

A photograph of a sewage treatment plant. In the foreground, a large circular aeration tank is filled with turbulent, greyish water. The tank is surrounded by a concrete wall. In the background, there are several industrial buildings, including a large cylindrical tank and a brick building with a chimney. The sky is clear and blue.

Sewage Treatment

Biological Oxygen Demand (BOD)

- BOD: Oxygen is removed from water when organic matter is consumed by bacteria.
- Low oxygen conditions may kill fish and other organisms.

Sources of organic matter

- Natural inputs-- bogs, swamps, leaf fall, and vegetation aligning waterways.
- Human inputs-- pulp and paper mills, meat-packing plants, food processing industries, and wastewater treatment plants.
- Nonpoint inputs-- runoff from urban areas, agricultural areas, and feedlots.

Water
Quality

ppm of DO at 20° C

Good

8-9

Slightly
polluted

6.7-8

Moderately
polluted

4.5-6.7

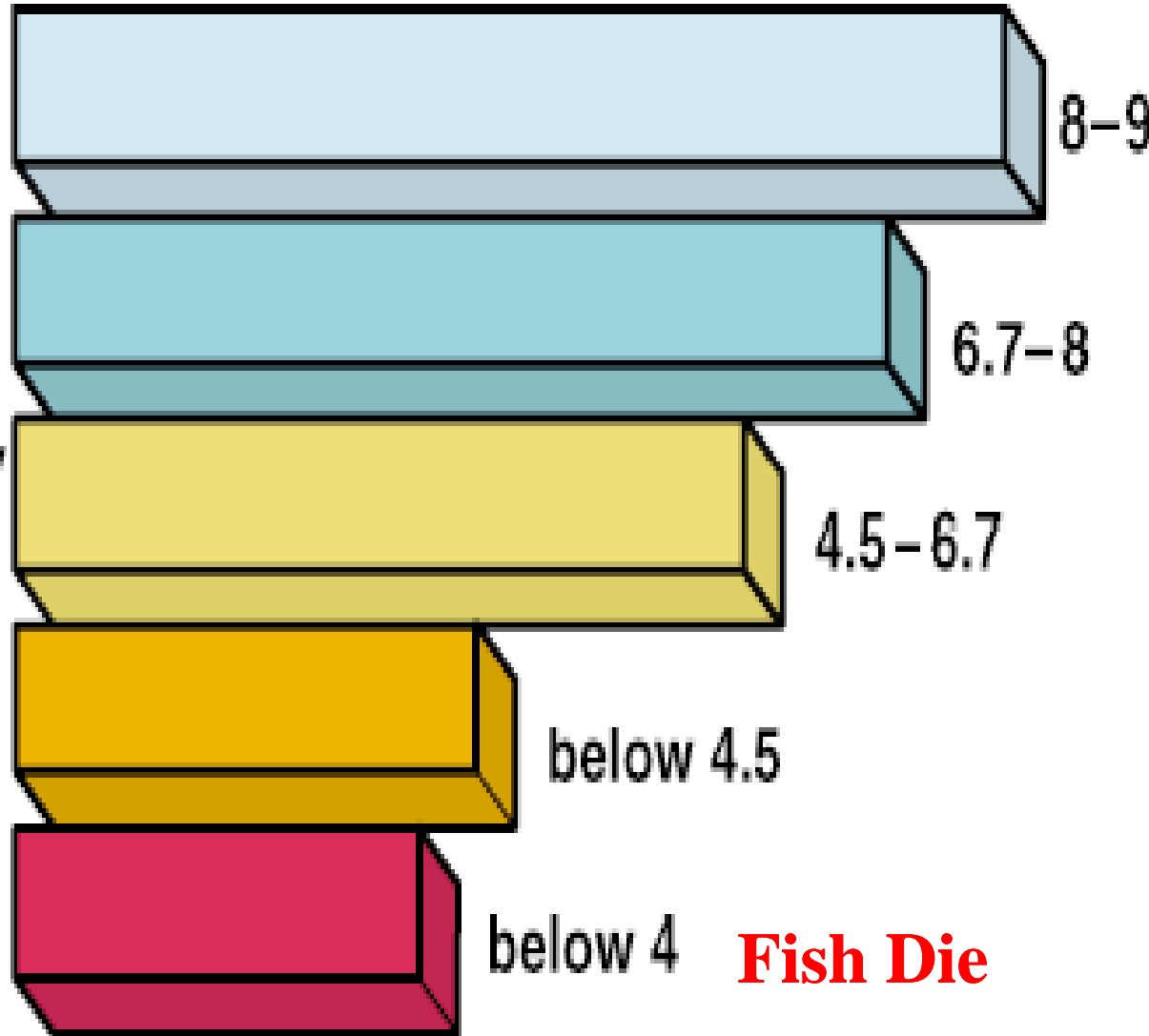
Heavily
polluted

below 4.5

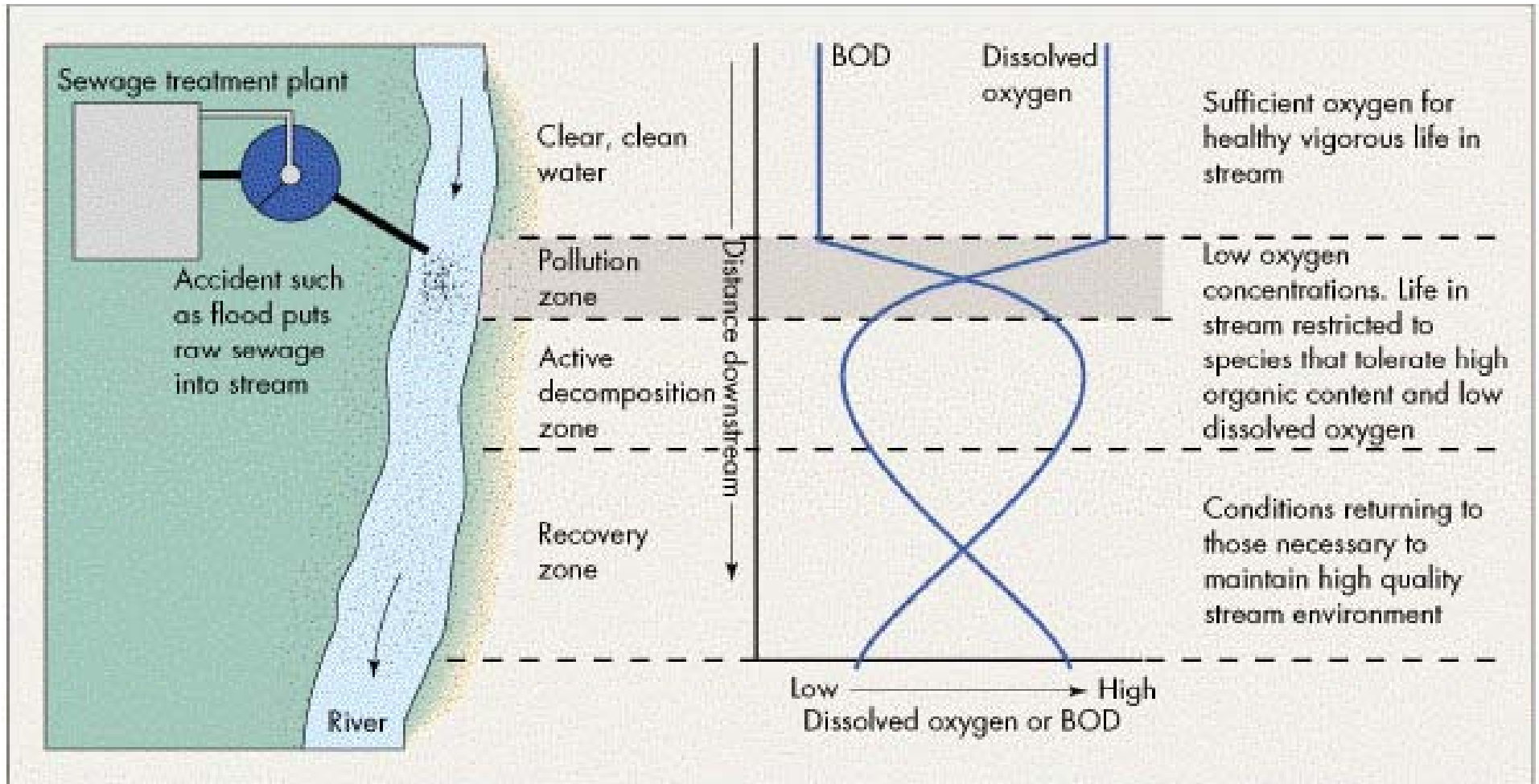
Gravely
polluted

below 4

Fish Die



BOD Effects on Water Quality



All streams have some capability to degrade organic waste. Problems occur when stream is overloaded with biochemical oxygen-demanding waste.

Wastewater Treatment Objectives

- Wastewater treatment systems take human and industrial liquid wastes and make them safe enough (from the public health perspective) to return to the aquatic or terrestrial environment.
- In some cases, wastewater can be clean enough for reuse for particular purposes.
- Wastewater treatment systems use the same processes of purification that would occur in a natural aquatic system only they do it faster and in a controlled situation.

Sewage or Wastewater Treatment

- Sewage or wastewater is composed of sewage or wastewater from:
 - Domestic used water and toilet wastes
 - Rainwater
 - Industrial effluent (**Toxic industrial water is pretreated**)
 - Livestock wastes
- ** microbes degrade organic compounds
- ** elimination of pathogens occurs

Wastewater Treatment

Types of treatment systems include: Septic Tanks or Wastewater Treatment Plants (WWTPs).

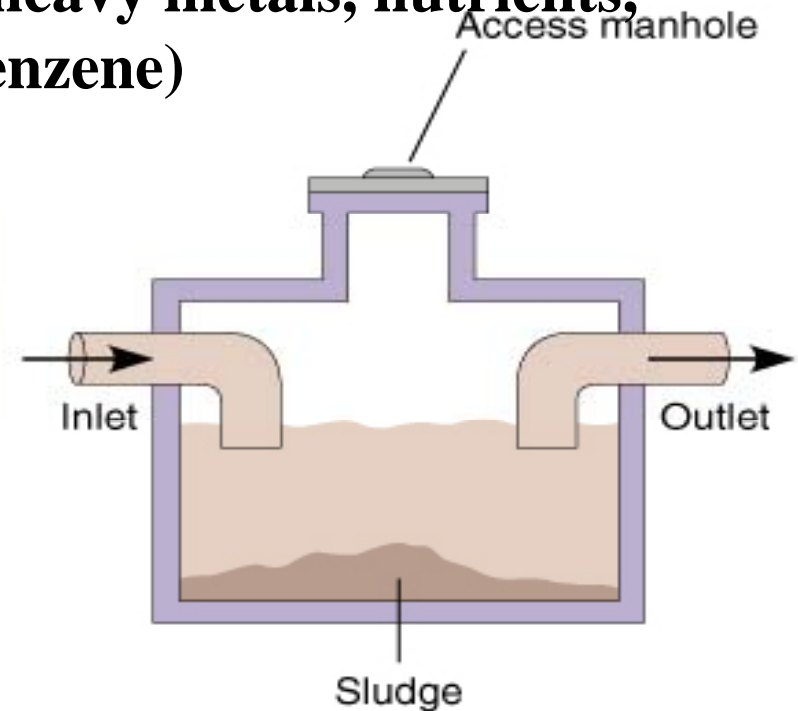
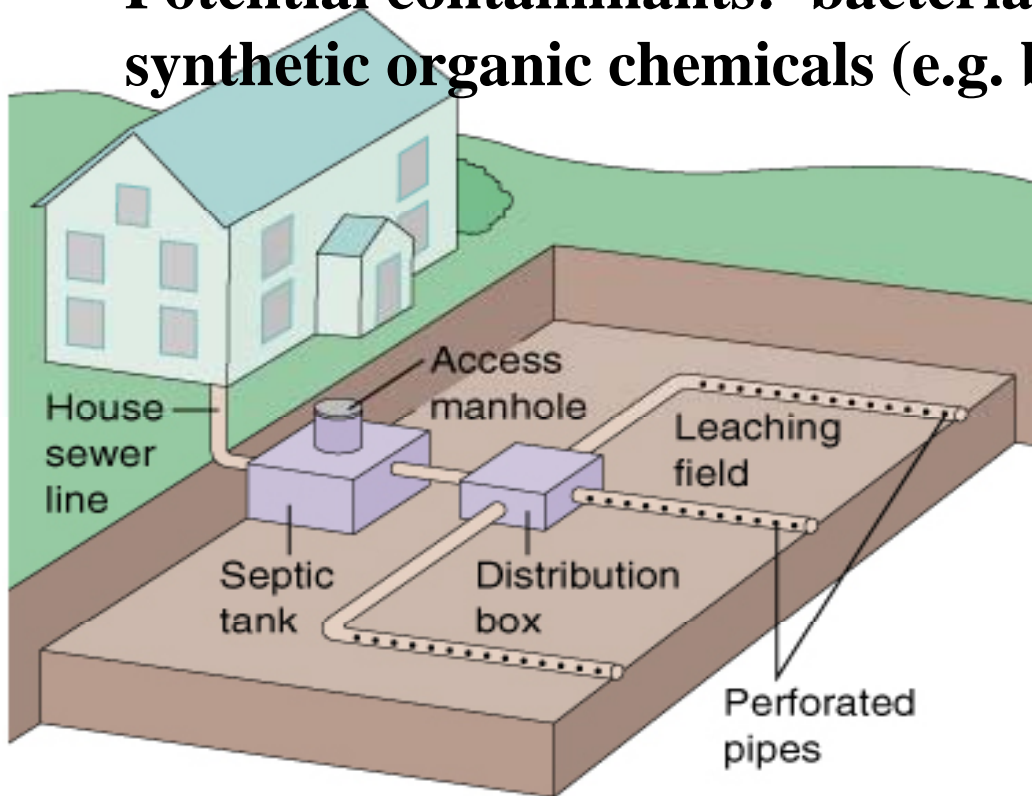
- Septic Tanks typically treat small volumes of waste (e.g., from a single household, small commercial/industrial)
- WWTPs typically treat larger volumes of municipal or industrial waste.

Decentralized Alternatives

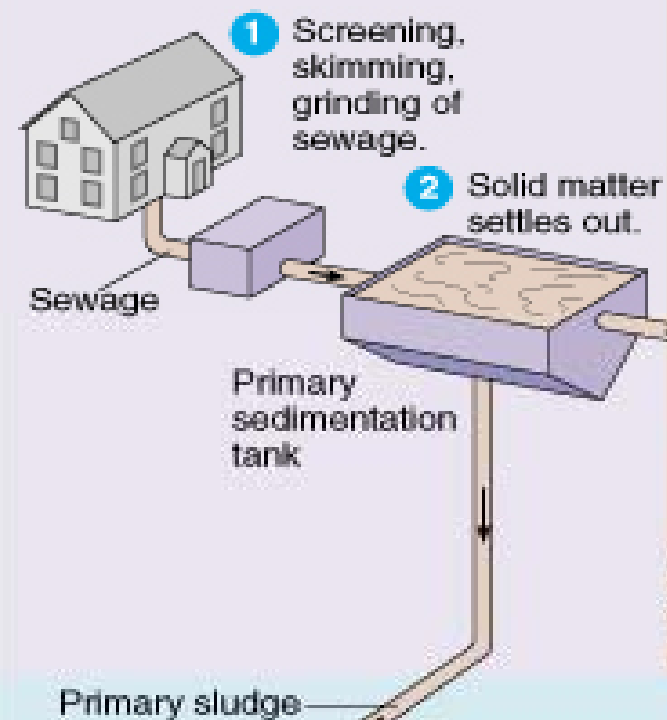
- In rural areas or in particular urban communities in the U.S., human wastewater will be treated through individual septic tank systems (pumped or leachfield varieties)
- Wastewater is filtered, microorganisms killed and chemicals adsorbed and/or diluted in its passage through the soils and rocks of the leachfield
- In developing countries, urban wastewater is seldom treated and instead flows raw through collectors to receiving water bodies (like in the US 100 years ago)
- The solution for many developing nations is centralized oxidation lagoon systems (but this needs space) or the use of individual ventilated pit-latrines, especially for shanty towns and rural villages

Septic Tanks

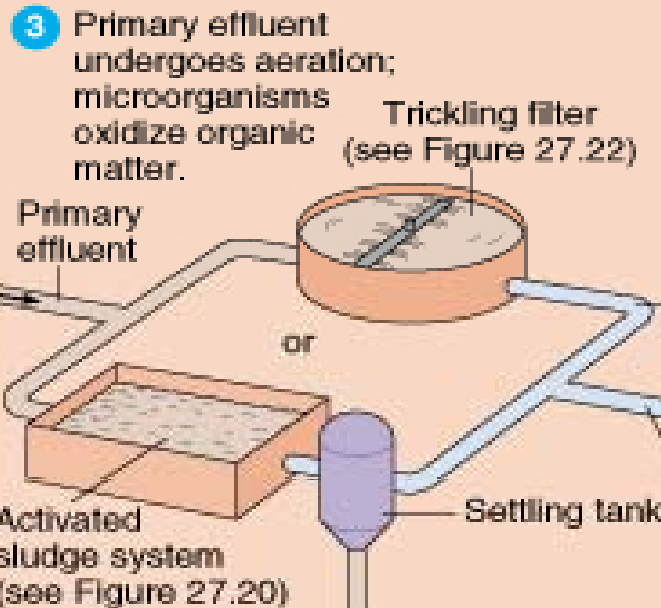
- **Approx. 22 million systems in operation (30% of US population)**
- **Suitability determined by soil type, depth to water table, depth to bedrock and topography**
- **Commonly fail due to poor soil drainage**
- **Potential contaminants: bacteria, heavy metals, nutrients, synthetic organic chemicals (e.g. benzene)**



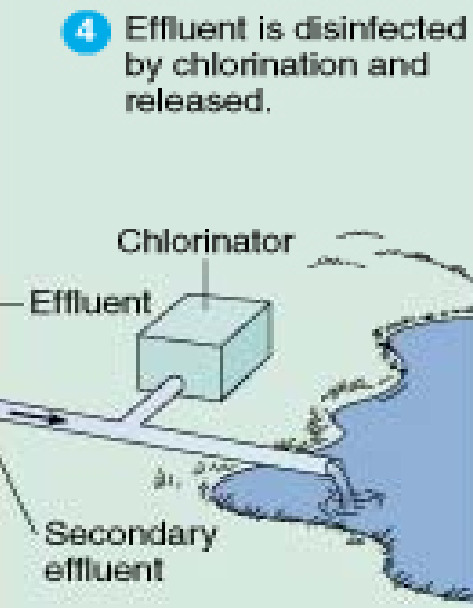
(a) PRIMARY TREATMENT



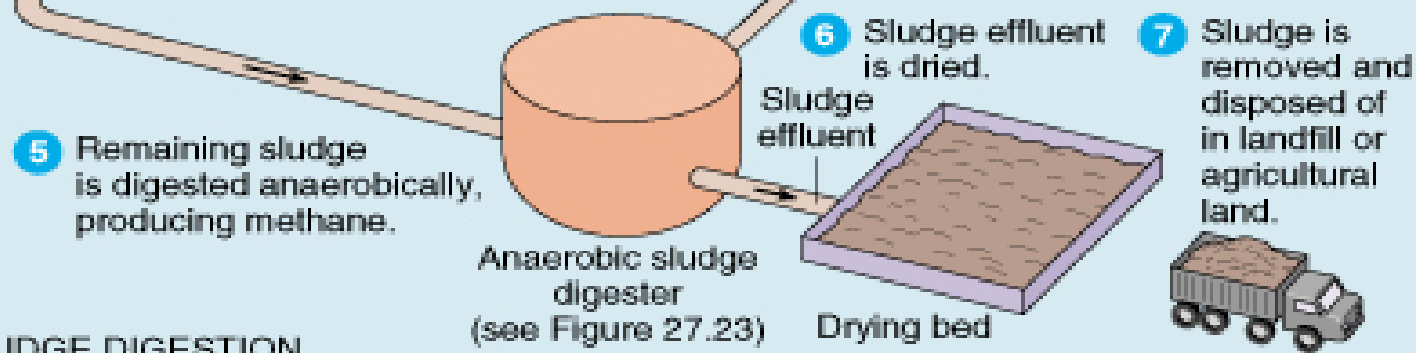
(b) SECONDARY TREATMENT (Biological oxidation)



(c) DISINFECTION AND RELEASE



(d) SLUDGE DIGESTION



Key

- Physical processes
- Microbial processes
- Chemical processes

Sewage Treatment

Wastewater or sewage treatment is a multistep process:

1. Primary Treatment (Physical Process)

- Removal of large objects using grates and screens
- Settling to remove suspended solids (primary sludge)
 - flocculating chemicals are added to enhance sedimentation

Sewage Treatment

- Secondary Treatment (Microbial Process)
 - Supernatant or primary effluent contains high levels of dissolved organic load (Biological Oxygen Demand)
 - Aeration to stimulate aerobic degradation
 - activated sludge reactor
 - trickling filter reactor
- bacteria degrade organic carbon to CO₂

Sewage Treatment

- Tertiary Treatment (Physicochemical Process)
 - Precipitation
 - Filtration
 - Chlorination
 - Treated water is discharged to waterways
 - Used for irrigation
 - Recycled into drinking water
- expensive process, sharply reduces inorganic nutrients (PO_4 , NO_3)

Sewage Treatment

Pathogen Removal by Activated Sludge

- More than 90% of *E.coli.* and Salmonella are destroyed
- Bacteria are removed by inactivation, grazing by ciliated protozoa, and adsorption to sludge solids
- Viruses are removed mainly by adsorption process

Anaerobic Digestion of Sludge

- Sludges from the primary and secondary treatment settling tanks are pumped into an anaerobic digester
- Sludges contain cellulose, proteins, lipid and other insoluble polymers
- Anaerobic bacteria digest the sludge to methane and carbon dioxide