Water Pollution

Indroduction

- Water pollution occurs when harmful substances are released into the water in large quantities which cause damage to people, wildlife, or habitat or indirectly into water bodies without proper treatment to remove harmful compounds.

Effects of water Pollution

- **Water pollution is a major problem in the global context. 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.**

- **An estimated 700 million Indians have no access to a proper toilet,**

  and 1,000 Indian children die of diarrhea sickness every day.

Definitions

- Impaired Waters

  Clean Water Act requires states to develop lists of impaired waters, those that do not meet water quality standards that states have set for them.

- Total Maximum Daily Load

  The law requires that states establish priority rankings for impaired waters and develop total maximum daily loads (TMDLs) for them. A TMDL specifies the maximum amount of a pollutant that a body of water can receive and still meet water quality standards.

http://www.epa.gov/owow/tmdl/overviewfs.html

Major Categorie of Water Pollutan

- 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

Point Source Pollution
vs.
Nonpoint Source Pollution

What's the difference?

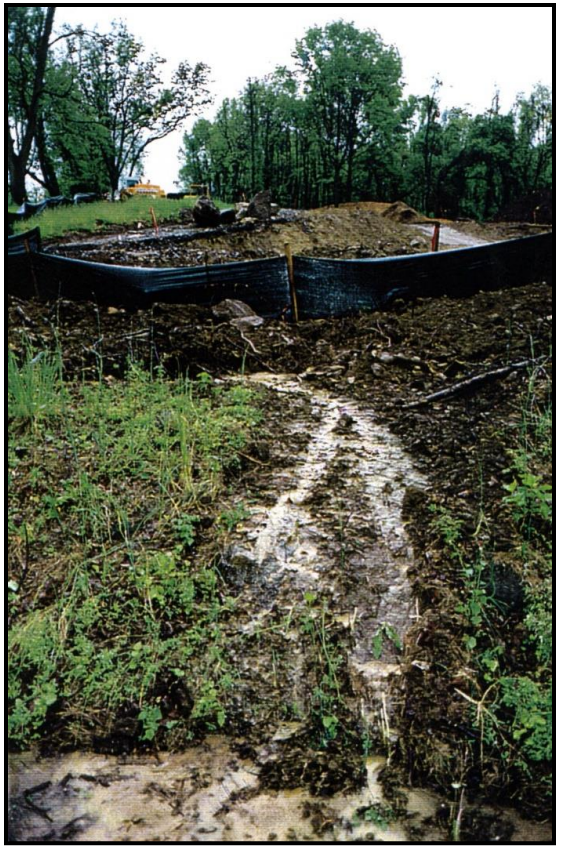
Point Source Pollution

- comes from a specific source, like a pipe
- factories, industry, municipal treatment plants
- can be monitored and controlled by a permit system

What is nonpoint source pollution?

- Nonpoint Source (NPS) Pollution is pollution associated with stormwater or runoff

- NPS pollution cannot be traced to a direct discharge point such as a wastewater treatment facility



Examples of NPS

- oil & grease from cars
- fertilizers
- animal waste
- grass clippings
- septic systems
- sewage & cleaners from boats
- household cleaning products
- litter

Pollutant Transport Mechanisms

- NPS pollutants build up on land surfaces during dry weather
  - Atmospheric deposition
  - Fertilizer applications
  - Animal waste
  - Automotive exhaust/fluid leaks
- Pollutants are washed off land surfaces during precipitation events (stormwater runoff)
- Stormwater runoff will flow to lakes and streams

Impact of Nonpoint Source Pollution

- fish and wildlife
- recreational water activities
- commercial fishing
- tourism
- drinking water quality

Pollutants Found in Runoff

Sediment
Soil particles transported from their source

Biochemical Oxygen Demand (BOD)
- Oxygen depleting material
  - Leaves
  - Organic material

Toxics
- Pesticides
  - Herbicides
  - Fungicides
  - Insecticides
- Metals (naturally occurring in soil, automotive emissions/ tires)
  - Lead
  - Zinc
  - Mercury
- Petroleum Hydrocarbons (automotive exhaust and fuel/oil)

Nutrients
- Various types of materials that become dissolved and suspended in water (commonly found in fertilizer and plant material):
  - Nitrogen (N)
  - Phosphorus (P)

Bacteria/ Pathogens
Originating from:
- Pets
- Waterfowl
- Failing septic systems

Thermal Stress
Heated runoff, removal of streamside vegetation

Debris
Litter and illegal dumping

Potential Sources of Pollutants Found in Residential Areas

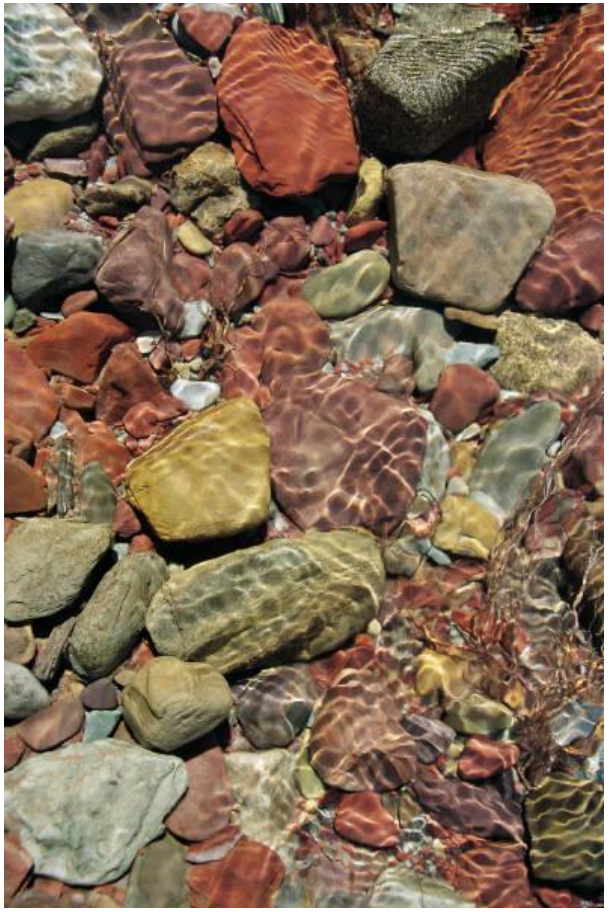
- Nutrients: Fertilizers and septic systems
- Pathogens: Pet waste and septic systems
- Sediment: Construction, road sand, soil erosion
- Toxic: Pesticides, household products
- Debris: Litter and illegal dumping
- Thermal: heated runoff, removal of streamside vegetation

Pollutants from Agriculture

- Sediment
- Nutrients
- Pathogens
- Pesticides

Why are these pollutants important?

- Sediment reduces light penetration in stream, clogs gills of fish and aquatic invertebrates.
- Nutrients act as fertilizer for algae & aquatic plants which can cause highly varying dissolved oxygen levels. At low DO levels, the aquatic life has the potential to be harmed.
- Toxics can impact life and contaminate drinking water supplies.
- Bacteria/Pathogens are an indicator of possible viruses present in the system.



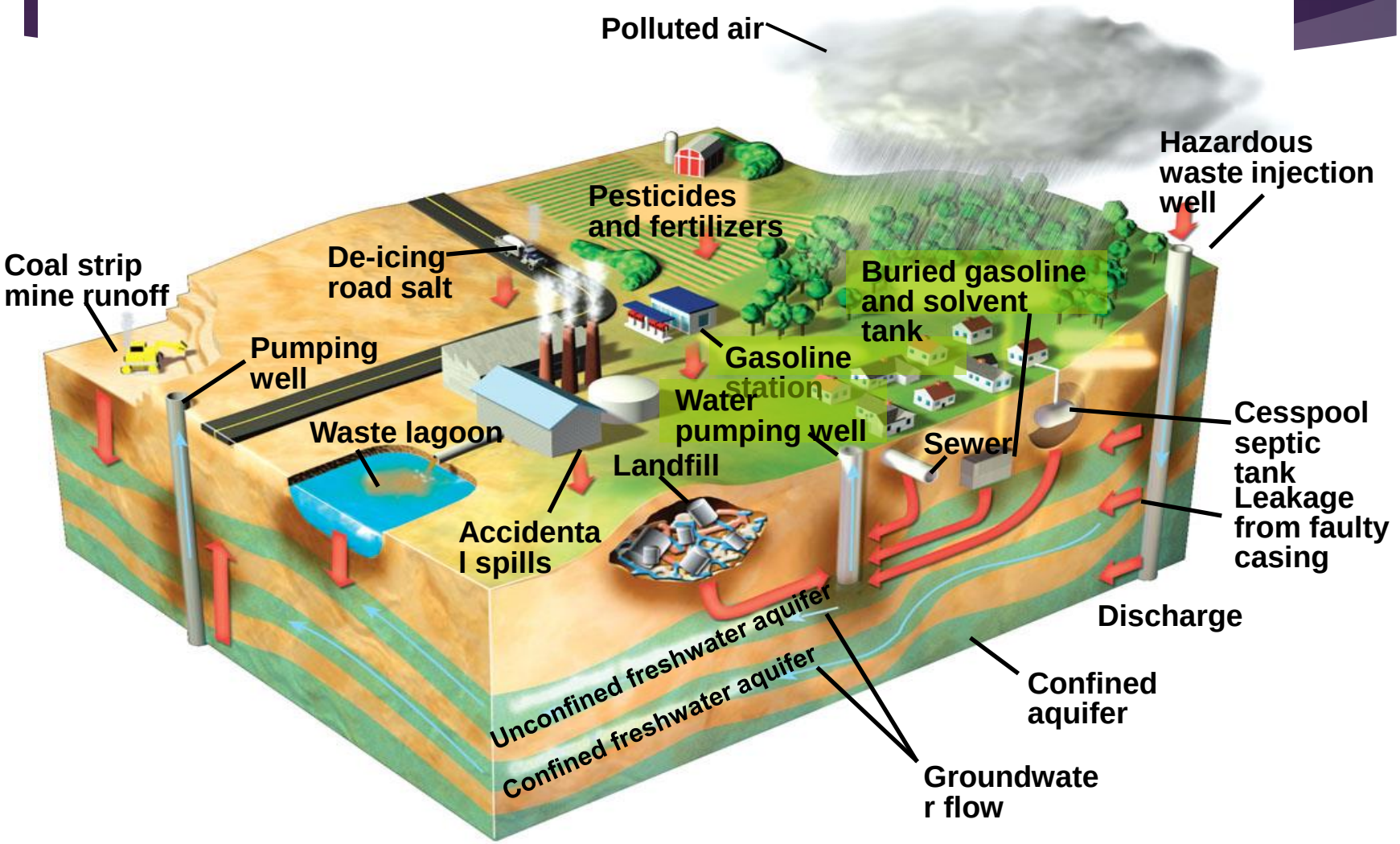
Lake Pollution

- 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

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

Pollution in Groundwater

Solutions

Groundwater Pollution

Prevention

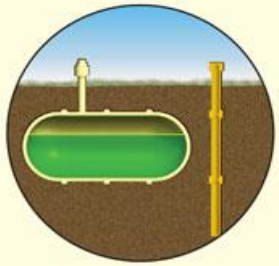
Find substitutes for toxic chemicals
Keep toxic chemicals out of the environment

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



Cleanup

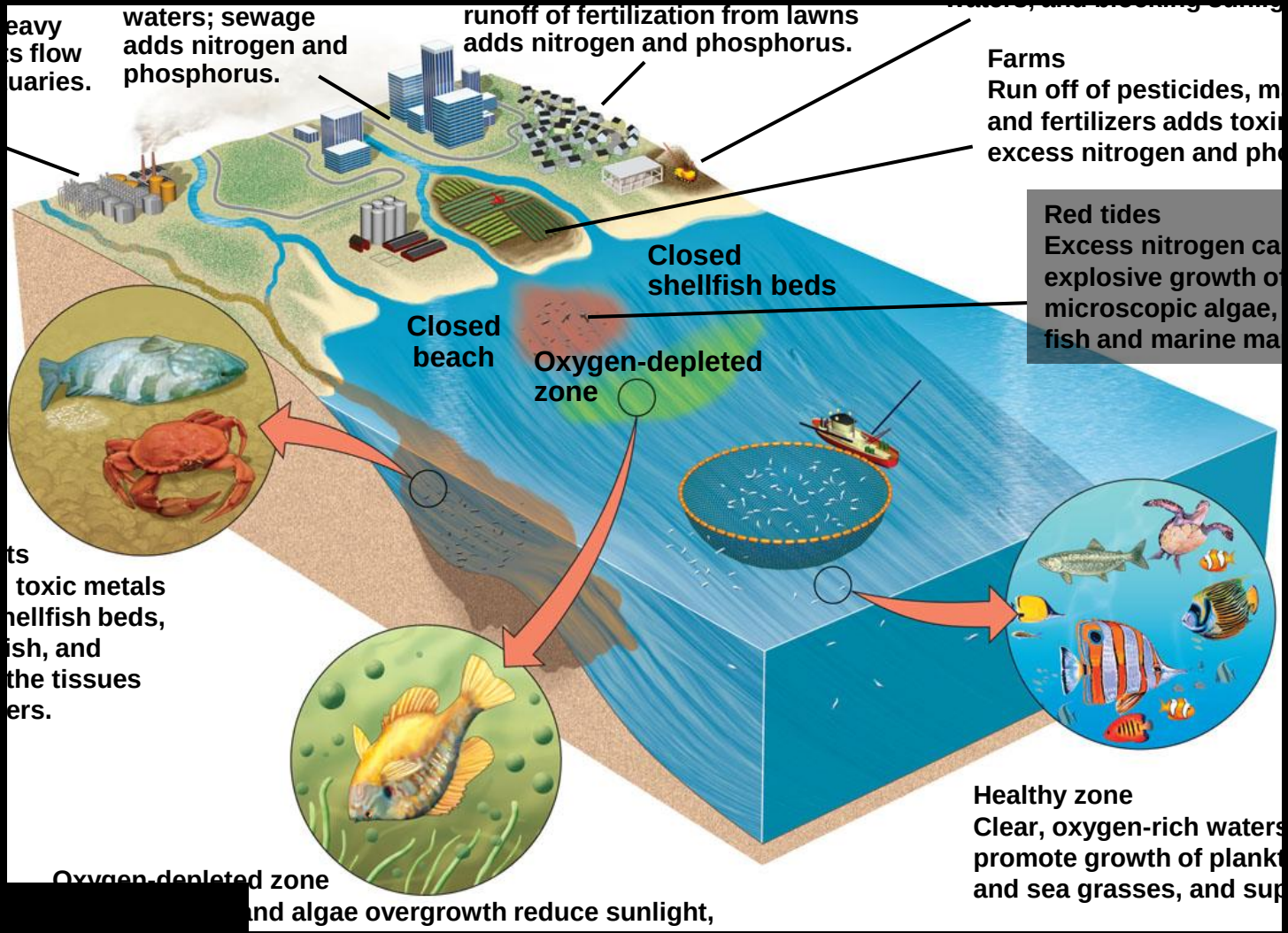
Pump to surface, clean, and return to aquifer (very expensive)

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


eavy
s flow
uaries.
waters; sewage
adds nitrogen and
phosphorus.
runoff of fertilization from lawns
adds nitrogen and phosphorus.
Farms
Run off of pesticides, m
and fertilizers adds toxi
excess nitrogen and ph
Red tides
Excess nitrogen ca
explosive growth o
microscopic algae,
fish and marine ma
Closed
shellfish beds
Closed
beach
Oxygen-depleted
zone
ts
toxic metals
hellfish beds,
ish, and
the tissues
ers.
Healthy zone
Clear, oxygen-rich waters
promote growth of plankt
and sea grasses, and sup
Oxygen-depleted zone
nd algae overgrowth reduce sunlight,

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
- Slow recovery
- Oil slicks ruin beaches
- Limited effectiveness of clean up methods

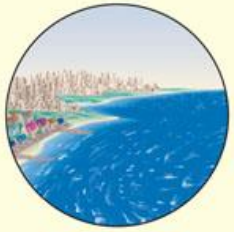
Pollution in Coastal Waters

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

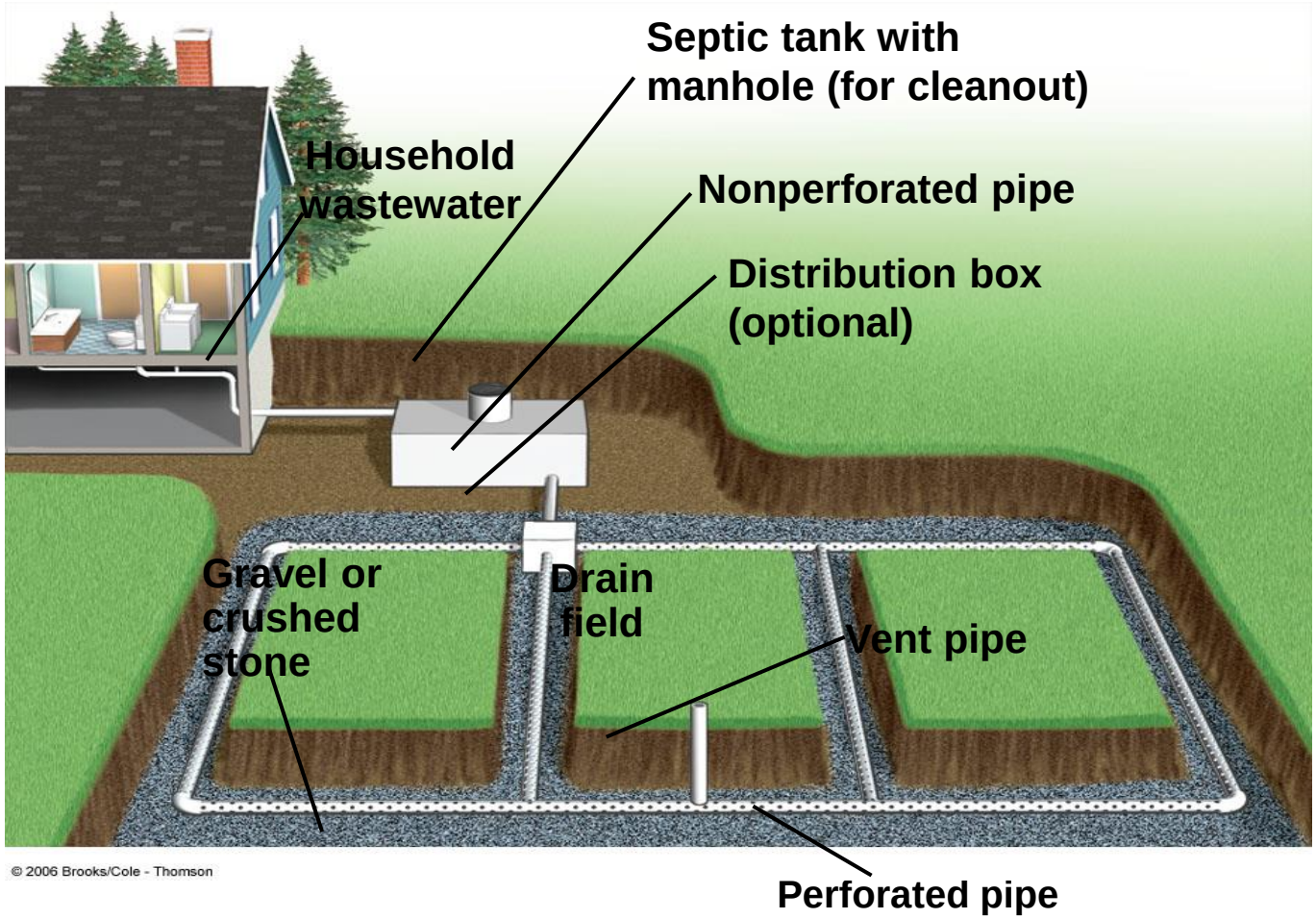
Laws for Reducing Point Source Pollution

- Clean Water Act
- Water Quality Act

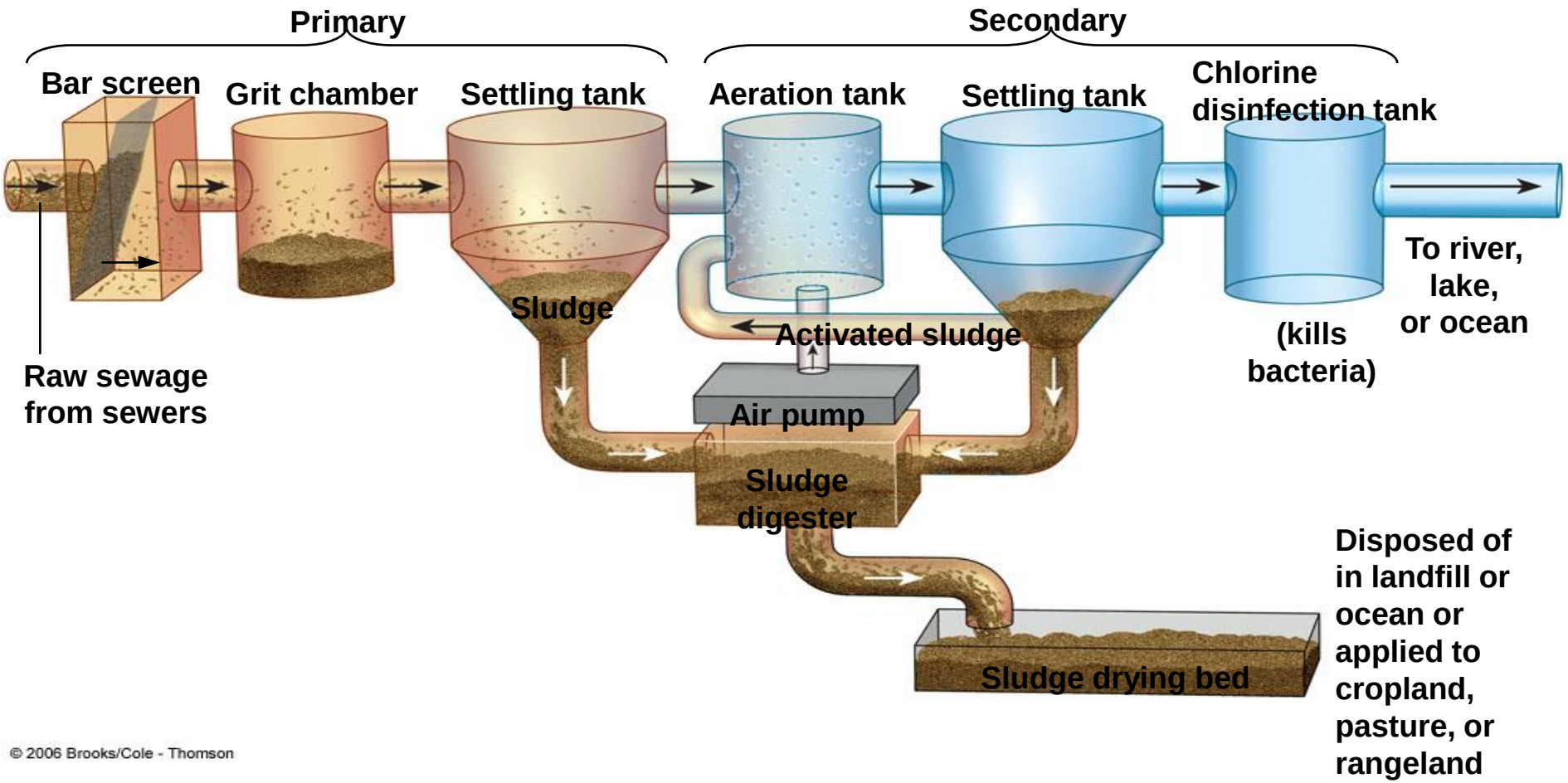
Sewage Treatment Systems

- 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

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.

Purification of water

- Purification of water involves physical, biological and chemical processes such as:-

1.Filtration

2.Sedimentation

3.Chlorination

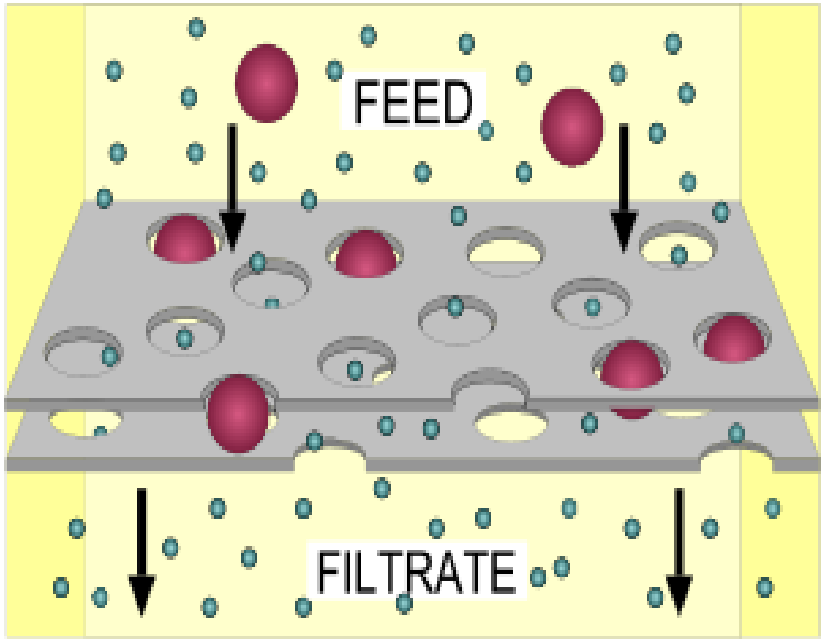
4.Slow sand filters

5.Activated Sludge

6.Flocculation

Physical processes

- **Filtration** is a mechanical or physical operation which is used for the separation of solids from fluids (liquids or gases) by interposing a medium through which only the fluid can pass.

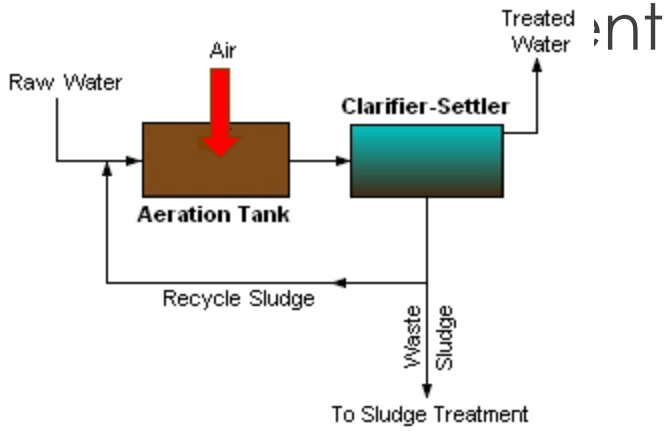


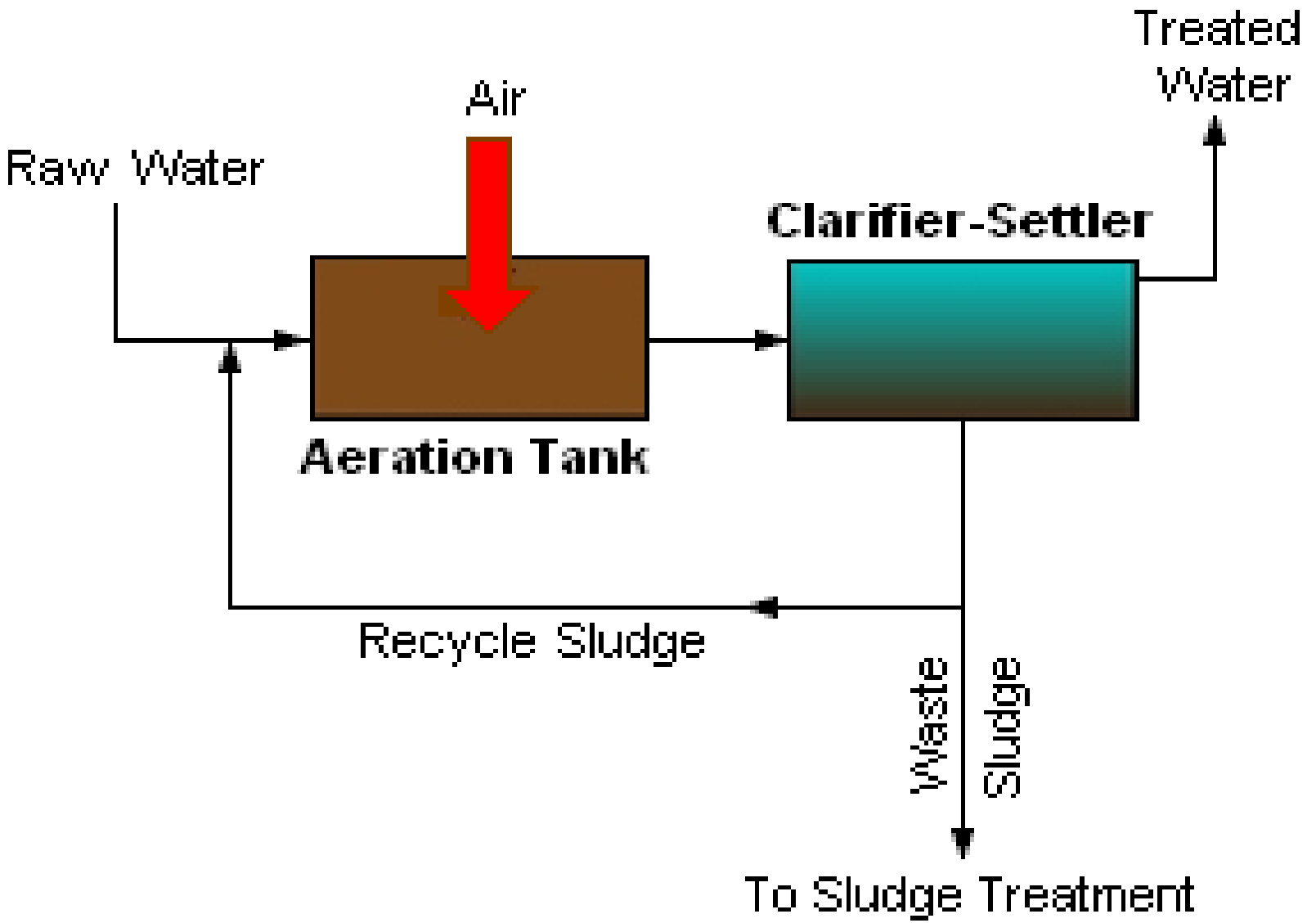
- **Sedimentation** is the tendency for particles in suspension or molecules in solution to settle out of the fluid in which they are entrained, and come to rest against a wall.

Biological processes

- **Slow sand filters** are used in water purification for treating raw water to produce a potable product. They are typically 1 to 2 metres deep, can be rectangular or cylindrical in cross section and are used primarily to treat surface water.

- **Activated sludge** is a process dealing with the treatment of sewage and industrial wastewaters and developed around 1912-1914.Atmospheric air or pure oxygen is introduced to a mixture of primary treated or screened sewage (or industrial wastewater) combined with organisms to develop a biological floc which reduce nt of the sewage.




Treated Water
Air
Raw Water
Clarifier-Settler
Aeration Tank
Recycle Sludge
Waste Sludge
To Sludge Treatment

Chemical process

- **Flocculation** is, in the field of chemistry, a process where colloids come out of suspension in the form of floc or flakes. The action differs from precipitation in that, prior to flocculation, colloids are merely suspended in a liquid and not actually dissolved in a solution.

- **Chlorination** is the process of adding the element chlorine to water as a method of water purification to make it fit for human consumption as drinking water. Water which has been treated with chlorine is effective in preventing the spread of water born disease.

Chemical & other contaminants

Contaminants may include organic and inorganic substances

- Inorganic water pollutants include:-
- Acidity caused by industrial discharges (especially sulphur dioxide from pow plants)
- Ammonia from food processing waste
- Chemical waste as industrial by-products
- Fertilizers containing nutrients--nitrates and phosphates--which are found in storm water run off from agriculture, as well as commercial and residential use

Heavy metals from motor vehicles (via urban storm water runoff) and acid mine drainage

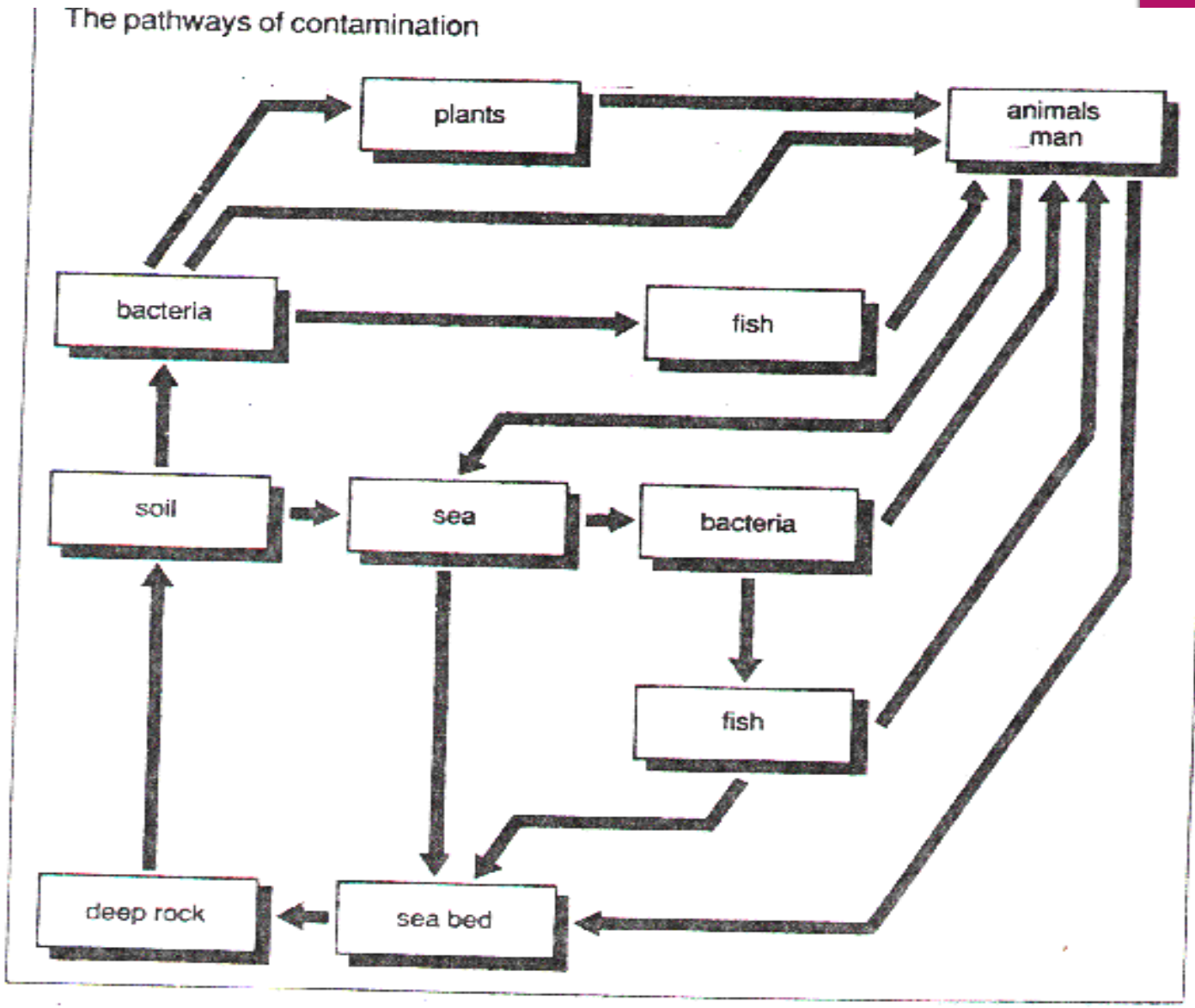
Silt (sediment) in runoff from construction sites, logging, slash and burn practices or land clearing sites

- Macroscopic pollution—large visible items polluting the water—may be termed "floatables" in an urban storm water context, or marine debris when found on the open seas, and can include such items as:

- Trash: (e.g. paper, plastic, or food waste) discarded by people on the ground, and that are washed by rainfall into storm drains and eventually discharged into surface waters
- Nurdles: small ubiquitous waterborne plastic pellets
- Shipwrecks: large derelict ships.

Pathogens are another type of pollution that prove very harmful. They can cause many illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. Pathogens include such organisms as bacteria, viruses, and protozoan. These pollutants enter waterways through untreated sewage, storm drains, septic tanks, runoff from farms, and particularly boats that dump sewage.

The pathways of contamination



Thermal Pollution

Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence.

A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers

Elevated water temperatures decreases oxygen levels (which can kill fish) and affects ecosystem composition

Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers.

What are the possible solutions of pollution?

Legislation has been passed forcing industry to make efforts to clean up their waste. Through reducing the waste that they produce, it has been possible to reduce the amount of pollutants that enter the water cycle .

Municipal treatment plants are designed to control conventional pollutants: BOD and suspended solids

Well-designed and operated systems (i.e., secondary treatment or better) can remove 90 percent or more of these pollutants.

Some plants have additional sub-systems to treat nutrients and pathogens. Most municipal plants are not designed to treat toxic pollutants found in industrial wastewater

Measurement of water pollution

Water pollution may be analyzed through several broad categories of methods: physical, chemical and biological. Most involve collection of samples, followed by specialized analytical tests. Some methods may be conducted without sampling, such as temperature

Farming Solutions

- Choosing organic options can help to reduce the amount of water pollution. These items are grown without the use of chemicals.
- Those chemicals, when used, enter the water cycle.
- Organic products don't introduce those chemicals to the water cycle.