic organisms more vulnerable to disease, parasites, and toxic chemicals. When a power plant first opens or shuts down for repair, fish and other organisms adapted to a particular temperature range can be killed by the abrupt change in water temperature—known as *thermal shock*.

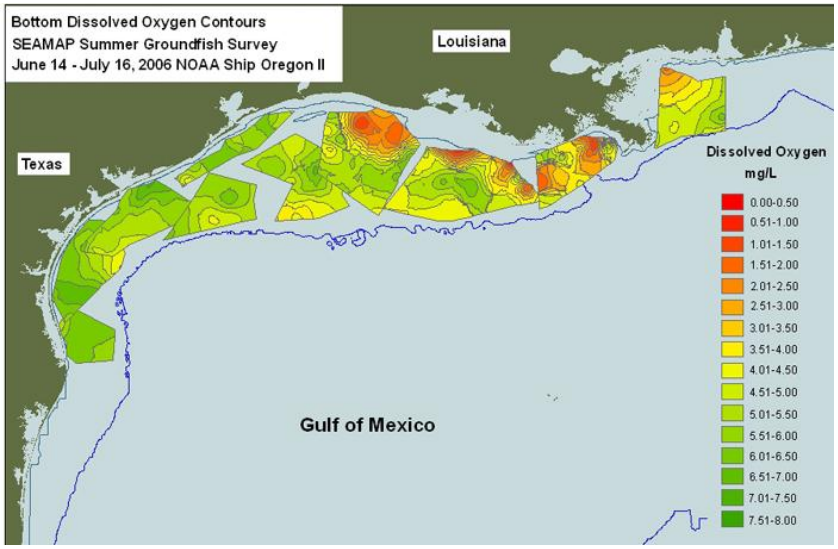
Eutrophication

- An increase in chemical nutrients — compounds containing nitrogen or phosphorus — in an ecosystem, and may occur on land or in water. However, the term is often used to mean the resultant increase in the ecosystem's primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.

Eutrophication of the Potomac River.

Hypoxia

- A phenomenon that occurs in aquatic environments as dissolved oxygen (**DO**; molecular oxygen dissolved in the water) becomes reduced in concentration to a point detrimental to aquatic organisms living in the system.
- Oxygen depletion can be the result of a number of factors including natural ones, but is of most concern as a consequence of pollution and eutrophication in which plant nutrients enter a river, lake, or ocean, phytoplankton blooms are encouraged.



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

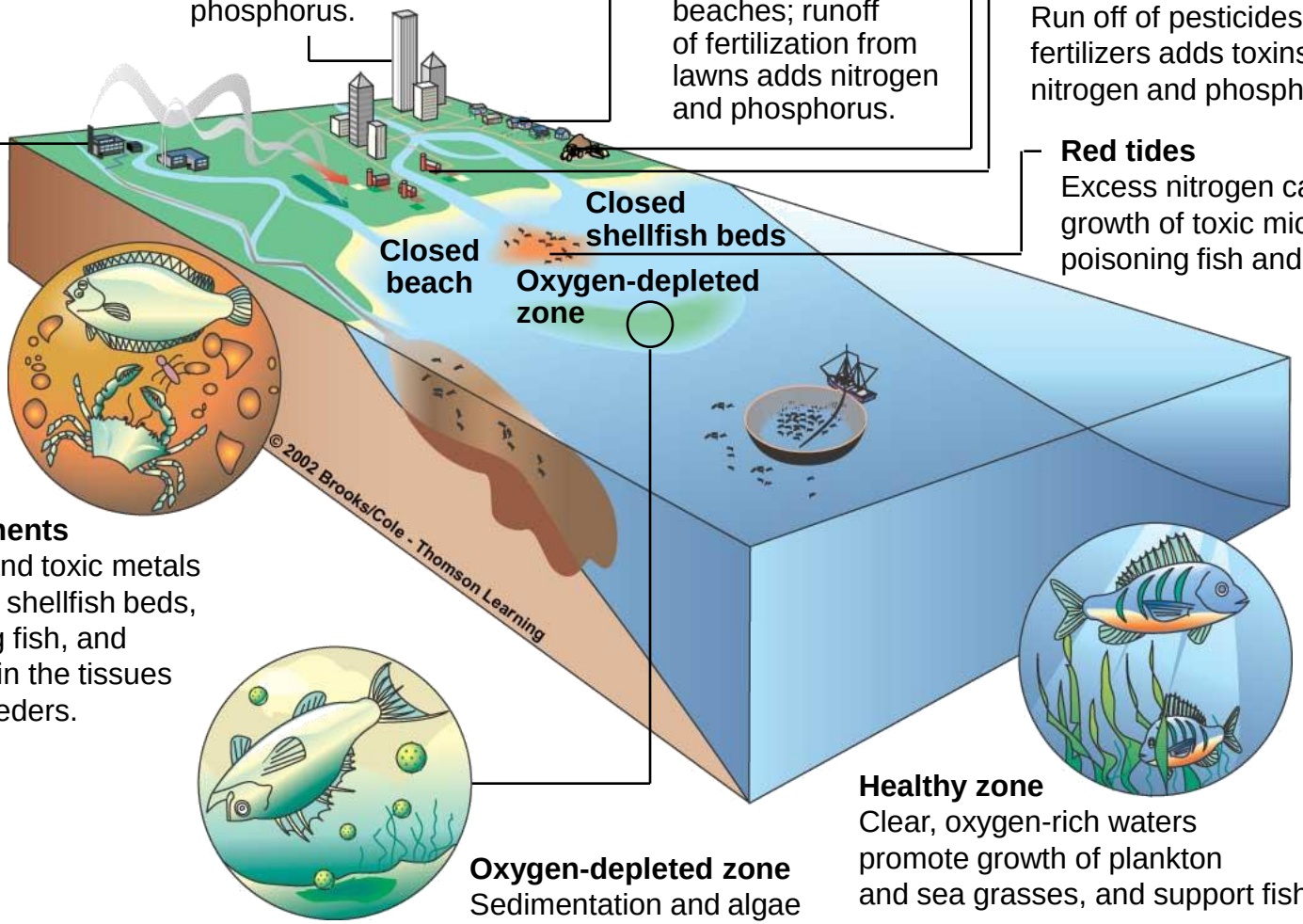
Cities
Toxic metals and oil from streets and parking lots pollute waters; sewage adds nitrogen and phosphorus.

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.



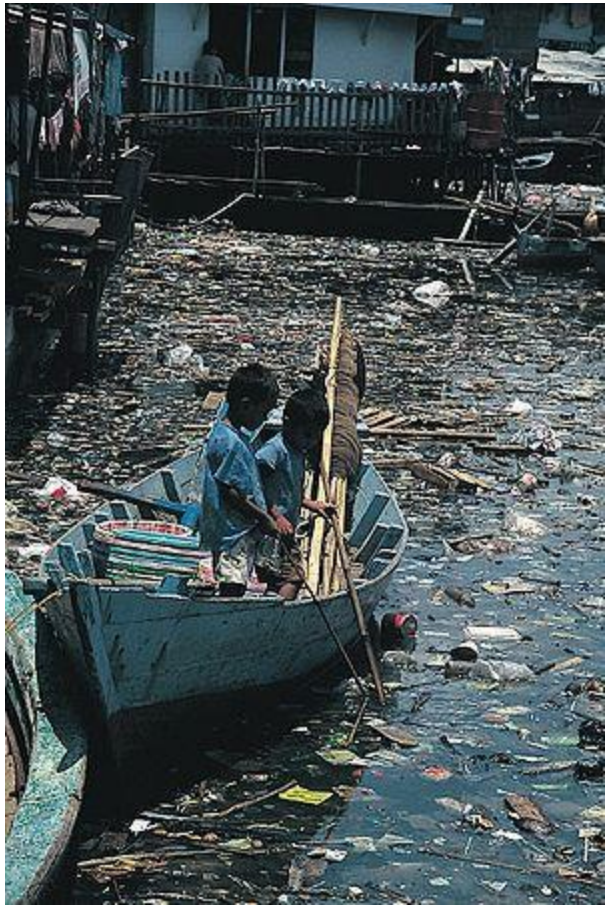
Toxic sediments
Chemicals and toxic metals contaminate shellfish beds, kill spawning fish, and accumulate in the tissues of bottom feeders.

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

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

Marine Pollution

- Entry into the ocean of chemicals, particles, industrial, agricultural and residential waste, or the spread of invasive organisms.
- Most sources of marine pollution are land based. The pollution often comes from nonpoint sources such as agricultural runoff and wind blown debris.
- Many potentially toxic chemicals adhere to tiny particles which are then taken up by plankton and benthos animals, most of which are either deposit or filter feeders.
- Toxins are concentrated upward (biomagnification) within ocean food chains.

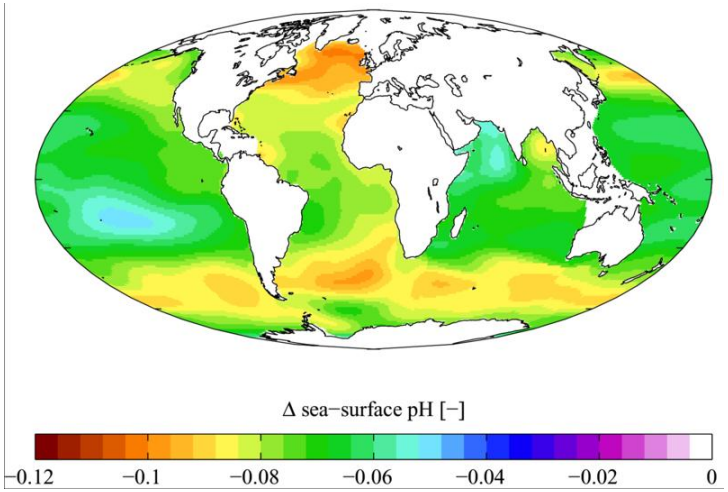


Marine Debris

- Human-created waste that has deliberately or accidentally become afloat in a lake, sea, ocean or waterway. Oceanic debris tends to accumulate at the centre of gyres and on coastlines, frequently washing aground, when it is known as beach litter.
- Plastic bags, balloons, buoys, rope, medical waste, glass bottles and plastic bottles, cigarette lighters, beverage cans, styrofoam, lost fishing line and nets, and various wastes from cruise ships and oil rigs are among the items commonly found.

Ocean Acidification

- The ongoing decrease in the pH of the Earth's oceans, caused by their uptake of anthropogenic carbon dioxide from the atmosphere.
- Human activities such as land-use changes, the combustion of fossil fuels, and the production of cement have led to a new flux of CO_2 into the atmosphere.
- Dissolving CO_2 in seawater also increases the hydrogen ion (H^+) concentration in the ocean, and thus decreases ocean pH.



Change in sea surface pH caused by anthropogenic CO_2 between the 1700s and the 1990s.

Ship Pollution

- Spills from oil tankers and chemical tankers
- Ejection of sulfur dioxide, nitrogen dioxide and carbon dioxide gases into the atmosphere from exhaust fumes.
- Discharge of cargo residues from bulk carriers can pollute ports, waterways and oceans.
- Noise pollution that disturbs natural wildlife.
- Water from ballast tanks can spread harmful algae and other invasive species.

Thermal Pollution

- The rise or fall in the temperature of a natural body of water caused by human influence.
- A common cause is the use of water as a coolant by power plants and industrial manufacturers.
- Warm water typically decreases the level of dissolved oxygen in the water . The decrease in levels of DO can harm aquatic animals.
- May also increase the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food.

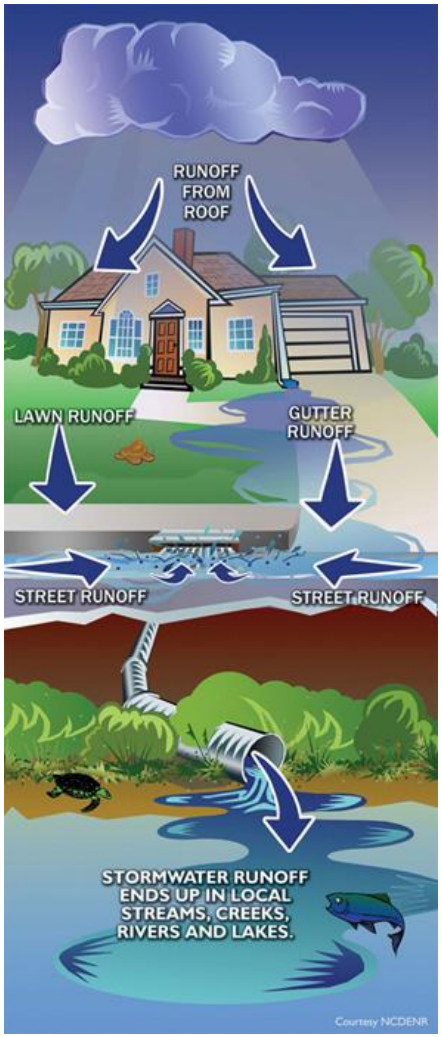
Surface Runoff

- Surface runoff can be generated either by rainfall or by the melting of snow or glaciers.
- It is the water flow which occurs when soil is infiltrated to full capacity and excess water, from rain, snowmelt, or other sources flows over the land. This is a major component of the water cycle.
- When runoff flows along the ground, it can pick up soil contaminants such as petroleum, pesticides (in particular herbicides and insecticides), or fertilizers that become discharge or nonpoint source pollution.

Runoff flowing into a stormwater drain.

Urbanization and Surface Run Off

- Urbanization increases surface runoff, by creating more impervious surfaces such as pavement and buildings, that do not allow percolation of the water down through the soil to the aquifer. It is instead forced directly into streams or storm water runoff drains, where erosion and siltation can be major problems, even when flooding is not. Increased runoff reduces groundwater recharge, thus lowering the water table and making droughts worse, especially for farmers and others who depend on water wells.



Water Stagnation

- Occurs when water stops flowing.
- Malaria and dengue are among the main dangers of stagnant water, which can become a breeding ground for the mosquitoes that transmit these diseases.

Protozoan Infections

Protozoal infections [edit]

Disease and Transmission	Microbial Agent	Sources of Agent in Water Supply	General Symptoms
Amoebiasis (hand-to-mouth)	Protozoan (*Entamoeba histolytic*) (Cyst-like appearance)	Sewage, non-treated drinking water, flies in water supply	Abdominal discomfort, fatigue, weight loss, diarrhea, gas pains Fever, abdominal pain
Cryptosporidiosis (oral)	Protozoan (*Cryptosporidium parvum*)	Collects on water filters and membranes that cannot be disinfected, animal manure, seasonal runoff of water.	Flu-like symptoms, watery diarrhea, loss of appetite, substantial loss of weight, bloating, increased gas, stomach
Cyclosporiasis	Protozoan parasite (*Cyclospora cayetanensis*)	Sewage, non-treated drinking water	cramps, nausea, vomiting, muscle aches, low-grade fever, and fatigue
Giardiasis (oral-fecal) (hand-to-mouth)	Protozoan (*Giardia lamblia*) Most common intestinal parasite	Untreated water, poor disinfection, pipe breaks, leaks, groundwater contamination, campgrounds where humans and wildlife use same source of water. Beavers and muskrats act as a reservoir for Giardia.	Diarrhea, abdominal discomfort, bloating, gas and gas pains
Microsporidiosis	Protozoan (*Microsporidia*), but closely related to fungi	The genera of *Encephalitozoon intestinalis* has been detected in groundwater, swimming pool via AIDS patients and the origin of drinking water [2]	

Parasitic Infections

Parasitic Infections [edit]

Disease and Transmission	Microbial Agent	Sources of Agent in Water Supply	General Symptoms
Schistosomiasis (immersion)	Schistosoma	Contaminated fresh water with certain types of snails that carry schistosomes	Rash or itchy skin. Fever, chills, cough, and muscle aches
dracunculiasis	dracanculus medinensis	drinking water containing infective cyclops	allergic reaction,urticaria rash, nausea, vomiting, diarrhea, asthmatic attack.
taeniasis solium	taenia solium	contaminate drinking water with eggs	intestinal disturbances, neurologic manifestations, loss of weight, cysticercosis
fasciolopsis	fasciola	contaminated drinking water with encysted metacercaria	GIT disturbance, diarrhea, liver enlargement, cholangitis, cholecystitis, obstructive jaundice.
hymenolepiasis nana	hymenolepis nana	contaminated drinking water with eggs	mild GIT symptoms, nervous manifestation
hyatidosis	echinococcus granulosus	contaminated drinking water with eggs	hyatid cyst press on bile duct and blood vessels, if it ruptured cause anaphylactic shock.
coenurosis	multiceps multiceps	contaminated drinking water with eggs	increases intacranial tension
ascariasis	ascaris lumbricoides	contaminated drinking water with eggs	Loefflers syndrome in lung, nausea, vomiting, diarrhoea, malnutrition, underdevelopment,
enterobiasis	entrobius vermicularis	contaminated drinking water with eggs	peri-anal itch, nervous irritability, hyperactivity and insomnia

Bacterial Infections

Bacterial infections [edit]

- Botulism - Clostridium botulinum bacteria - gastro-intestinal food/water borne; can grow in food
- Campylobacteriosis
- Cholera - Vibrio cholerae bacteria - gastro-intestinal often waterborne
- Chronic granulomatous disease - caused by the Mycobacterium marinum infection and localized in skin, frequently occurred with aquarium keepers.[3]
- Diarrheal disease due to *E. coli*.
- Dysentery - Shigella/Salmonella bacteria - gastro-intestinal food/water
- Legionellosis - cause Pontiac fever and Legionnaires' disease
- Leptospirosis-
- Otitis externa- "Swimmer's Ear"
- Typhoid - Salmonella typhi bacteria - gastro-intestinal water/food borne. Salmonellosis - due to many Salmonella species. Water/food/direct contact borne.
- Vibrio illness caused by the bacteria of Vibrio vulnificus, Vibrio alginolyticus and Vibrio parahaemolyticus commonly found in seafood and recreational water.[4]

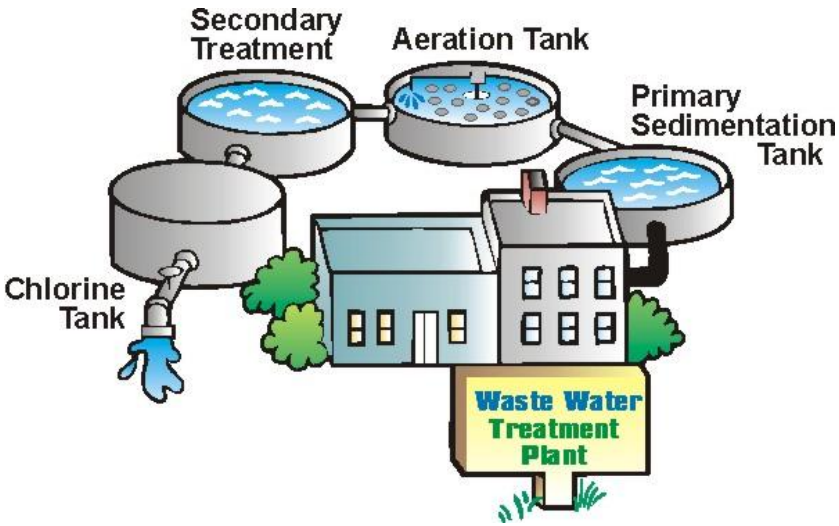
Viral Infections

Viral Infections [edit]

- Adenovirus infection - its serotypes are typically waterborne.[5]
- Astroviruses -
- Caliciviruses -
- Circoviruses - its human form of Transfusion Transmitted Virus found in feces, saliva, skin and hair [2]
- Coronaviruses - cause SARS and excreted in the feces [2]
- Enteric Adenoviruses -
- Hepatitis A - Hepatitis A virus - gastro-intestinal water/food borne
- Parvoviruses - associated with Gastroenteritis.[2]
- Picobimaviruses - associated with Gastroenteritis in AIDS patients, children and elderlies.[2]
- Polio - polioviruses - gastro-intestinal exposure to untreated
- Polyomaviruses - its human form of JC virus cause Progressive multifocal leukoencephalopathy and detected in sewage [2]
- Small Round Structured Virus

Waste Water

- Comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations.



HOW DO WE MEASURE WATER QUALITY?

Quantitative Water Quality Tests

- Fecal Coliform/Coliform
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Temperature
- Turbidity/Total Suspended Solids (TSS)
- Heavy metals, (e.g., lead, mercury, cadmium)
- Carbon dioxide
- Nitrite
- Salinity
- Ammonia
- Macro or micronutrients (e.g., K, S, Mo)
- Chlorine
- Iron
- Selenium
- Hardness
- Sulfate and Sulfite
- Methane
- Conductivity/Total Dissolved Solids (TDS)
- Alkalinity/Acid Neutralizing
- Capacity (ANC) Color Odor
- Synthetic organics (e.g., pesticides, PCBs)

Turbidity

- The cloudiness or haziness of a fluid caused by individual particles (total suspended solids - TSS) that are generally invisible to the naked eye, similar to smoke in air.
- Turbidity in open water may be caused by growth of phytoplankton.
- Human activities that disturb land, such as construction, can lead to high sediment levels entering water bodies during rain storms, due to storm water runoff, and create turbid conditions.
- Urbanized areas contribute large amounts of turbidity to nearby waters, through stormwater pollution from paved surfaces such as roads, bridges and parking lots.
- Industries such as quarrying, mining and coal recovery can generate very high levels of turbidity from colloidal rock particles.

Turbidity standards of 5, 50, and 500 NTU

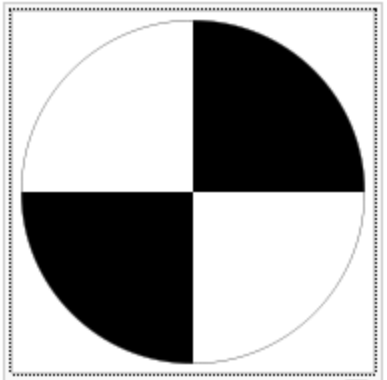
Measuring Turbidity

- A nephelometer is an instrument for measuring suspended particulates in a liquid or gas colloid. It does so by employing a light beam (source beam) and a light detector set to one side (usually 90°) of the source beam. Particle density is then a function of the light reflected into the detector from the particles.
- A nephelometric turbidimeter always monitors light reflected off the particles and not attenuation due to cloudiness.
- In the United States environmental monitoring the turbidity standard unit is called Nephelometric Turbidity Units (NTU), while the international standard unit is called Formazin Nephelometric Unit (FNU).

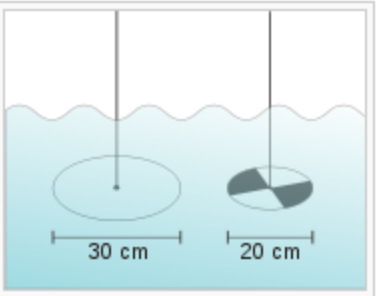
A nephelometer at the Kosan, Cheju Island, South Korea NOAA facility.

Secchi Disks

- Turbidity in lakes, reservoirs, and the ocean can be measured using a Secchi disk. This black and white disk is lowered into the water until it can no longer be seen; the depth (Secchi depth) is then recorded as a measure of the transparency of the water (inversely related to turbidity). The Secchi depth is reached when the reflectance equals the intensity of light backscattered from the water.
- The Secchi disk has the advantages of integrating turbidity over depth (where variable turbidity layers are present), being quick and easy to use, and inexpensive. It can provide a rough indication of the depth of the euphotic zone with a 3-fold division of the *Secchi depth*.
- Limitations: Secchi disk readings do not provide an exact measure of transparency, as there can be errors due to the sun's glare on the water, or one person may see the disk at one depth, but another, with better eyesight, may see it at a greater depth.



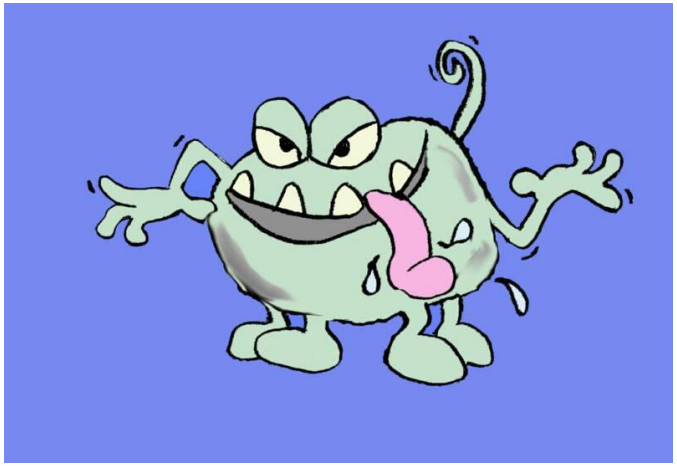
Secchi disk pattern



Different kinds of Secchi disks

Biochemical Oxygen Demand (BOD)

- A chemical procedure for determining how fast biological organisms use up oxygen in a body of water.
- BOD can be used as a gauge of the effectiveness of wastewater treatment plants.
- The BOD test is carried out by:
  - 1. diluting the sample (sludge) with oxygen saturated de-ionized water,
  - 2. inoculating it with a fixed aliquot of seed, measuring the dissolved oxygen (DO) and then sealing the sample to prevent further oxygen dissolving in.
  - 3. sample is kept at 20 °C in the dark to prevent photosynthesis (and thereby the addition of oxygen) for five days, and the dissolved oxygen is measured again.
  - 4. difference between the final DO and initial DO is the BOD.

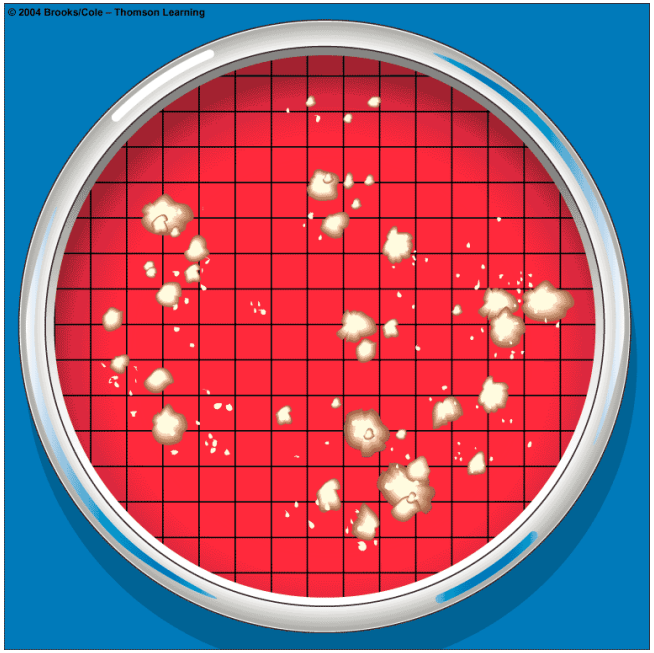


Common Levels of BOD:

- Most pristine rivers below - 1 mg/L.
- Moderately polluted rivers - in the range of 2 to 8 mg/L.
- Municipal sewage that is efficiently treated by a three-stage process would have a value of about 20 mg/L or less.
- Untreated sewage varies, but averages around 600 mg/L.

Fecal Coliforms

- Are facultatively-anaerobic, rod-shaped, gram-negative, non-sporulating bacteria.
- Include the genera that originate in feces; *Escherichia* as well as genera that are not of fecal origin; *Enterobacter*, *Klebsiella*, and *Citrobacter*.
- Increased levels of fecal coliforms (fecal bacteria) provide a warning of failure in water treatment, a break in the integrity of the distribution system, or possible contamination with pathogens.
- Fecal coliform bacteria can enter rivers through direct discharge of waste from mammals and birds, from agricultural and storm runoff, and from untreated human sewage. However their presence may also be the result of plant material, and pulp or paper mill effluent.
- The assay is intended to be an indicator of fecal contamination, or more specifically *E. coli* which is an indicator microorganism for other pathogens that may be present in feces.
- EPA acceptable Levels is 0 colonies.



A fecal *coliform* plate

Qualitative Water Tests

- Habitat Evaluation Index
  - (e.g., substrate analysis, in-stream cover, channel morphology, raparian zone and bank erosion, gradient) - http://rock.geo.csuohio.edu/norp/qhei.htm
- Biodiversity Index . the different numbers and types of species,
  - (e.g., macroinvertebrates, bacteria, algae, amphibians, fish,plants).

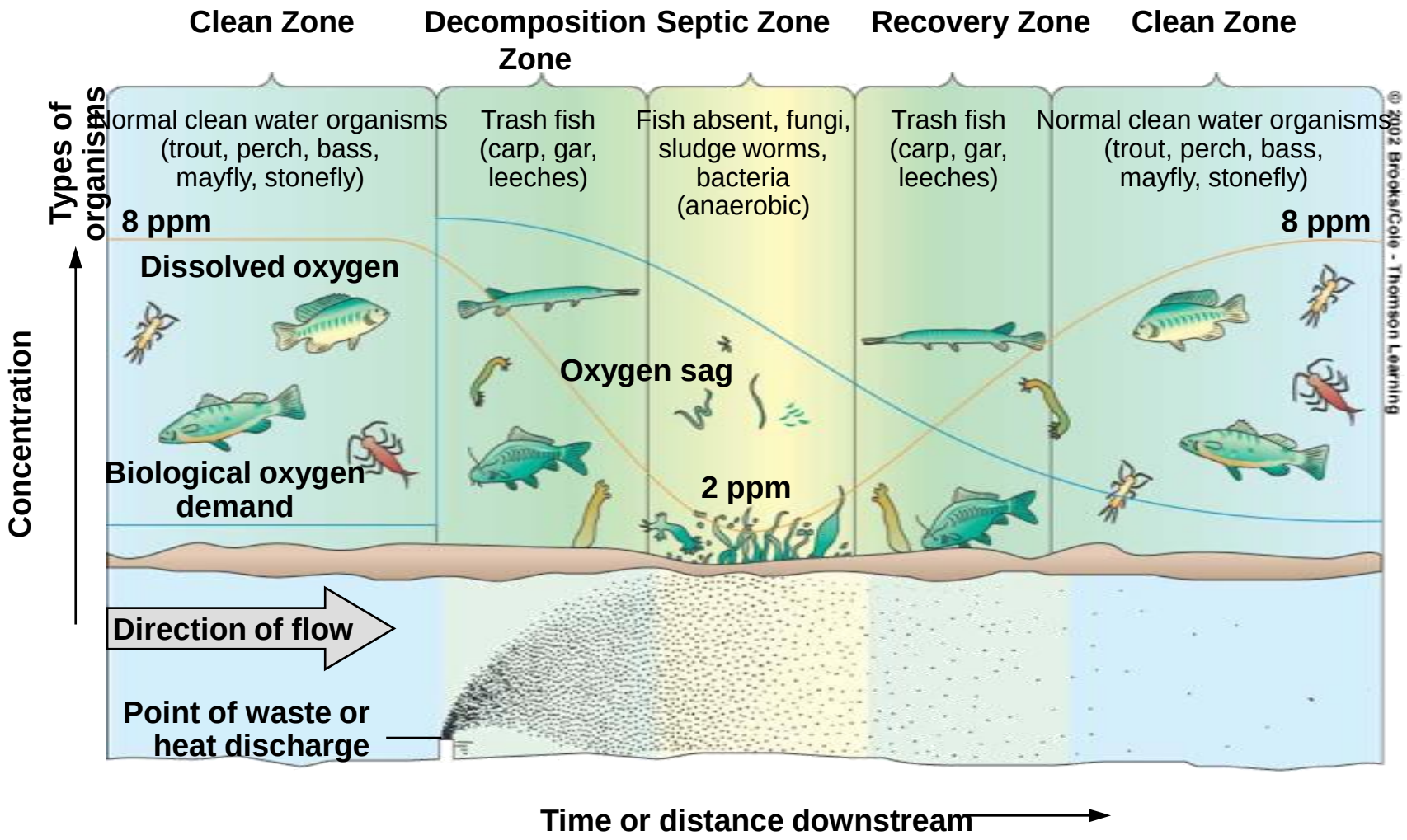
WHAT ARE SOME INDICATOR SPECIES OF WATER POLLUTION?

Indicator Species

- Any biological species that defines a trait or characteristic of the environment.
- Species may delineate an ecoregion or indicate an environmental condition such as a disease outbreak, pollution, species competition or climate change.
- Can be among the most sensitive species in a region, and sometimes act as an early warning to monitoring biologists.

The American Dipper is a bird that requires a habitat of clear, mountainous streams, and can be displaced by siltation from land development, land-wasting runoff and forest fire runoff.

Range of Tollerance



Indicator Species

Pollution Sensitive	Somewhat Pollution Tolerant	Pollution tolerant
caddisfly larvae	beetle larvae	aquatic worms
hellgrammite clams	blackfly larvae	leeches
mayfly nymphs	crane fly larvae	midge larvae
gilled snails	crayfish	catfish
riffle beetle	adult damselfly nymphs pouch	carp
stonefly nymphs	dragonfly nymphs	
water penny larvae	scuds	
trout sowbugs		
fishfly larvae		
alderfly larvae		
atherix		
bass		

Amphibians

- Include frogs, toads, salamanders, newts, and gymnophiona, and are cold-blooded animals that metamorphose from a juvenile, water-breathing form to an adult, air-breathing form.
- Are indicator species of ecological conditions relating to global warming, air pollution chemicals, stormwater runoff, and newly extant diseases (e.g. fungus).

Frogs

http://www.hcn.org/issues/60/1859

- Farm fertilizers. These chemicals boost algae production which in turn boost the population of certain flatworm parasites. These parasite attack frogs at their larval stage (tadpoles), causing them to develop deformities in adulthood. Deformities include missing or extra limbs.

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Frogs: The ultimate indicator species

SIDEBAR ARTICLE - From the May 27, 1996 issue of High Country News

By Todd Wilkinson

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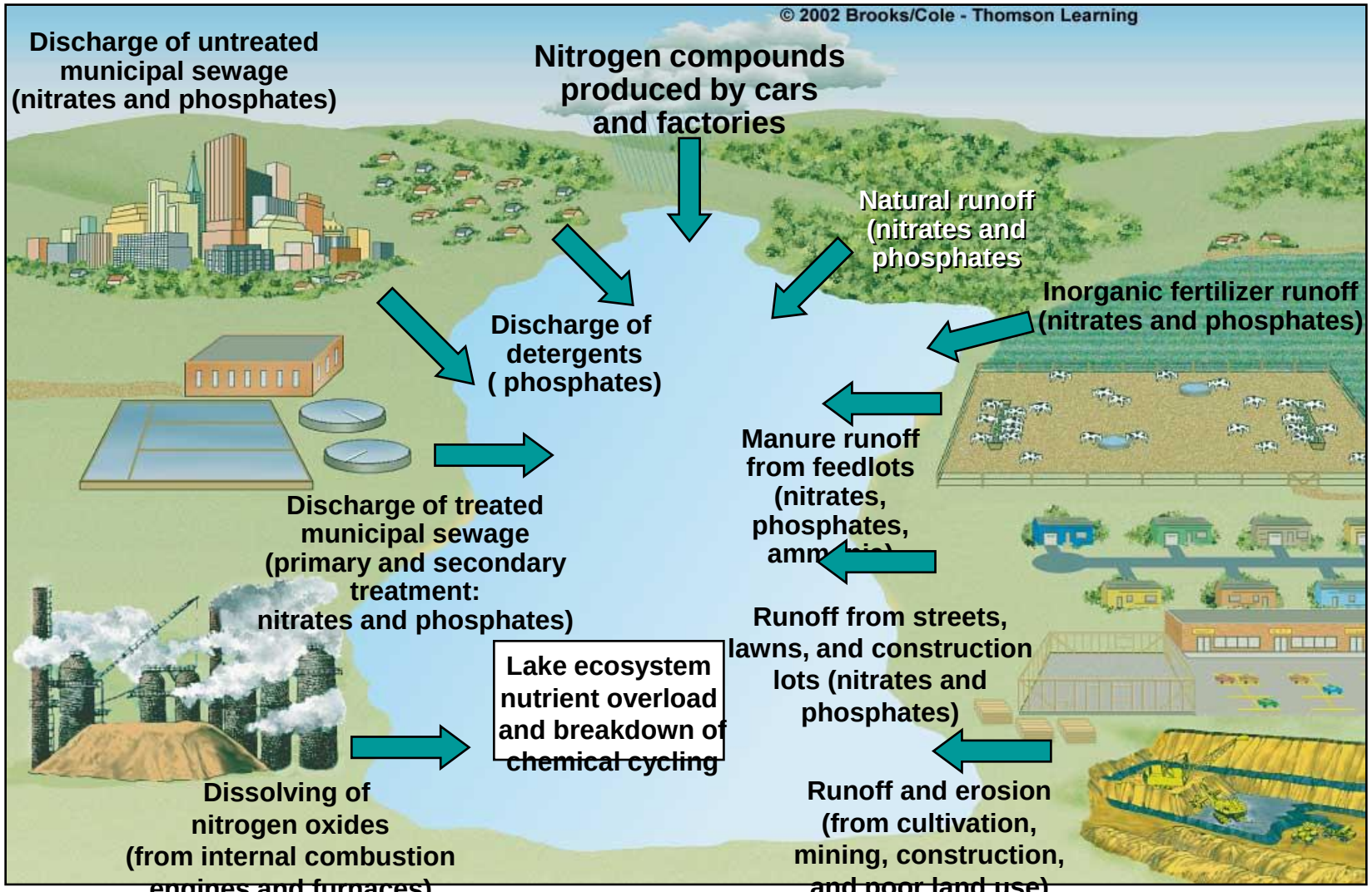
Native frog populations are plummeting all over the world. No one knows exactly why, but there are six prominent possibilities. Destruction of wetlands is one, contamination of water supplies by biocides, pollutants, and acid rain another. A third is the introduction of non-native predators such as voracious game fish from hatcheries, as well as bullfrogs and crawfish that eat the eggs of native frogs. A fourth is natural population variation. The fifth factor is a fungal disease called Saprolegnia, which has long plagued hatchery fish and recently spread to the wild, where it is suspected of affecting frogs as well as fish. The sixth is the depletion of the ozone layer: Now that it is known that sunbathing sets the stage for skin cancer, many scientists wonder what the effects are upon frogs, whose bodies are protected from the elements by a thin skin permeable to both water and gas.

Some scientists wonder why the crash of frog numbers in Utah is outpacing decline in most other areas. Does it foreshadow a system collapse? Are the frogs aquatic versions of the canary in the coal mine? Jasper Carlton, director of the Biodiversity Legal Foundation, says the answer to both questions is yes.

Sources of Eutrophication



Effects of Natural and Cultural Eutrophication

- Excessive amounts of algae can deplete dissolved oxygen content in the lake
- It can also cause bacteria to take over and produce toxic levels of hydrogen sulfide and flammable methane

Reduction Methods

- Use advanced waste treatment to remove nitrates and phosphates
- Bans or limits on phosphates in household detergents and other cleaning agents
- Soil conservation and land-use control to reduce nutrient runoff

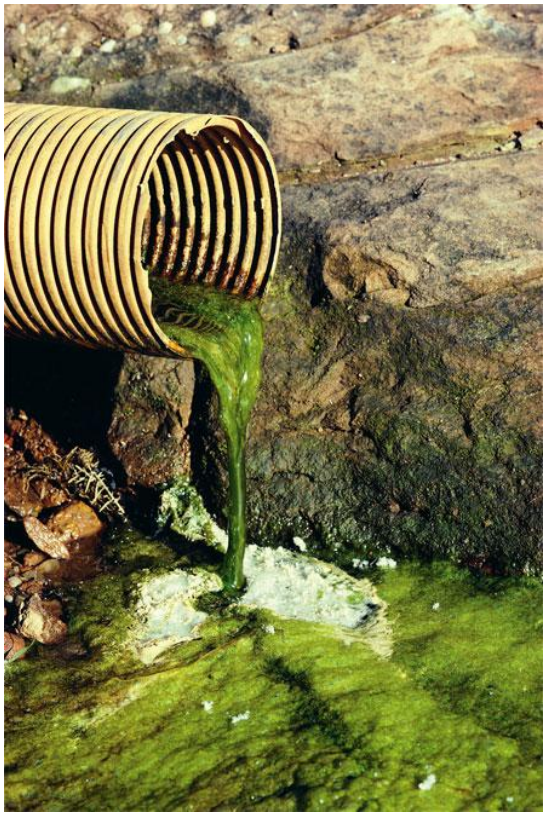
Climate Change and Water Pollution

- Global warming changes patters of precipitation, such as flooding and drought.
- Flooding can cause an increase of disease-carrying pathogens, or the overflow of human and animal wastes from sewer lines.
- Drought can cause reduced river flows that dilute wastes, increase salinity levels, and cause infectious disease to spread more rapidly because people lack enough water to stay clean.

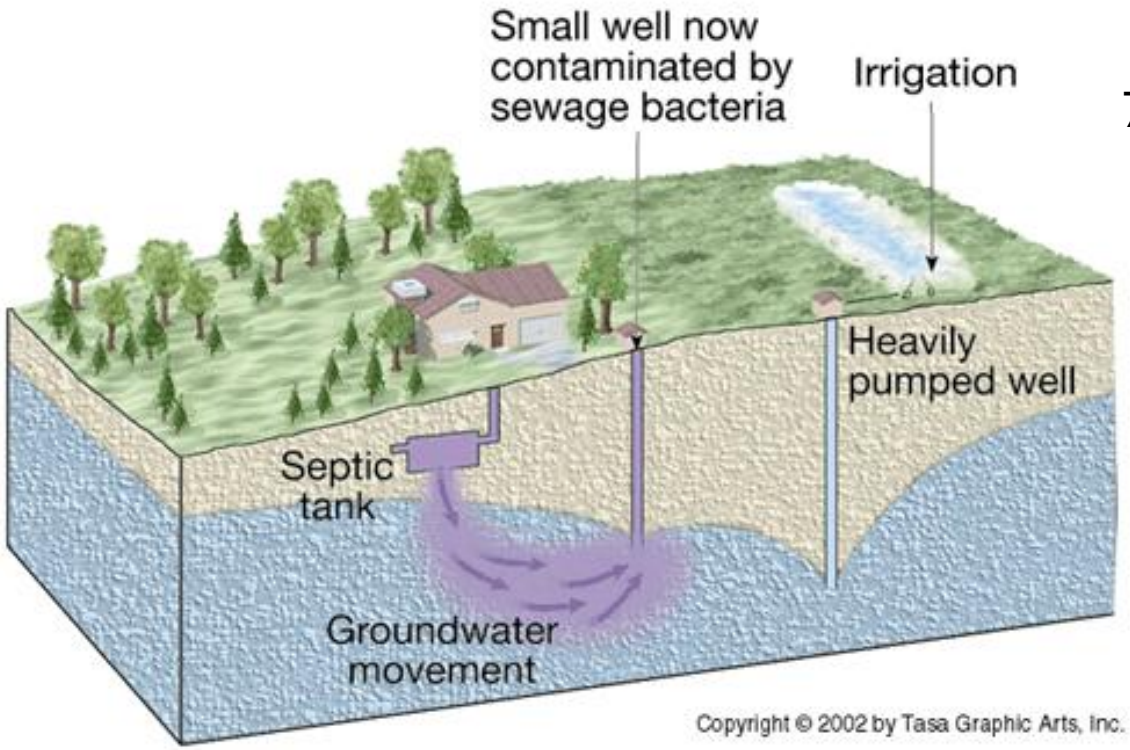
WHAT ARE THE MAJOR SOURCES OF WATER POLLUTION

Major Sources

- Agricultural Activities (non-point sources)
- Industrial Facilities (point-sources)
- Housing Developments (non-point sources)



Agricultural Pollution



64% of the total mass of pollutants entering streams

73% of those entering lakes.

Other Examples of Non-Point Sources

- Acid Deposition
- Runoff of Chemicals into Surface Water
  - Croplands
  - Livestock Feedlots
  - Logged Forests
  - Urban Streets
  - Lawns
  - Golf Courses
  - Parking lots

Examples of Point Sources

- Factories
- Sewage Treatment Plants
- Active and Abandoned Underground Mines
- Oil tankers

IS THE WATER SAFE TO DRINK?

Safe Drinking Water

- Is water that is of sufficiently high quality so that it can be consumed or utilized without risk of immediate or long term harm, such water is commonly called potable water.
- 95% in (more developed countries) MDC's have safe drinking water
- 74% in (less developed countries) LDC's have safe drinking water

Human Requirements

- 2 to 3 liters of water for men
- 1 to 2 liters of water for women should be taken in as fluid
- RDI – Reference Daily Intake

Local Drinking Water

http://www.epa.gov/safewater/dwinfo/index.html

U.S. ENVIRONMENTAL PROTECTION AGENCY

Local Drinking Water Information

Recent Additions | Contact Us | Print Version Search: GO

EPA Home > Water > Ground Water & Drinking Water > Local Drinking Water Information

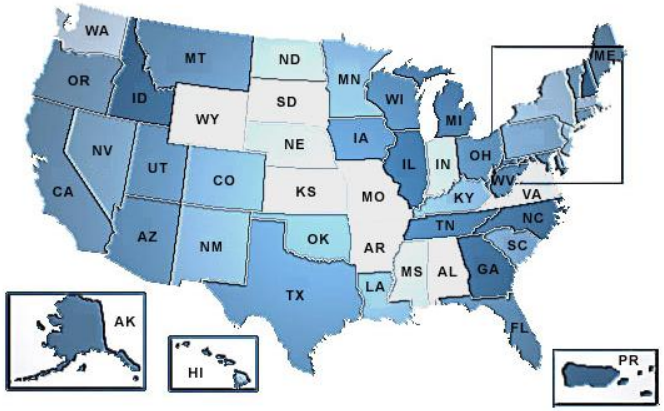
Local Drinking Water Information

Each year by July 1 you should receive in the mail a short report (consumer confidence report, or drinking water quality report) from your water supplier that tells where your water comes from and what's in it:

- see if your annual drinking water quality report is posted on-line, or
- read some frequent questions about these reports.

Note: The external links to state web sites and contacts may not be accurate at this time, we are currently reviewing this information. Please check back with us for the updates on these pages.

To find information about your local drinking water system, select a state or zoom in on the Northeast.



- Guam
- American Samoa
- Virgin Islands
- Northern Mariana Islands

WHAT HAVE DEVELOPED COUNTRIES DONE TO REDUCE STREAM POLLUTION?

WHO Report on Drinking Water

http://www.who.int/water_sanitation_health/monitoring/jmp2006/en/

- 1.4 billion people do not have safe drinking water
- 9,300 die daily from water-borne diseases
- Cost of $23 billion to bring safe drinking water and sanitation to everyone over 8-10 years.

Clean Water Act 1972

http://www.epa.gov/watertrain/cwa/

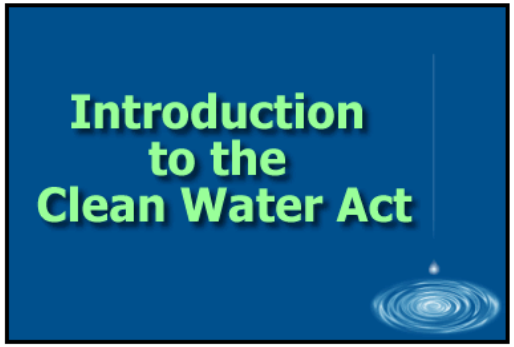
U.S. Environmental Protection Agency

Watershed Academy Web

EPA Home > Water> Wetlands, Oceans, & Watersheds > Watersheds> Watershed Academy > Watershed Academy Web

Introduction to the Clean Water Act

Academy Web Home | CWA Big Picture | Glossary NEXT



Introduction to the Clean Water Act

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. (The Act does not deal directly with ground water nor with water quantity issues.) The statute employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

For many years following the passage of CWA in 1972, EPA, states, and Indian tribes focused mainly on the chemical aspects of the "integrity" goal. During the last decade, however, more attention has been given to physical and biological integrity. Also, in the early decades of the Act's implementation, efforts focused on regulating discharges from traditional "point source" facilities, such as municipal sewage plants and industrial facilities, with little attention paid to runoff from streets, construction sites, farms, and other "wet-weather" sources.

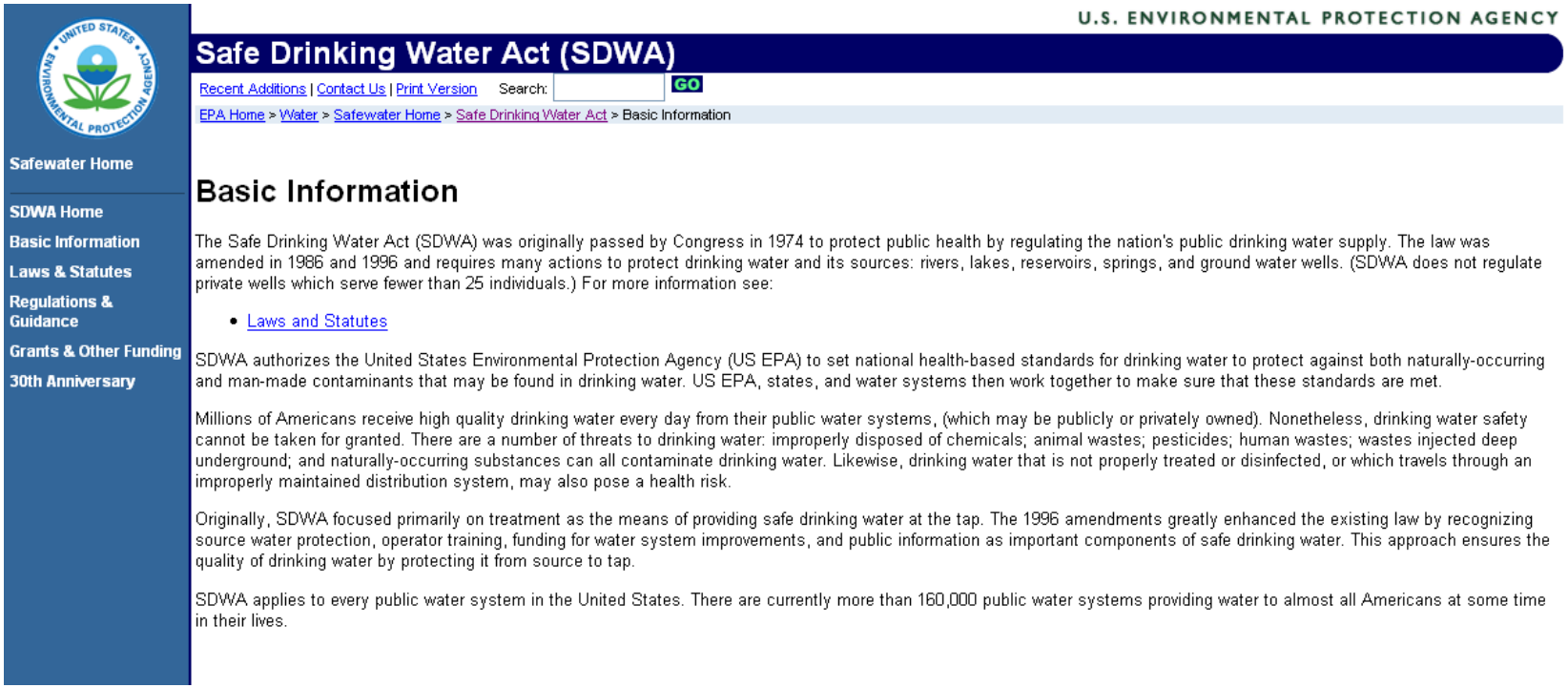
Starting in the late 1980s, efforts to address polluted runoff have increased significantly. For "nonpoint" runoff, voluntary programs, including cost-sharing with landowners are the key tool. For "wet weather point sources" like urban storm sewer systems and construction sites, a regulatory approach is being employed.

Key Points of Clean Water Act

- regulate the discharge of pollutants into U.S. waterways
- attain water quality levels that make these waterways safe to fish and/or swim in
- restore and maintain the chemical, physical, and biological integrity of the nations water
- set water quality standards to limit pollutants
- require states and tribes to complete an assessment of all state rivers impacted, or
- potentially impacted, by non-point pollution (Section 319)
- reduce polluted runoff from urban areas and animal feeding operations (Section 319)
- provide enforcement mechanisms (e.g. civil actions/criminal penalties) to ensure

Safe Water Drinking Act 1974

http://www.epa.gov/safewater/sdwa/index.html



U.S. ENVIRONMENTAL PROTECTION AGENCY

Safe Drinking Water Act (SDWA)

Recent Additions | Contact Us | Print Version Search: GO

EPA Home > Water > Safewater Home > Safe Drinking Water Act > Basic Information

Safewater Home

SDWA Home
Basic Information
Laws & Statutes
Regulations & Guidance
Grants & Other Funding
30th Anniversary

Basic Information

The Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and ground water wells. (SDWA does not regulate private wells which serve fewer than 25 individuals.) For more information see:

- Laws and Statutes

SDWA authorizes the United States Environmental Protection Agency (US EPA) to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. US EPA, states, and water systems then work together to make sure that these standards are met.

Millions of Americans receive high quality drinking water every day from their public water systems, (which may be publicly or privately owned). Nonetheless, drinking water safety cannot be taken for granted. There are a number of threats to drinking water: improperly disposed of chemicals; animal wastes; pesticides; human wastes; wastes injected deep underground; and naturally-occurring substances can all contaminate drinking water. Likewise, drinking water that is not properly treated or disinfected, or which travels through an improperly maintained distribution system, may also pose a health risk.

Originally, SDWA focused primarily on treatment as the means of providing safe drinking water at the tap. The 1996 amendments greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water. This approach ensures the quality of drinking water by protecting it from source to tap.

SDWA applies to every public water system in the United States. There are currently more than 160,000 public water systems providing water to almost all Americans at some time in their lives.

Key points of Safe Drinking Water Act

- Established maximum contaminate levels
- Regulated volatile organic compounds
- Required lead-free plumbing
- Well-head protection

WATER PURIFICATION

Environmental Science

The Walker School

Water Purification

- The process of removing undesirable chemical and biological contaminants from raw water.
- Designed to meet drinking, medical, pharmacology, chemical and industrial applications.
- Treatment processes also lead to the presence of some mineral nutrients: fluoride, calcium, zinc, manganese, phosphate, and sodium compounds.

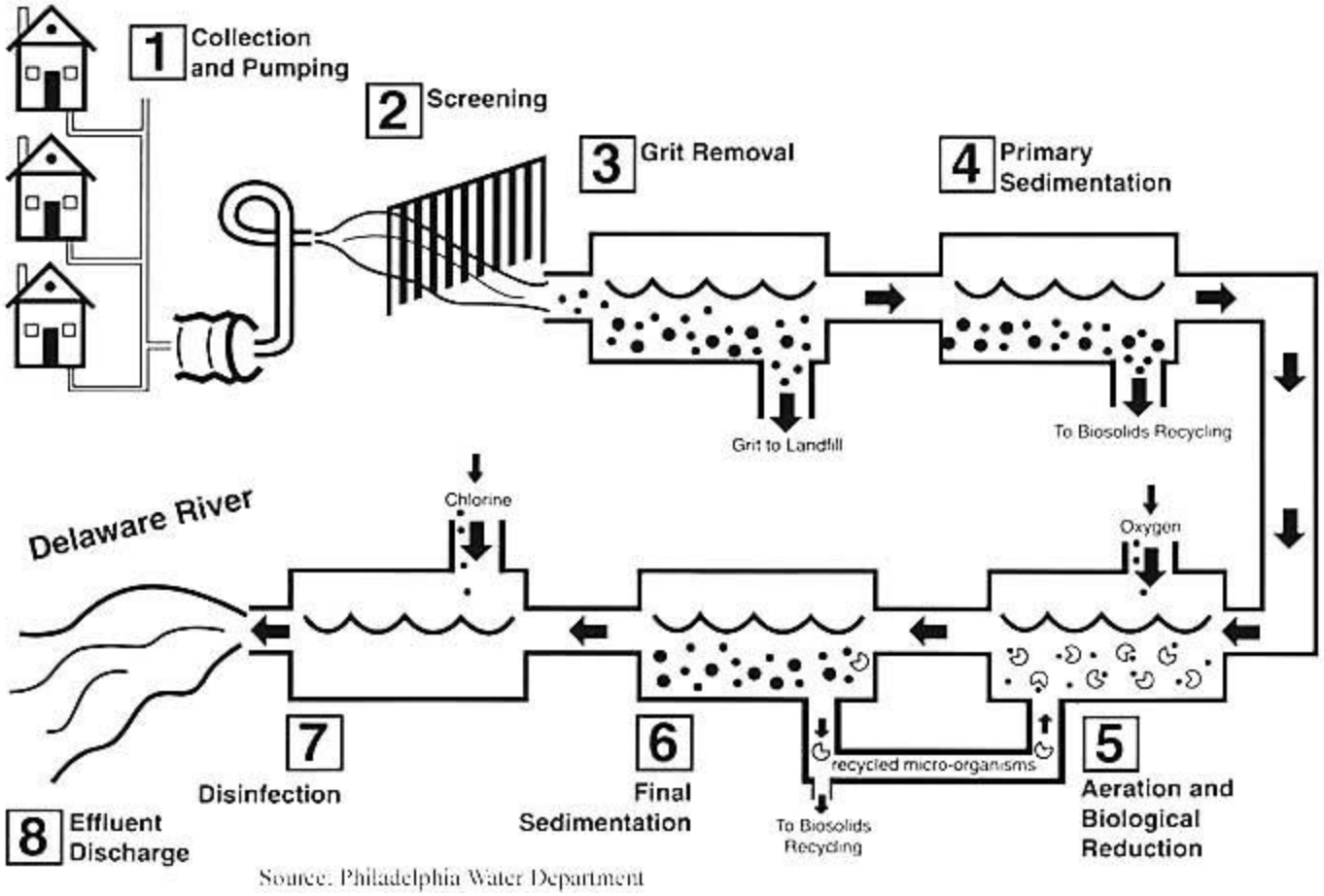
General Methods

- **Physical Process:** Filtration, Sedimentation
- **Biological Processes:** Slow Sand Filters, Activated Sludge
- **Chemical Processes:** Flocculation, Chlorination
- **Radiation:** Ultraviolet Light

Pre-Treatment

- Pumping and Containment
- Screening
- Storage
- Pre-conditioning (sodium carbontate)
- Pre-chlorination

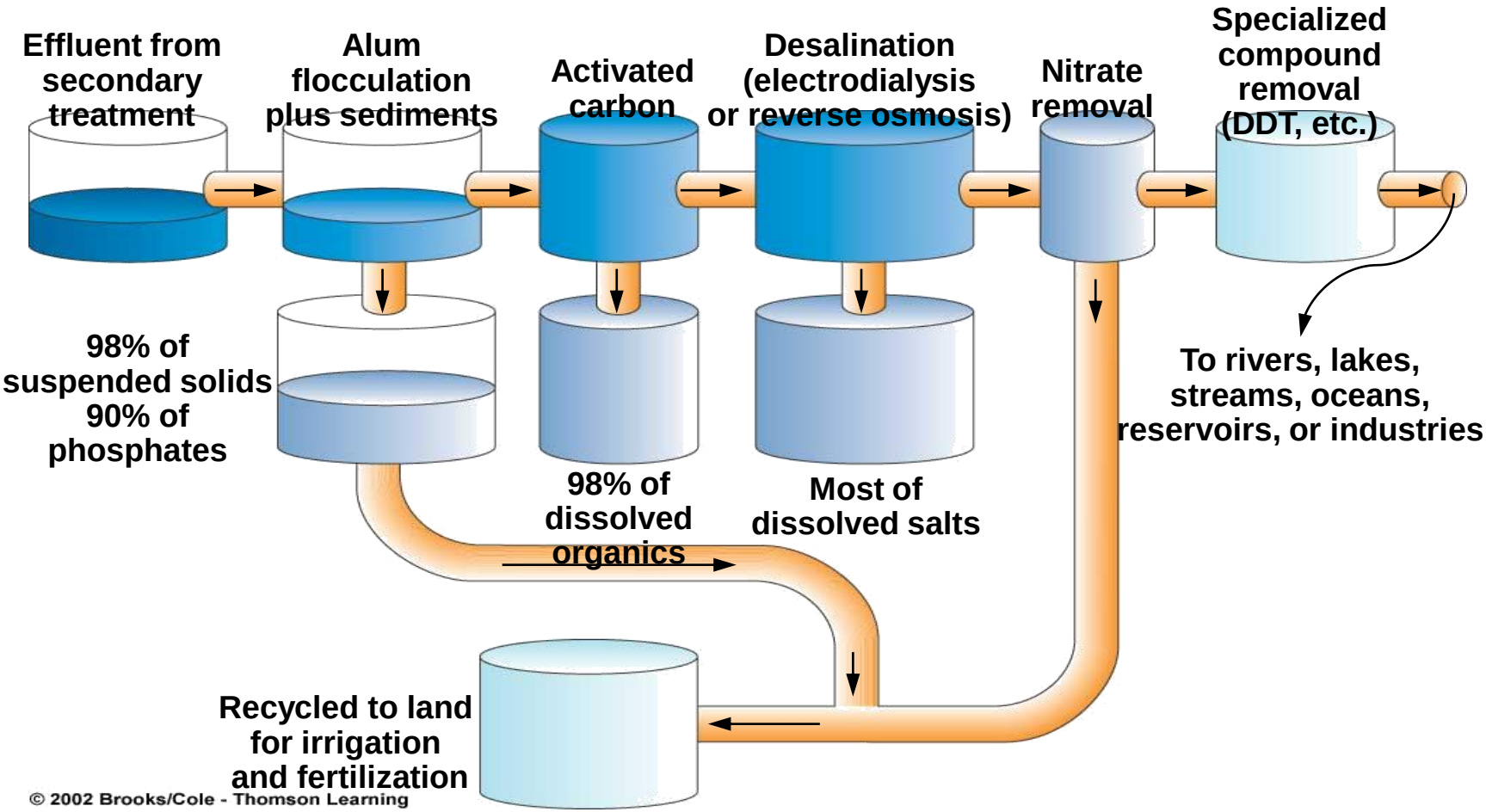
Sewage Treatment Process



Primary and SecondaryTreatment

- pH Adjustment
- Flocculation
- Sedimentation
- Filtration
- Disinfection

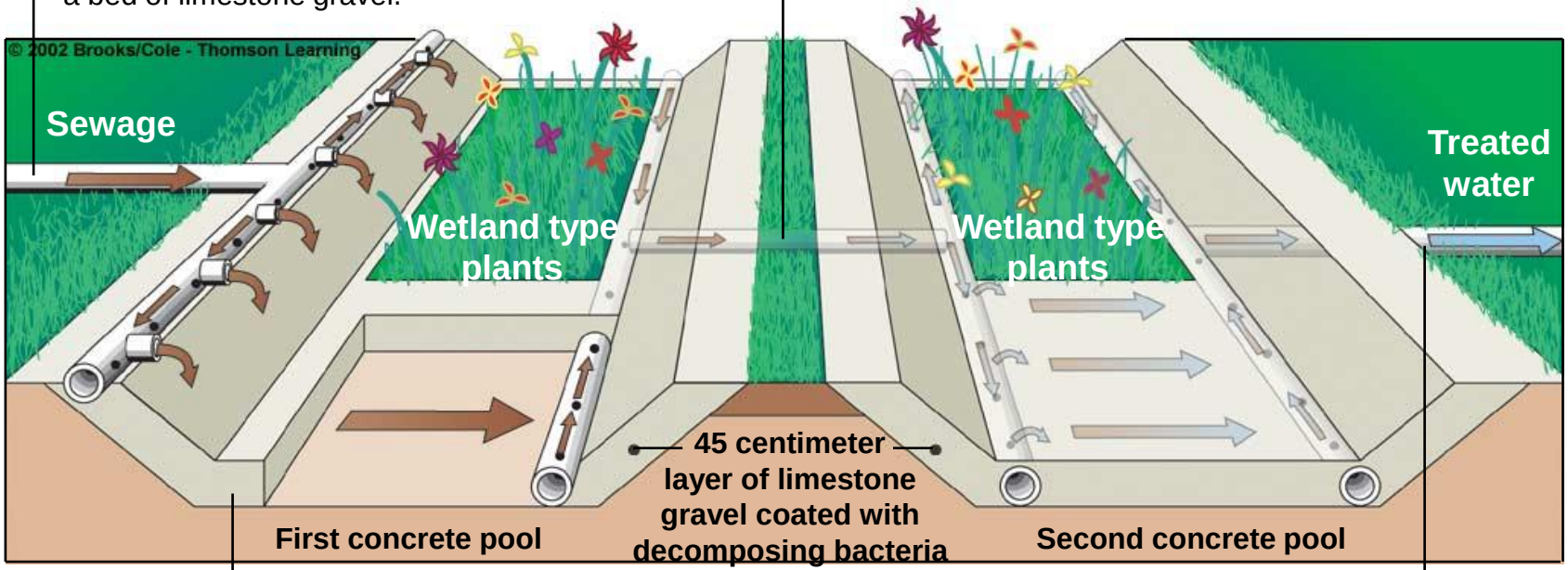
Tertiary Treatment



Wetland Addition

(1) Raw sewage drains by gravity into the first pool and flows through a long perforated PVC pipe into a bed of limestone gravel.

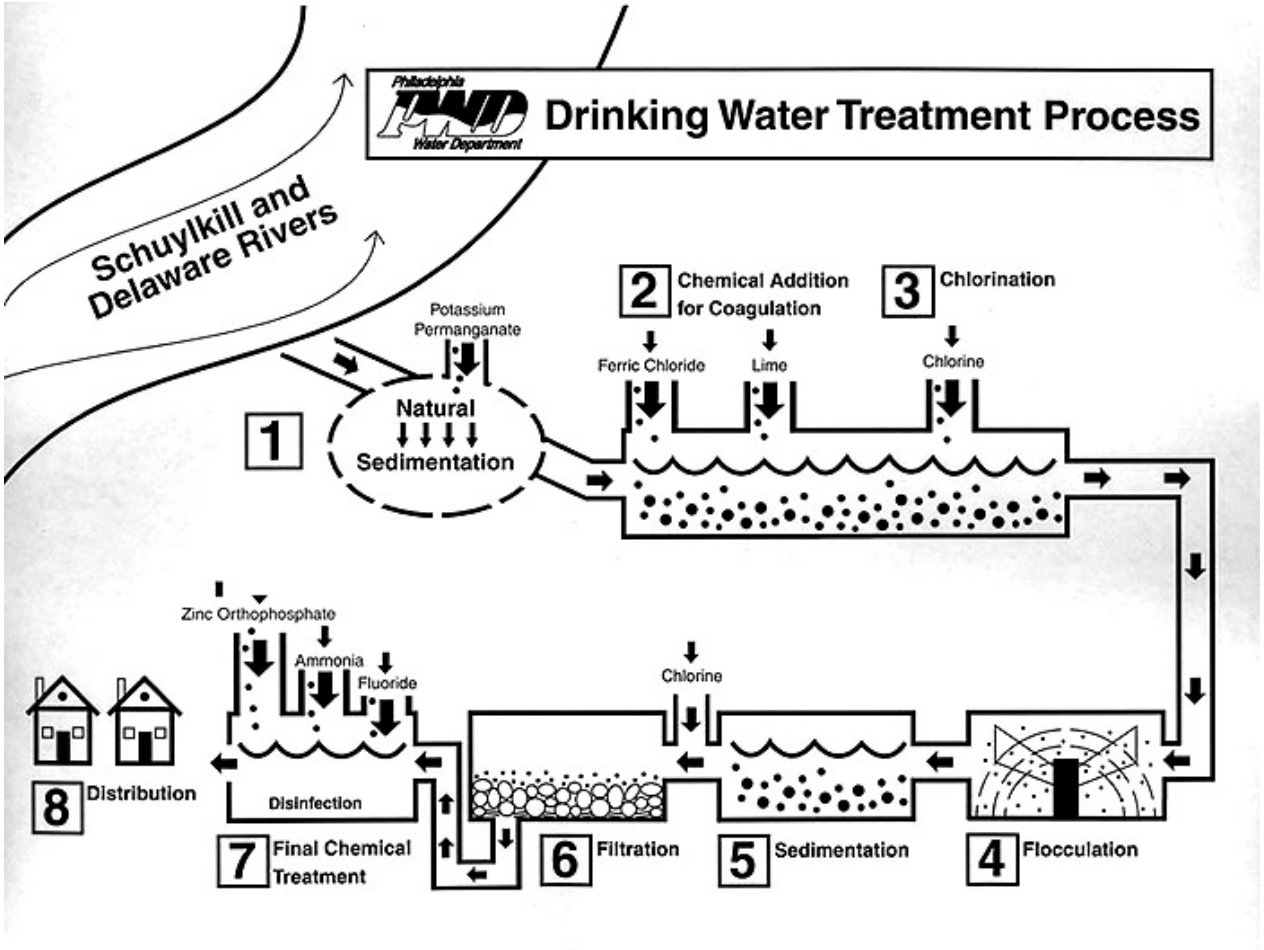
(3) Wastewater flows through another perforated pipe into a second pool, where the same process is repeated.



(2) Microbes in the limestone gravel break down the sewage into chemicals that can be absorbed by the plant roots, and the gravel absorbs phosphorus.

(4) Treated water flowing from the second pool is nearly free of bacteria and plant nutrients. Treated water can be recycled for irrigation and flushing toilets.

Drinking Water Treatment Process



Other Methods

- Boiling
- Activated Carbon
- Distillation
- Reverse Osmosis
- Direct Contact Membrane Distillation (DCMD)