Physicochemical Waste Water Treatment

BY
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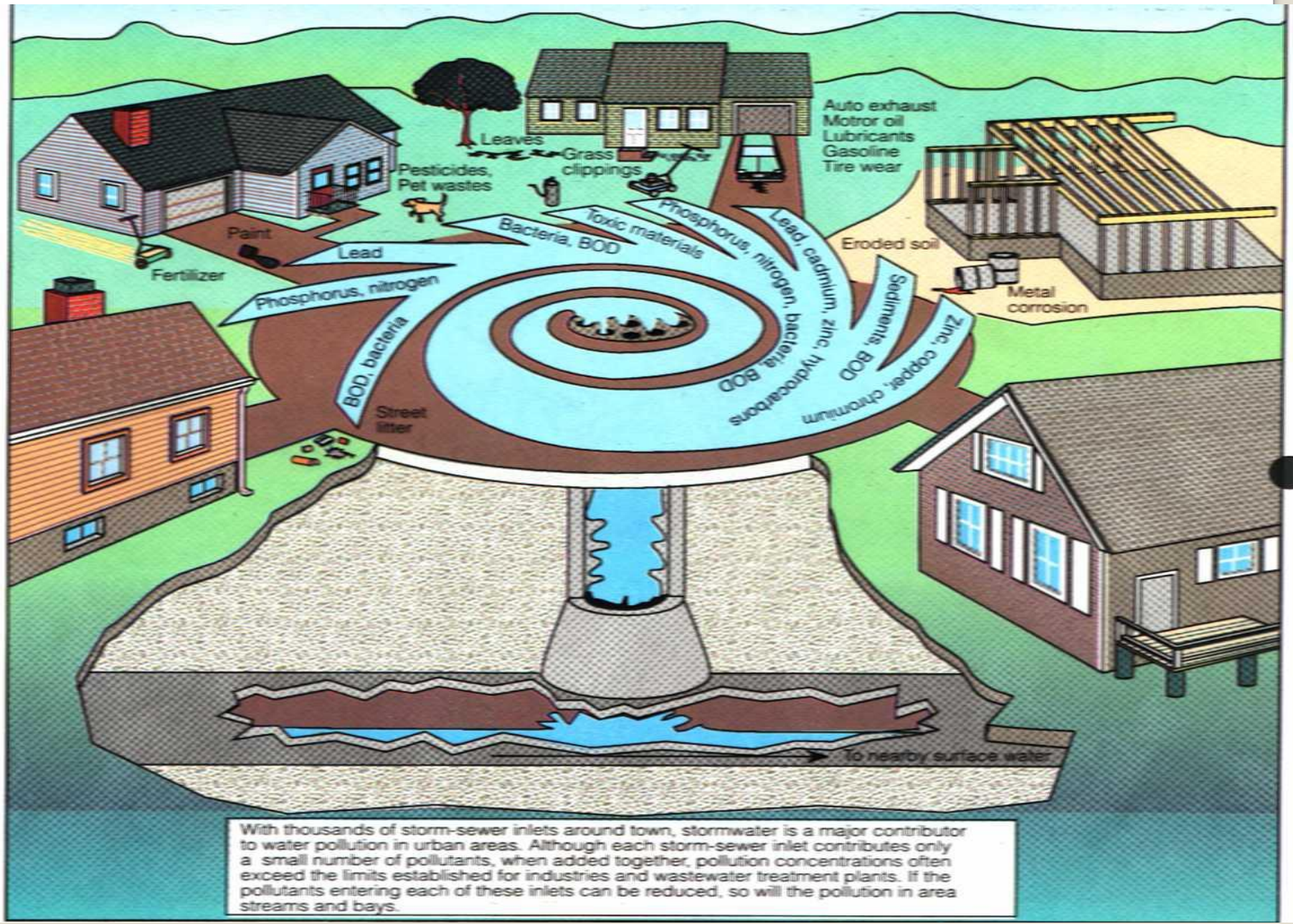
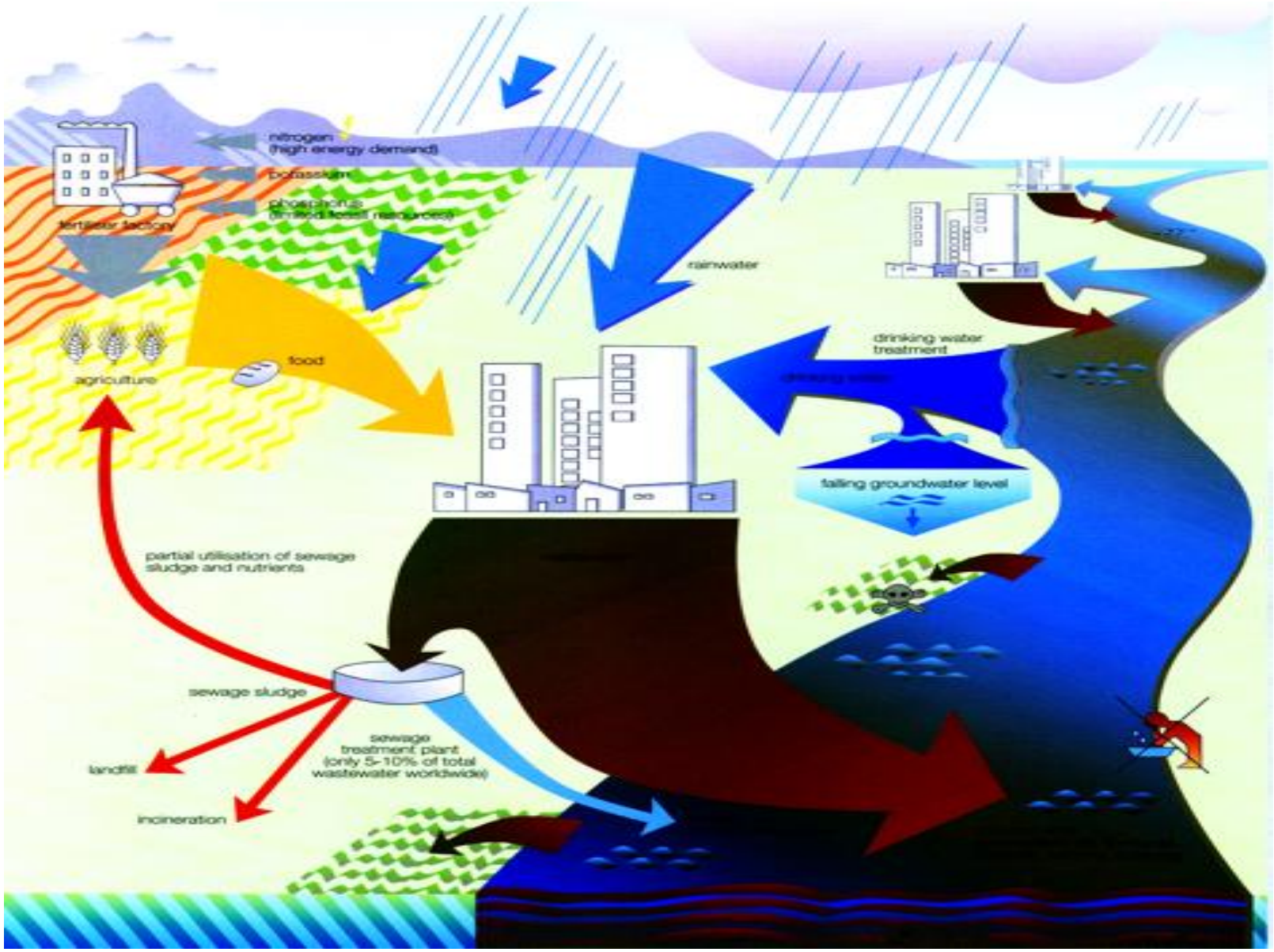


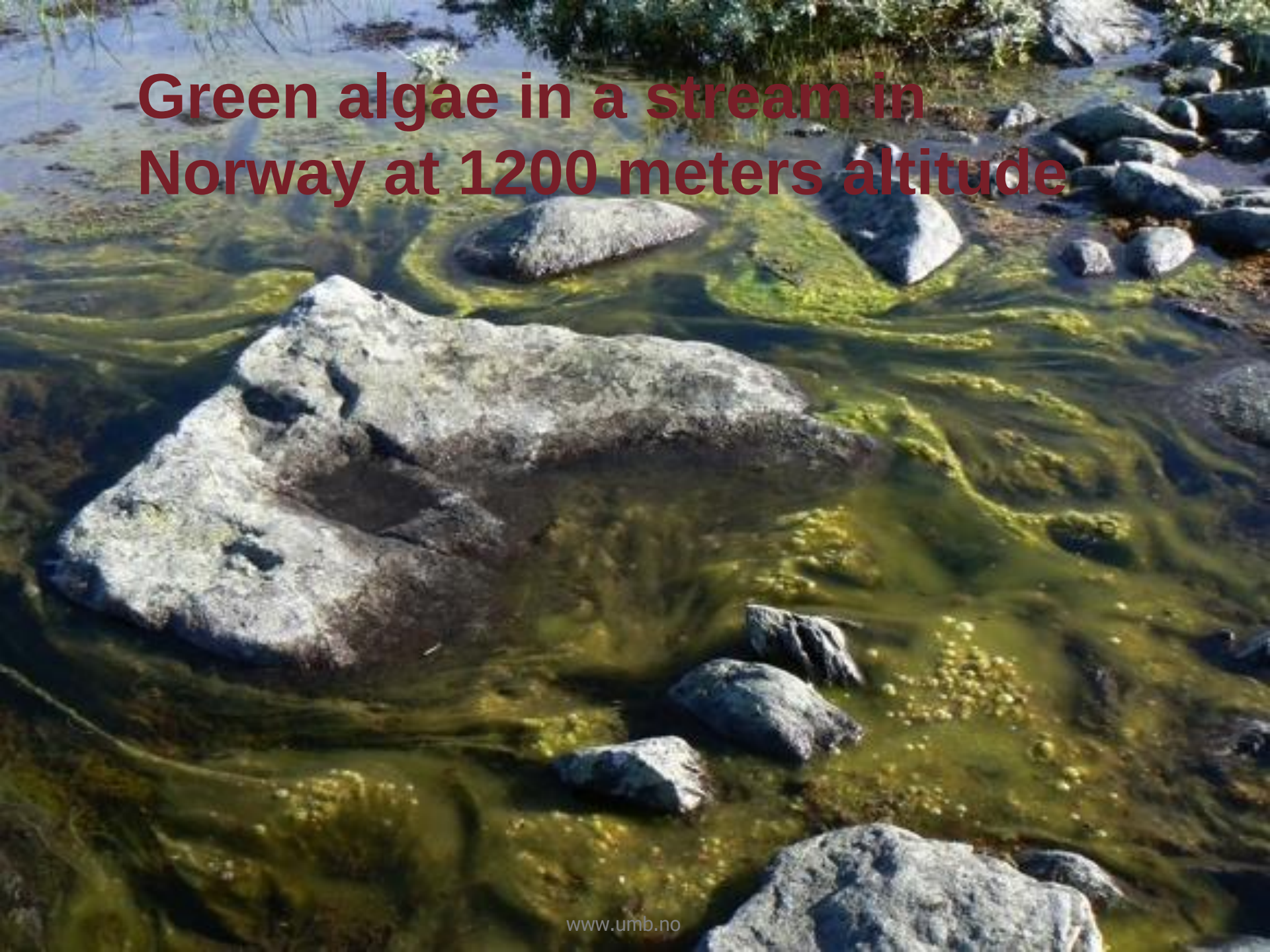
With thousands of storm-sewer inlets around town, stormwater is a major contributor to water pollution in urban areas. Although each storm-sewer inlet contributes only a small number of pollutants, when added together, pollution concentrations often exceed the limits established for industries and wastewater treatment plants. If the pollutants entering each of these inlets can be reduced, so will the pollution in area streams and bays.


nitrogen
(high energy demand)
potassium
phosphorus
(limited fossil resources)
fertilizer factory
rainwater
drinking water
treatment
agriculture
food
falling groundwater level
partial utilisation of sewage
sludge and nutrients
sewage sludge
sewage
treatment plant
(only 5-10% of total
wastewater worldwide)
landfill
incineration

Phosphorus is the major agent triggering eutrophication (algeal blooms) in freshwaters

The North Sea

Nitrogen is considered the main element triggering eutrophication in saltwater


Green algae in a stream in Norway at 1200 meters altitude
www.umb.no

Nitrogen can cause algea growth in freshwater in alpine regions

Goals of wastewater treatment

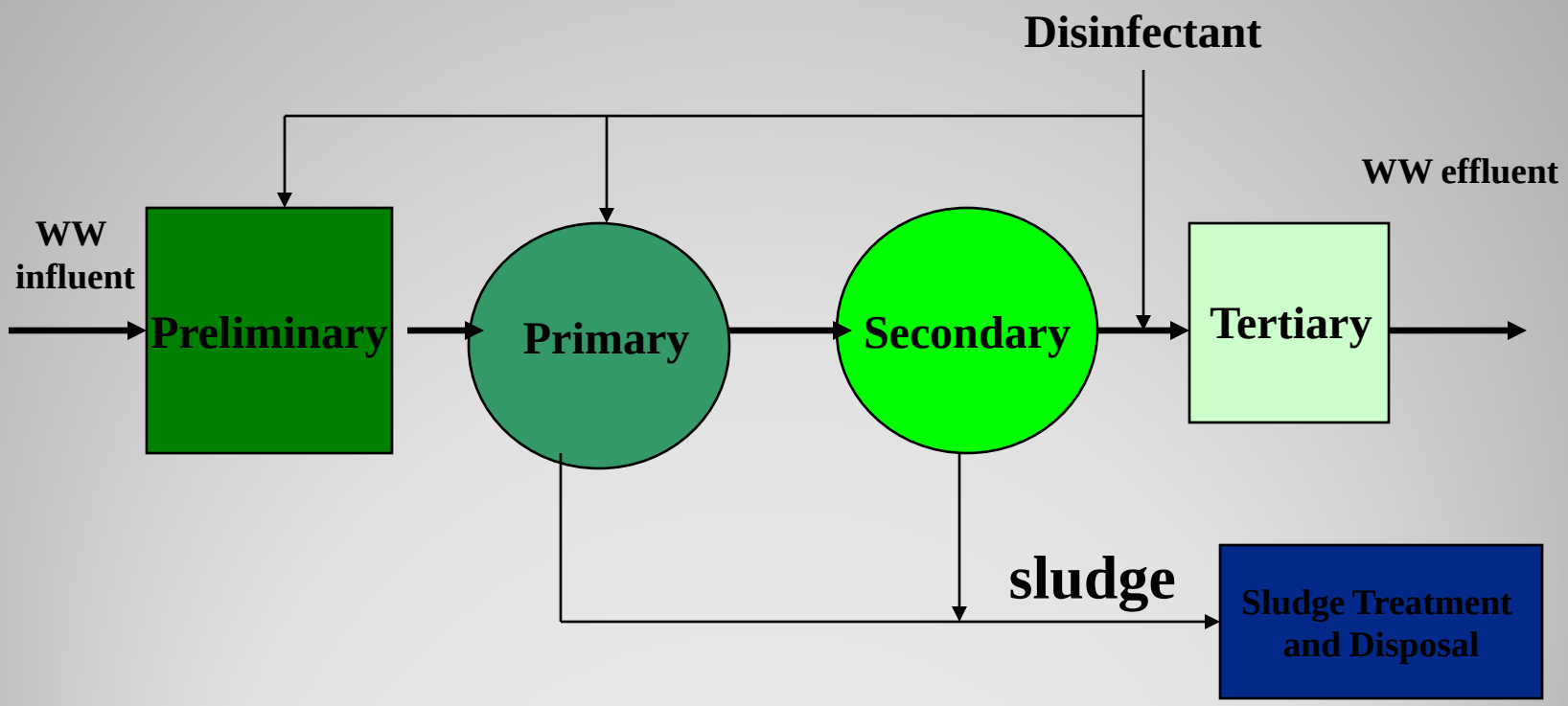
- Suspended solids;
- Organic (biodegradable) material;
- Nutrients (nitrogen and phosphorous);
- Pathogenic organisms (expressed as E. Coli)
- Medicine residues, organic chemicals and Heavy metals

Methods of Removal

The contaminants in wastewater are removed by different **unit processes**:

- Physical (sedimetation, flotation, screening, filtration)
- Biological (trickling filters, RBC, activated sludge)
- Chemical (chemical precipitation, ozonation, chlorination)

Wastewater Treatment Scheme

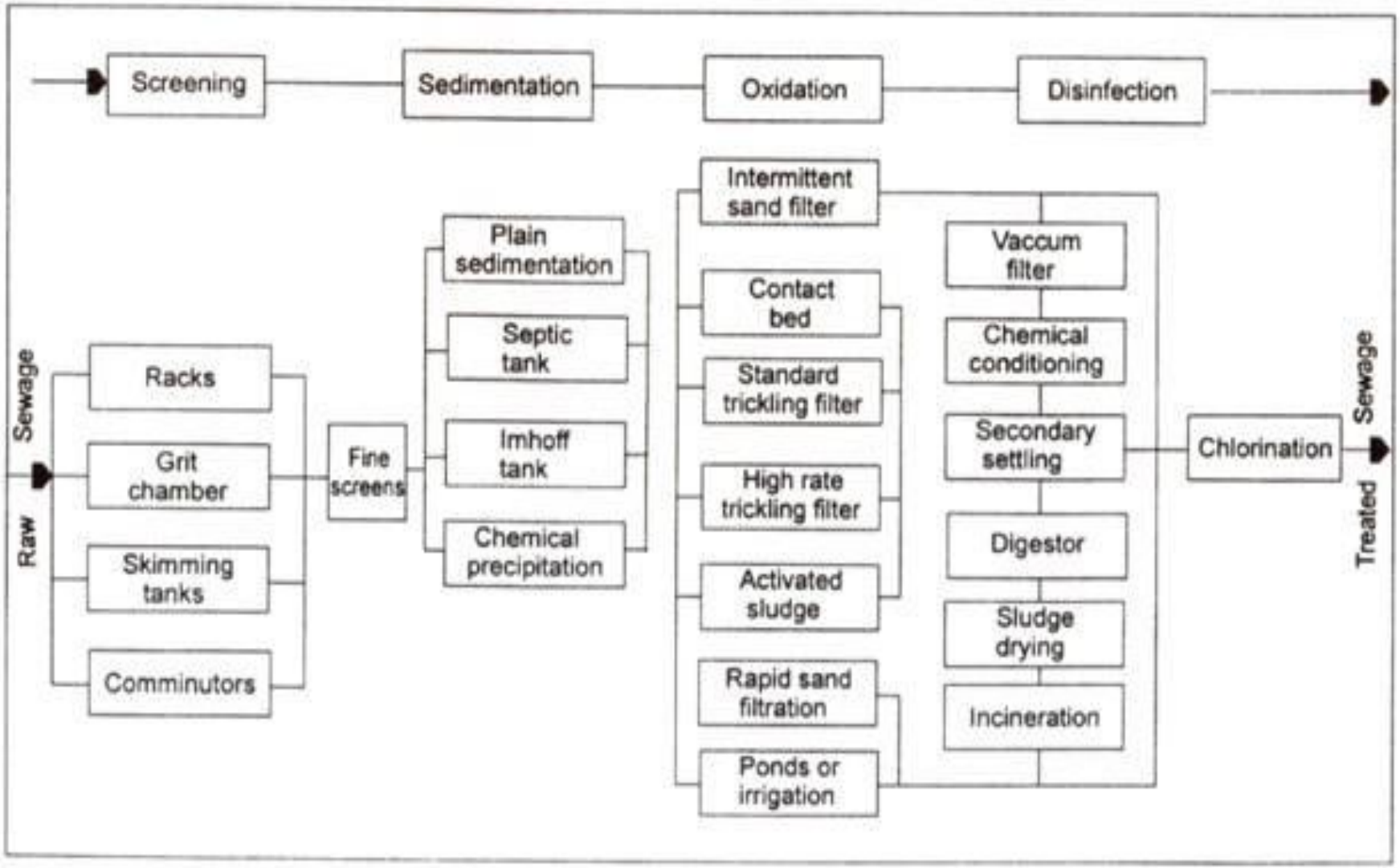


Wastewater treatment processes:

- Preliminary treatment is a physical process that removes large contaminants.
- Primary treatment involves physical sedimentation of particulates.
- Secondary treatment involves physical and biological treatment to reduce organic load of wastewater.
- Tertiary or advanced treatments.

Figure 8.3

Sewage Treatment Process



Physical Unit Processes (mainly primary)

Treatment methods in which the application of physical forces predominates are known as physical unit operations. Typical unit operations are:

- Screening
- Sedimentation
- Floatation

Biological Unit Processes (mainly secondary)

The treatment method in which the removal of contaminants is brought about by biological activity are known as biological unit process. Some examples are:

aerobic processes - presence of dissolved oxygen

- Biofilters
- Trickling filters
- Activated sludge

anaerobic processes – absence of dissolved oxygen

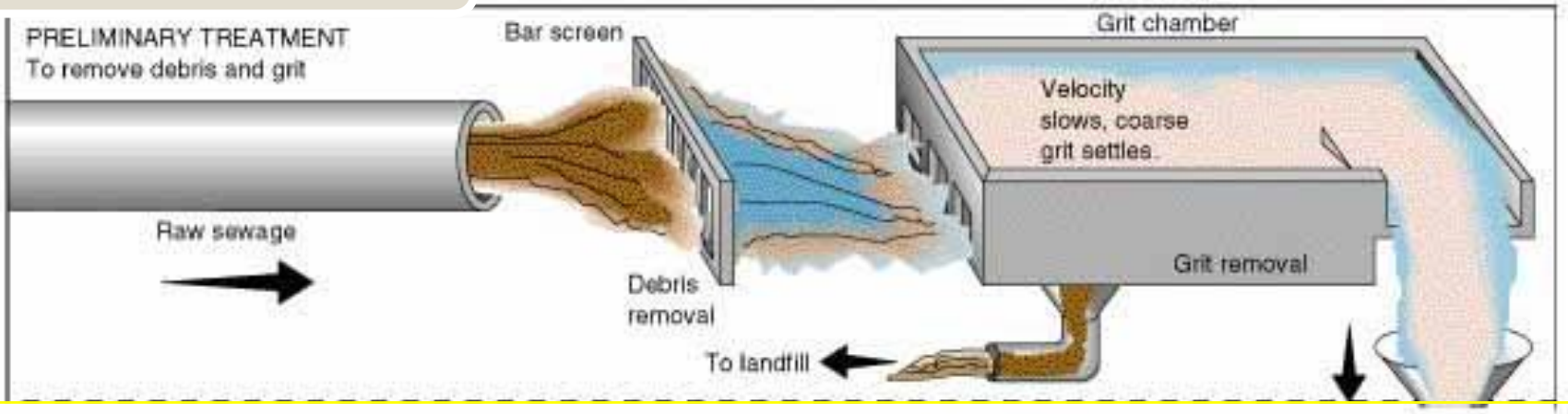
- Denitrification (tertiary)
- Septic tanks
- Ponds

Chemical Unit Process (tertiary)

Treatment methods in which the removal or conversion of contaminants is brought about by the addition of chemicals or by chemical reactions are known as chemical unit processes. Some of the most common are:

- **Precipitation (lime, Fe- of Al salts, Struvite formation)**
- Adsorption
- Disinfection

Grit Chamber



- Grit are small inorganic solids like pebbles, sand, silt, eggshells, glass and metal fragment. As Grits are abrasive in nature and will cause wear on pumps. Grit deposits in pipes, sumps and clarifiers can absorb grease and solidify. They are non biodegradable and occupy valuable space in the digest. The major contributor is infiltration and depends on the type, age and condition of sewerage systems

- Industrial waste and Domestic garbage also contribute grit materials. Therefore its removal is essential.
- Usually grit particles are inert and dry, however 15 to 65% moisture content are present depend on the nature of grit.
- Inorganic particles with Sp. gravity ≥ 2.65 and approximate diameter of 0.20 mm or larger can be removed. while organic matters be keep in suspension.
- The physical operation to remove is termed as Grit Chamber.

Grit Chamber

- Grit chamber are provided to (i) protect moving mechanical equipment from abrasion and abnormal wear

  (ii) Reduce formation of heavy deposits in pipelines

  (iii) Reduce the frequency of digester cleaning caused by excessive accumulation of grit and

  (iv) To separate inorganic particles from organic and disposed off of these particles just to wash without passing any further treatment process.

- Grit Chambers are usually located after bar racks and before sedimentation tanks. Similarly, the installation of screening facilities ahead of the grit chambers make the operation and maintenance of grit removal easier.

- Two important types of Grit Chambers (i) Horizontal flow Rectangular and (ii) Aerated Grit Chamber

Aeration

•Aeration brings water and air in close contact in order to remove dissolved gases

• Volatile organic chemicals, such as benzene (found in gasoline), or trichloroethylene, dichloroethylene, and perchloroethylene (used in dry-cleaning or industrial processes)

- Ammonia
- Chlorine
- Carbon dioxide
- Hydrogen sulfide
- Methane
- Iron and Manganese

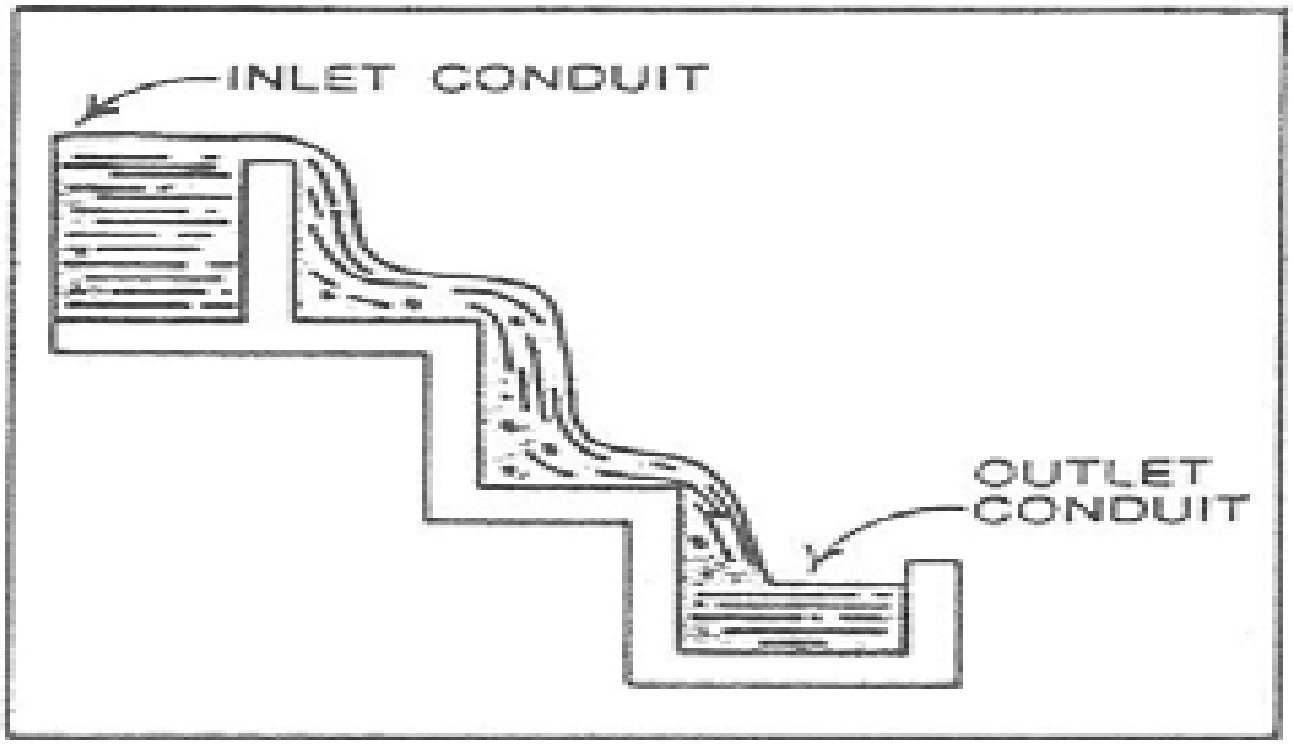
TYPES OF AERATORS

Aerators fall into two categories.

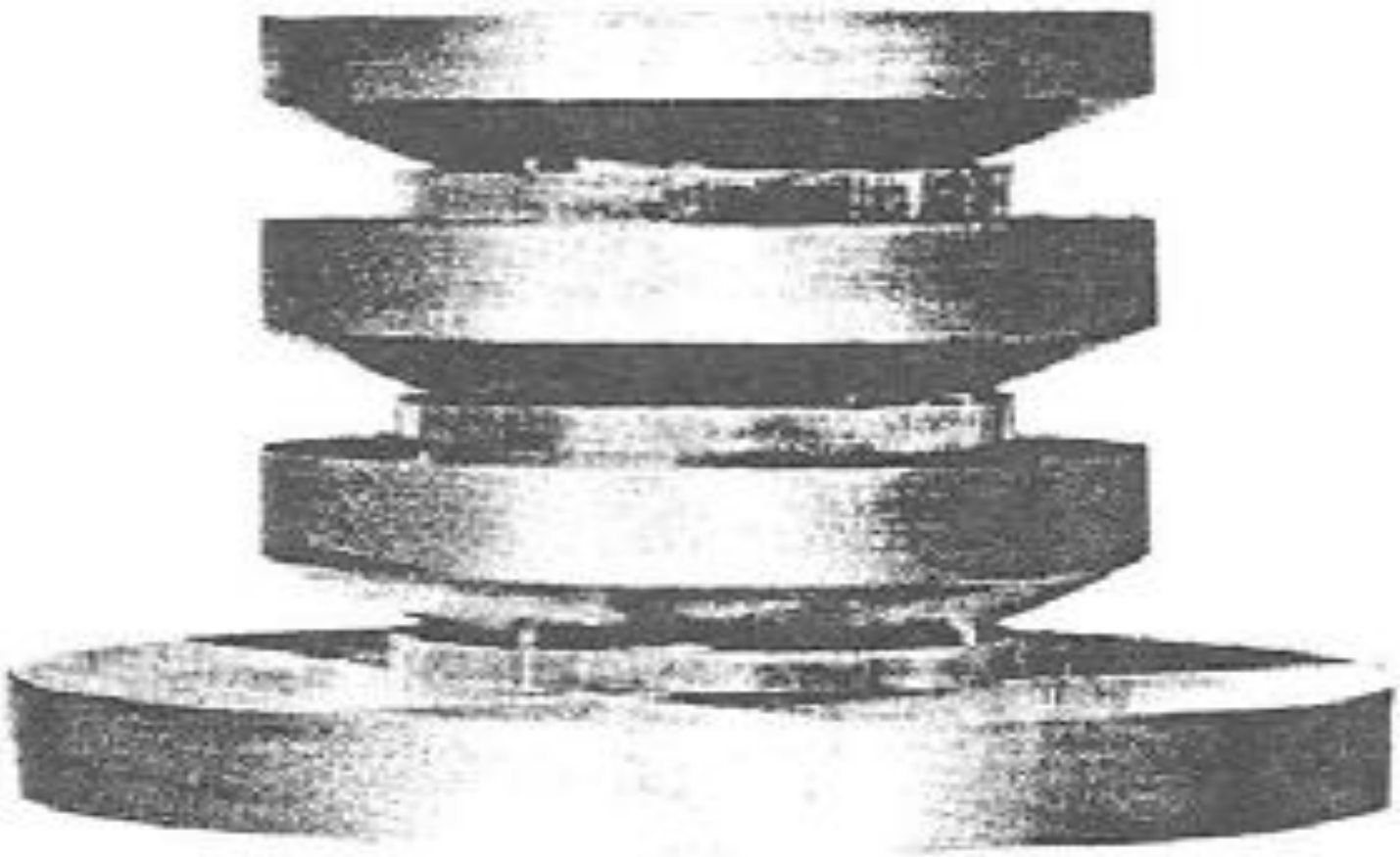
- They either introduce air to water, or water to air.
- The water-in air method is designed to produce small drops of water that fall through the air.
- The air-in-water method creates small bubbles of air that are injected into the water stream.
- All aerators are designed to create a greater amount of contact between air and water to enhance the transfer of gases and increase oxidation.

Water-Into-Air Aerators

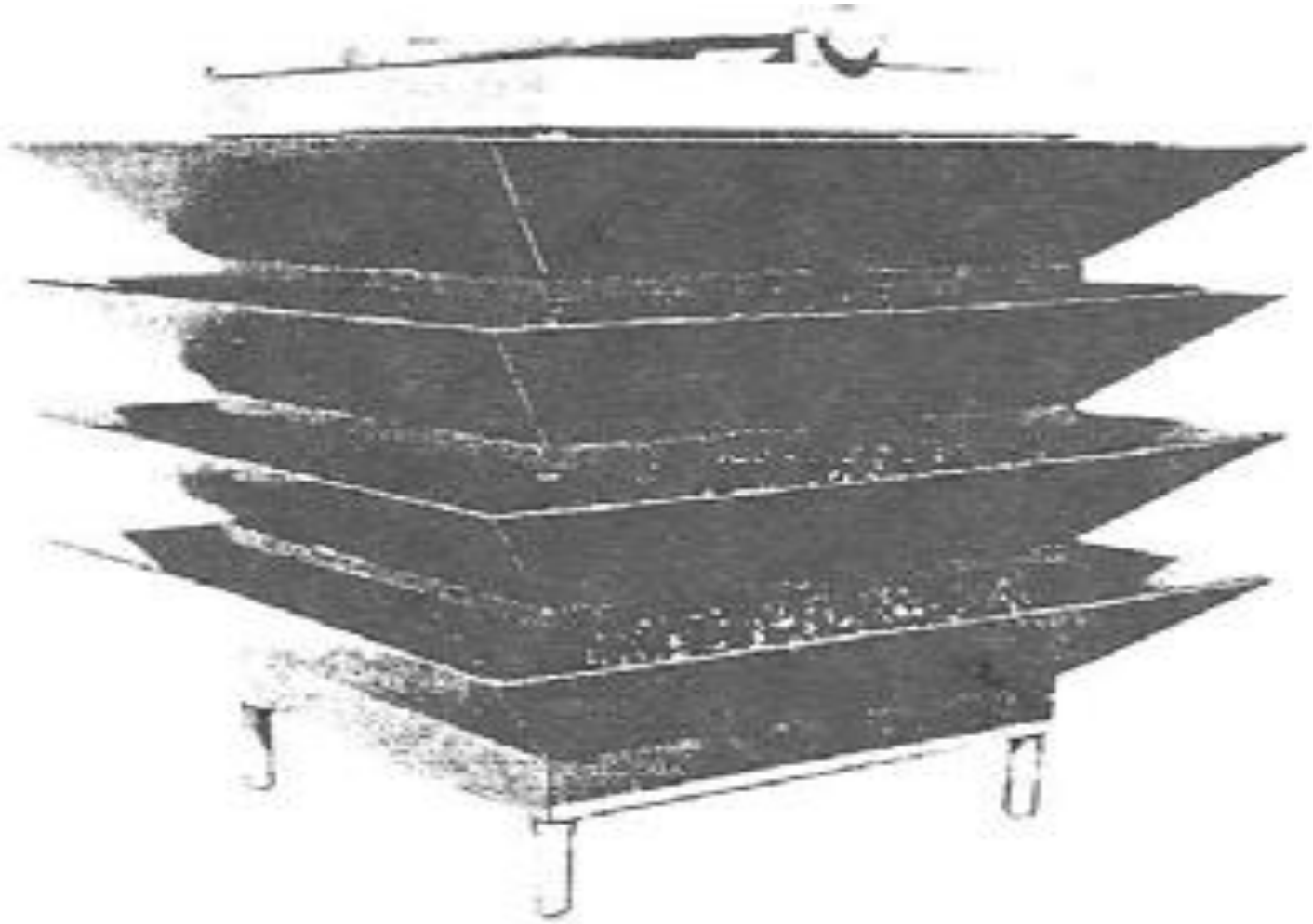
- Cascade Aerators



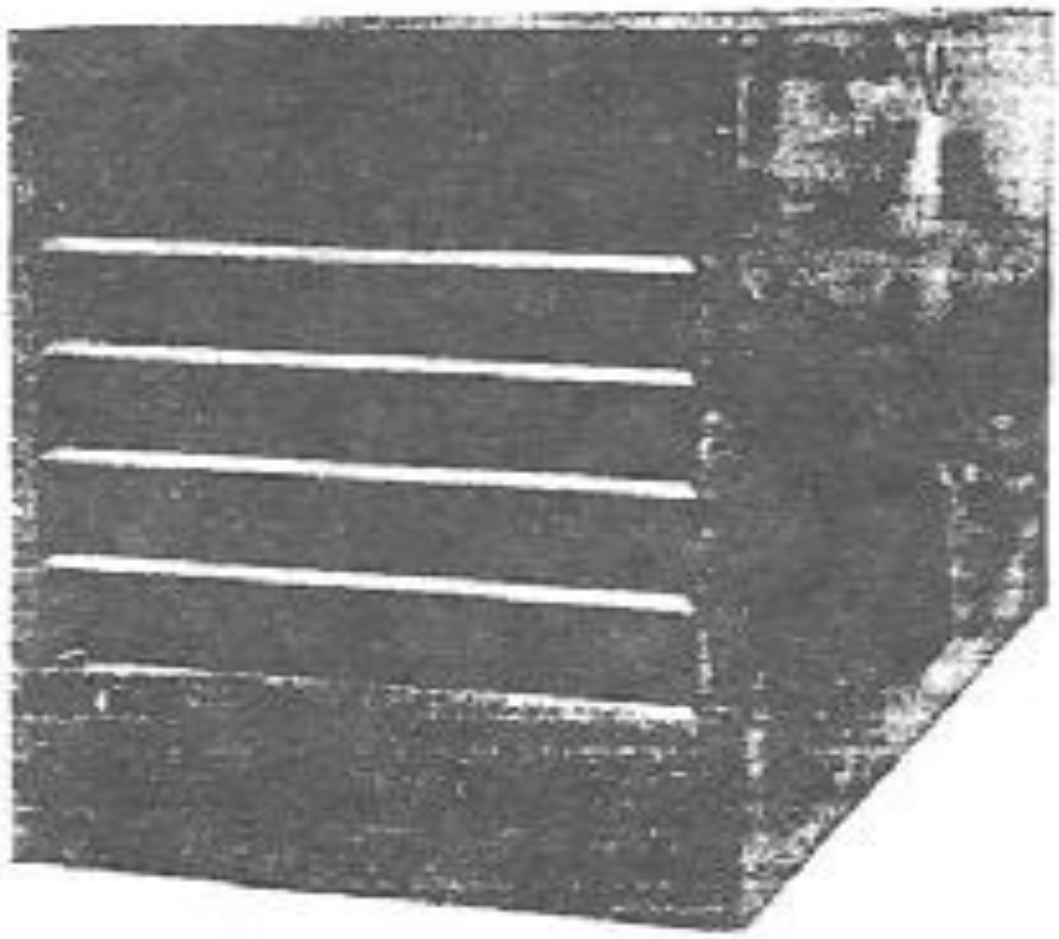
Cone Aerators



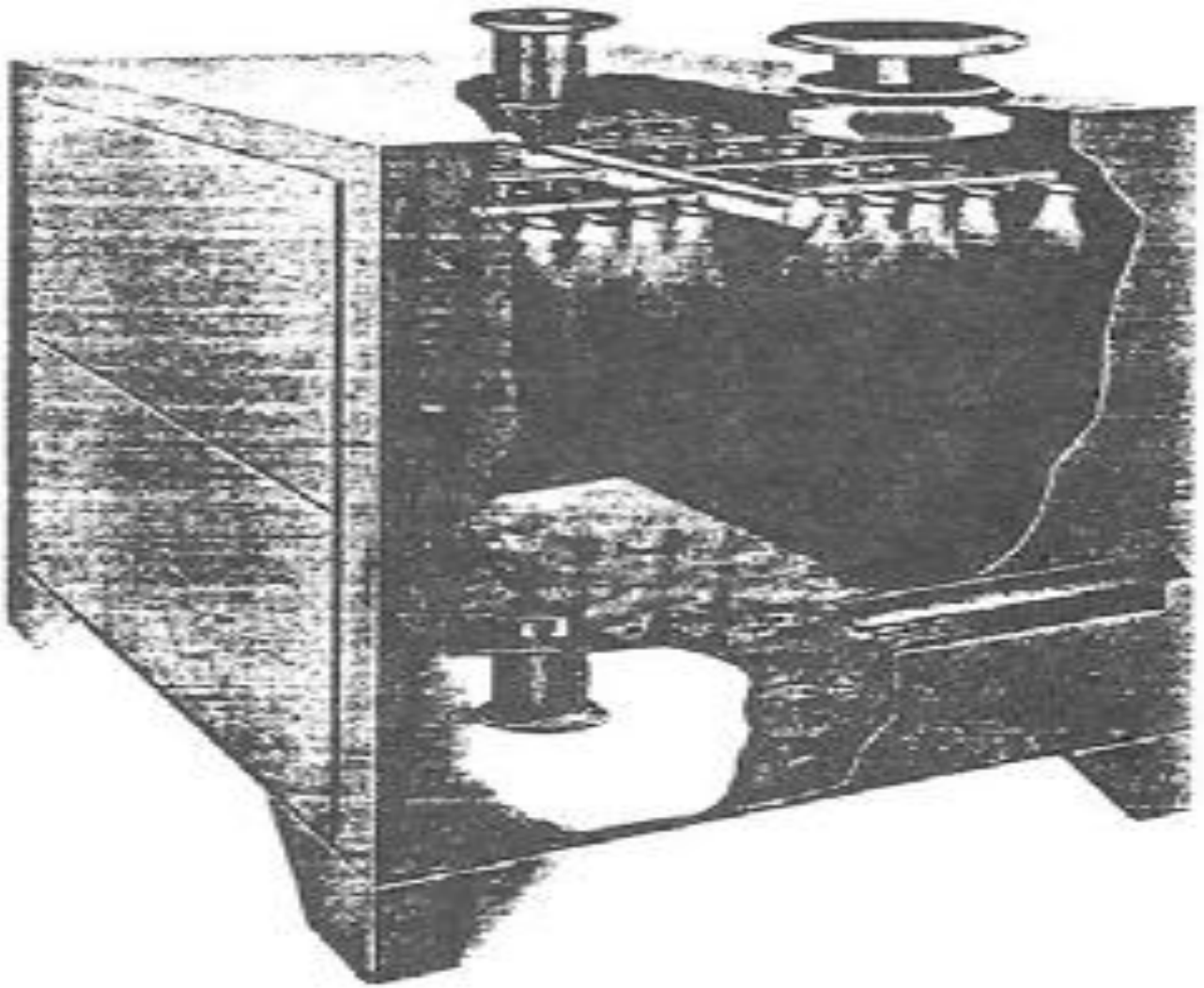
Slat and Coke Aerators

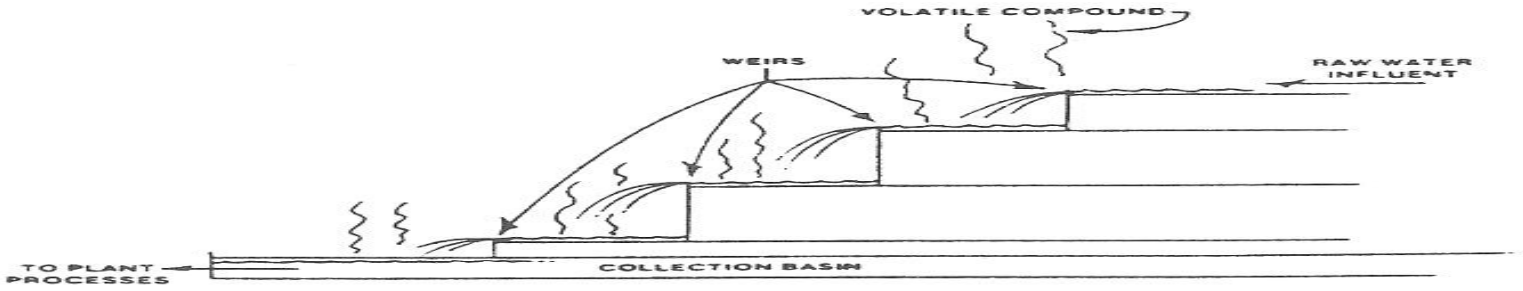


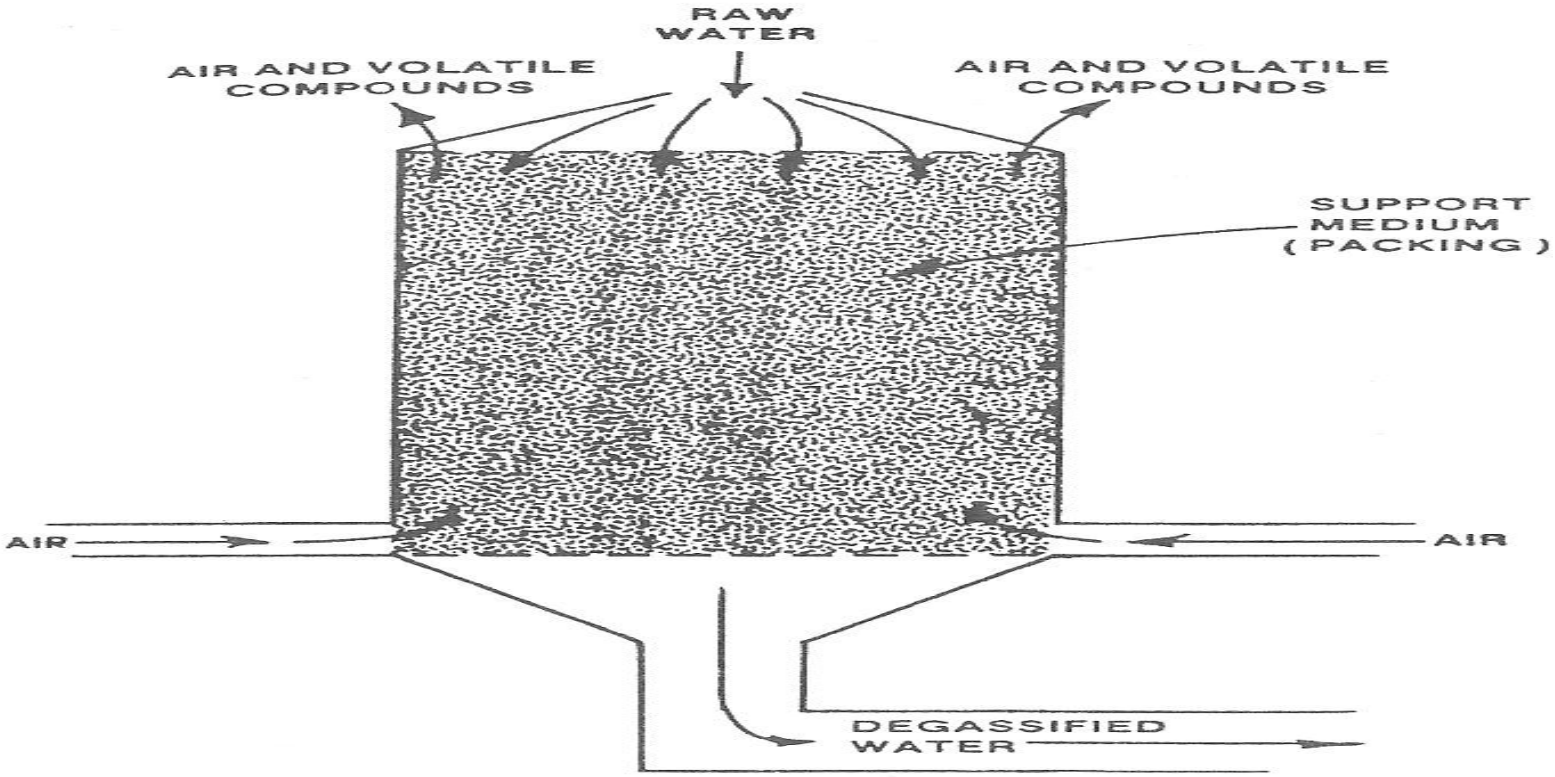
Draft Aerators



Spray Aerators



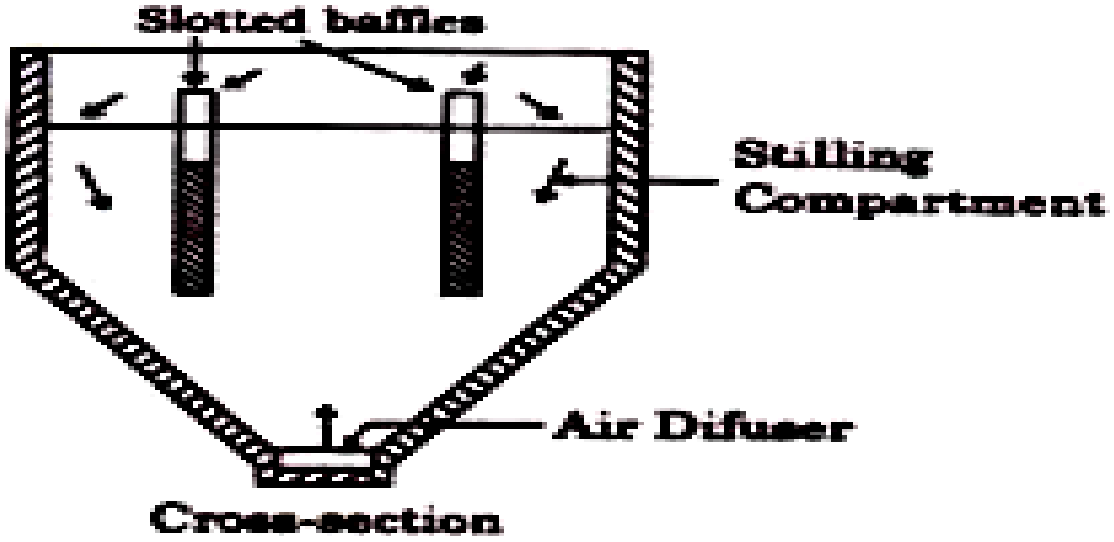

VOLATILE COMPOUND
WEIRS
RAW WATER INFLUENT
TO PLANT PROCESSES
COLLECTION BASIN

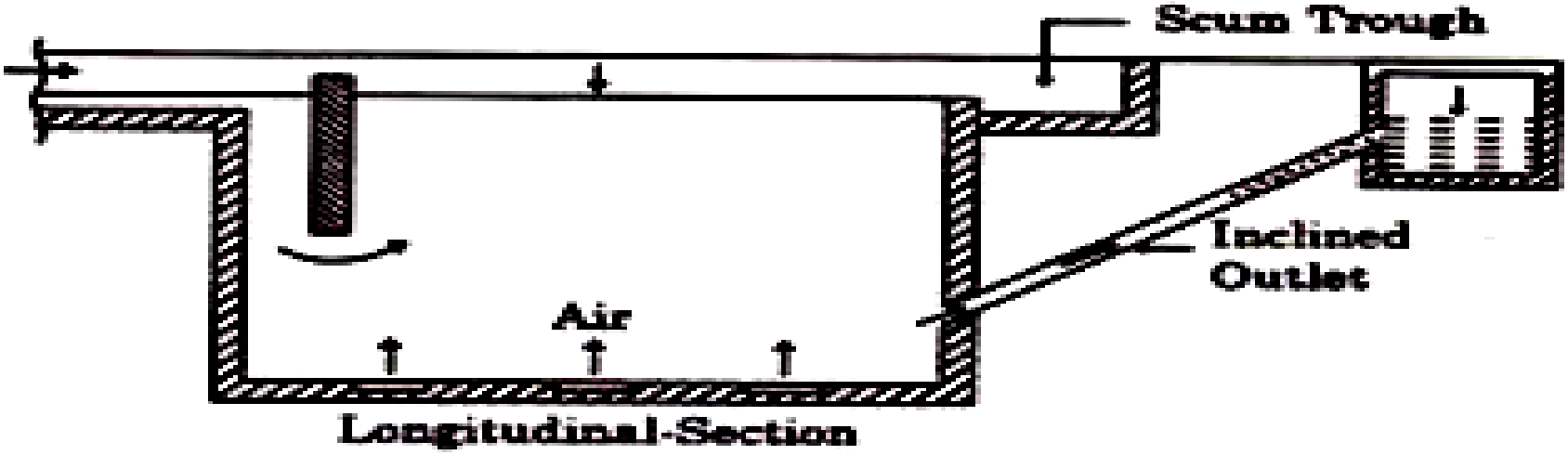

RAW WATER
AIR AND VOLATILE COMPOUNDS
AIR AND VOLATILE COMPOUNDS
SUPPORT MEDIUM (PACKING)
AIR
AIR
DEGASSIFIED WATER

SKIMMING

A skimming tank is a chamber so arranged that the floating matter like oil, fat, grease etc., rise and remain on the surface of the waste water (Sewage) until removed, while the liquid flows out continuously under partitions or baffles.

It is necessary to remove the floating matter from sewage otherwise it may ap-pear in the form of unsightly scum on the surface of the settling tanks or inter-fere with the activated sludge





Skimming Tank

Sedimentation

- Sedimentation, or clarification, is the processes of letting suspended material settle by gravity.

PARTICLE SIZE

WATER TEMPERATURE

CURRENTS

SEDIMENTATION BASIN ZONES

Inlet Zone

The inlet or influent zone should distribute flow uniformly across the inlet to the tank.

Settling Zone

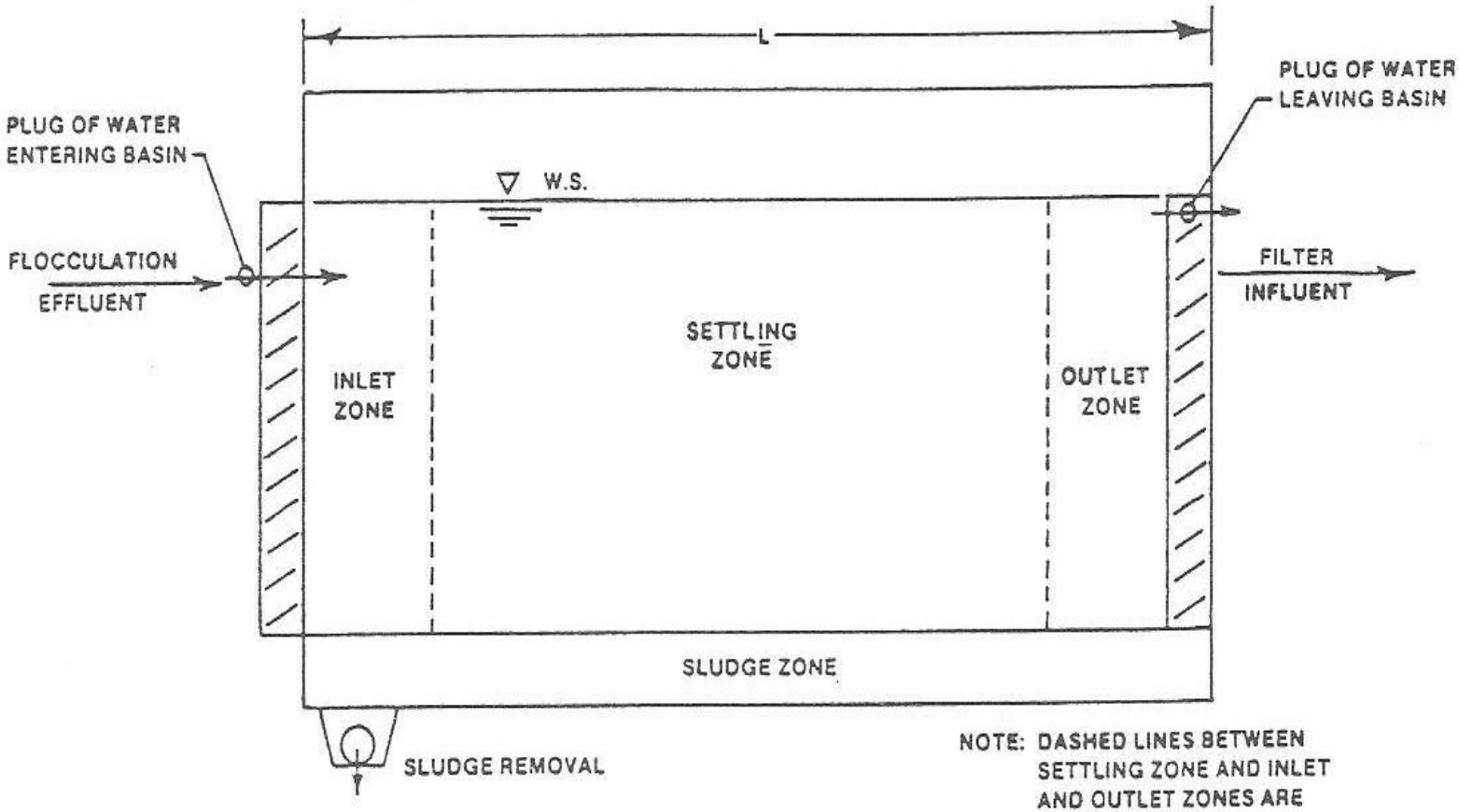
The settling zone is the largest portion of the sedimentation basin. This zone provides the calm area necessary for the suspended particles to settle.

Sludge Zone

The sludge zone, located at the bottom of the tank, provides a storage area for the sludge before it is removed for additional treatment or disposal.

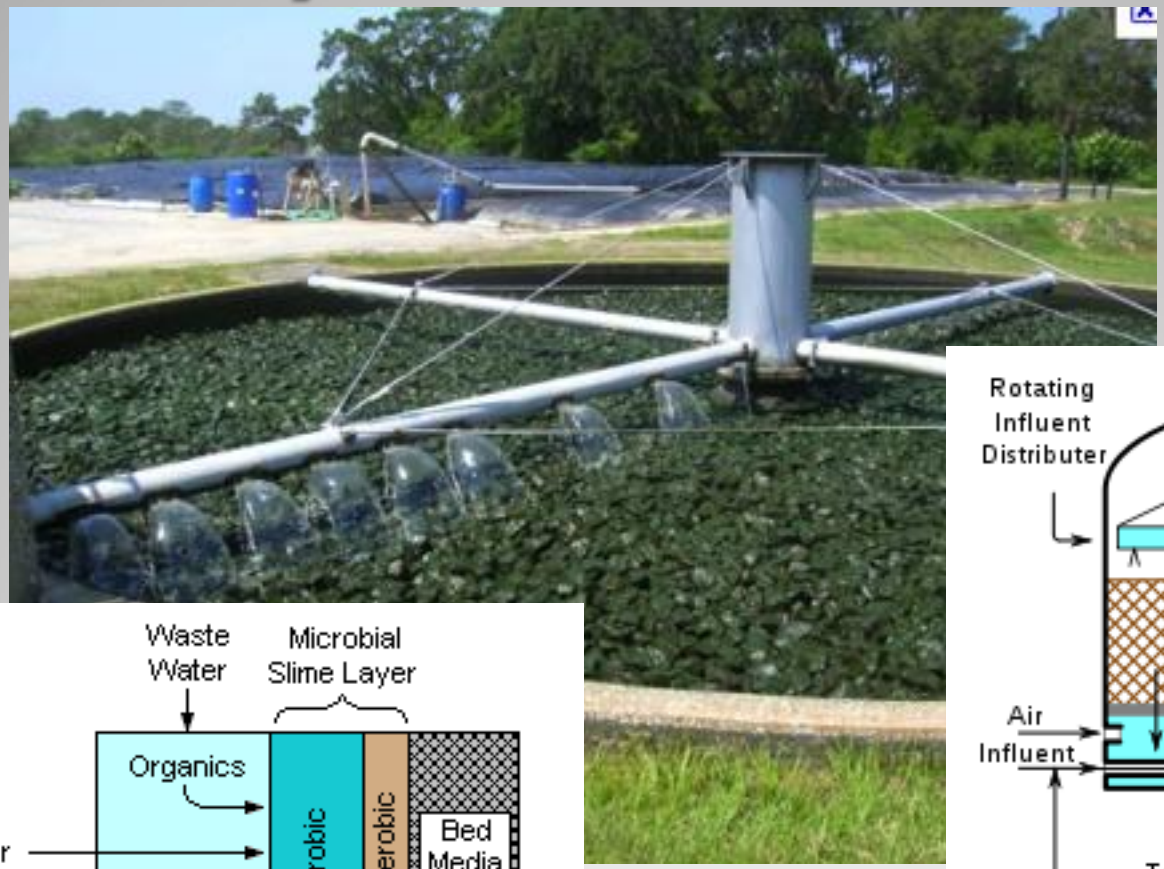
Outlet Zone

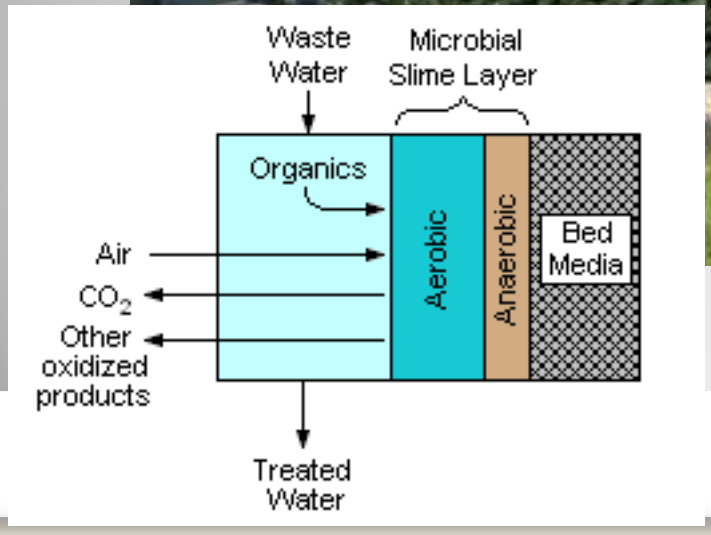
The basin outlet zone (or launder) should provide a smooth transition from the sedimentation zone to the outlet from the tank.

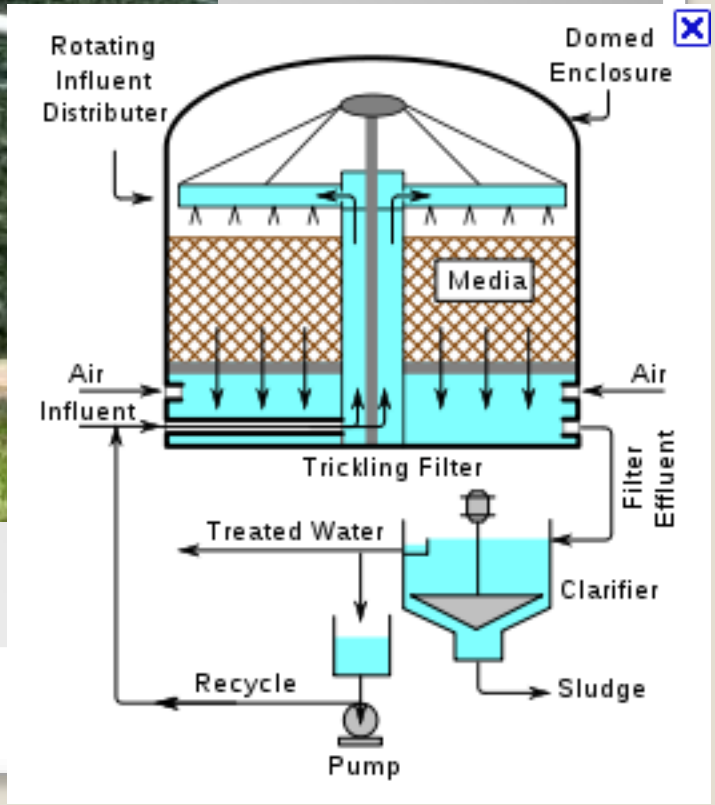


Sedimentation basin zones

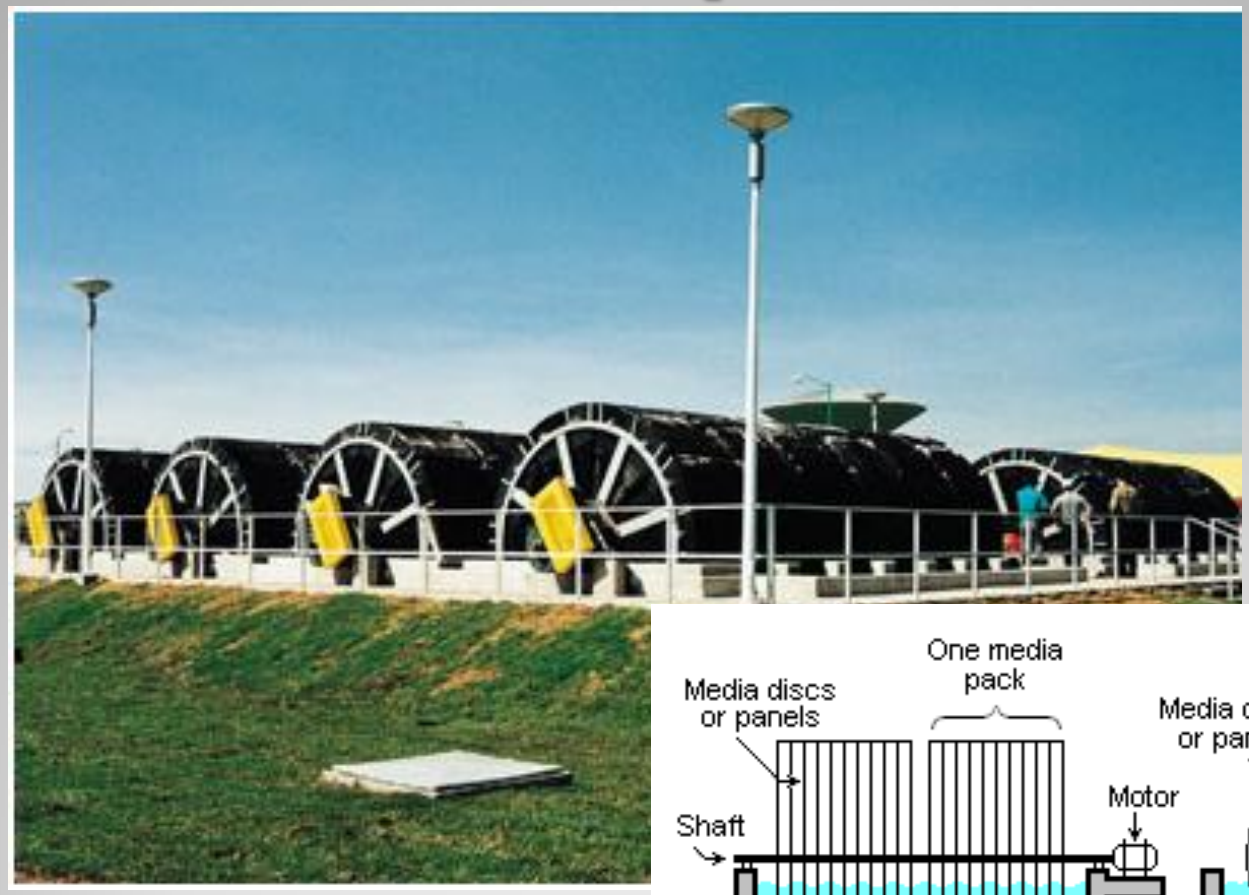
Biofilter: trickling filter (fixed biofilm)

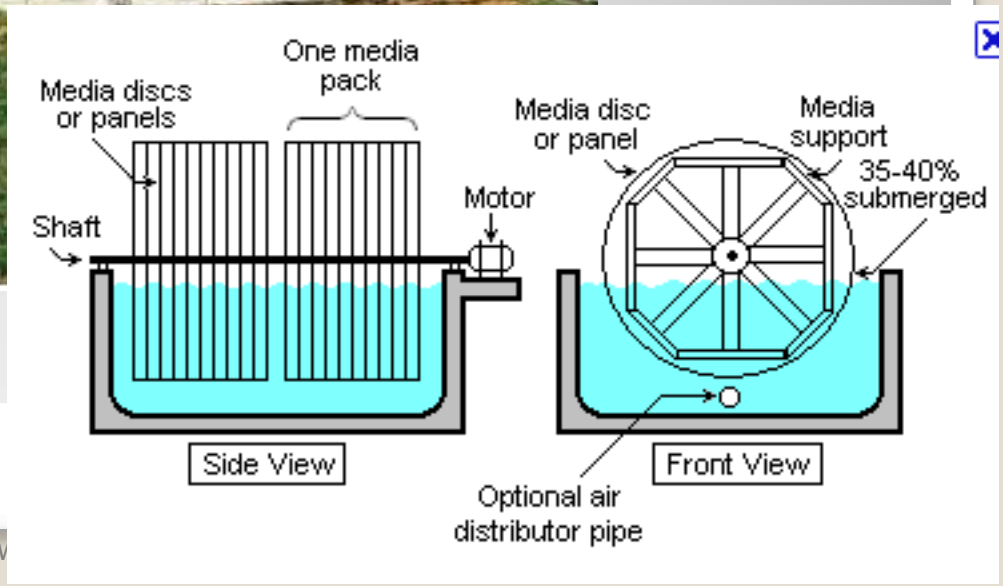




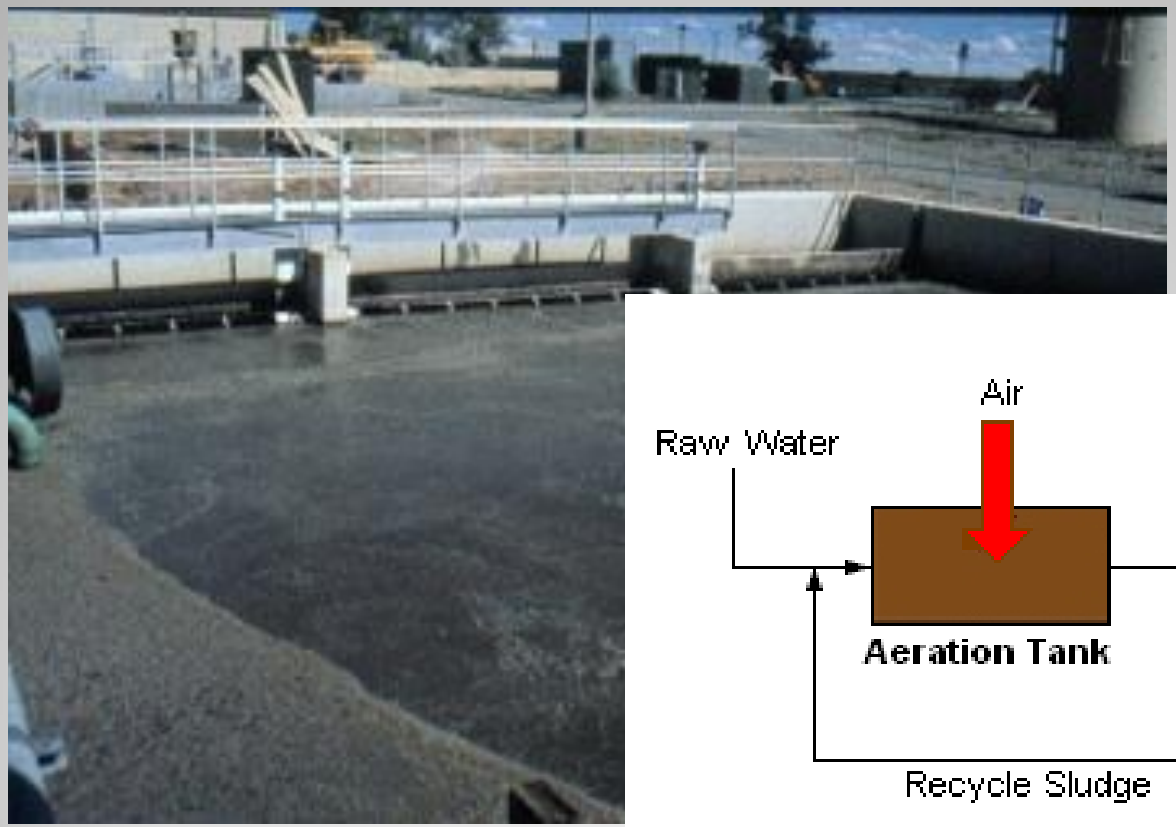


Biofilter: Rotating biological contactor - RBC (fixed biofilm)





Biological treatment: Activated sludge
(biofilm in suspension)



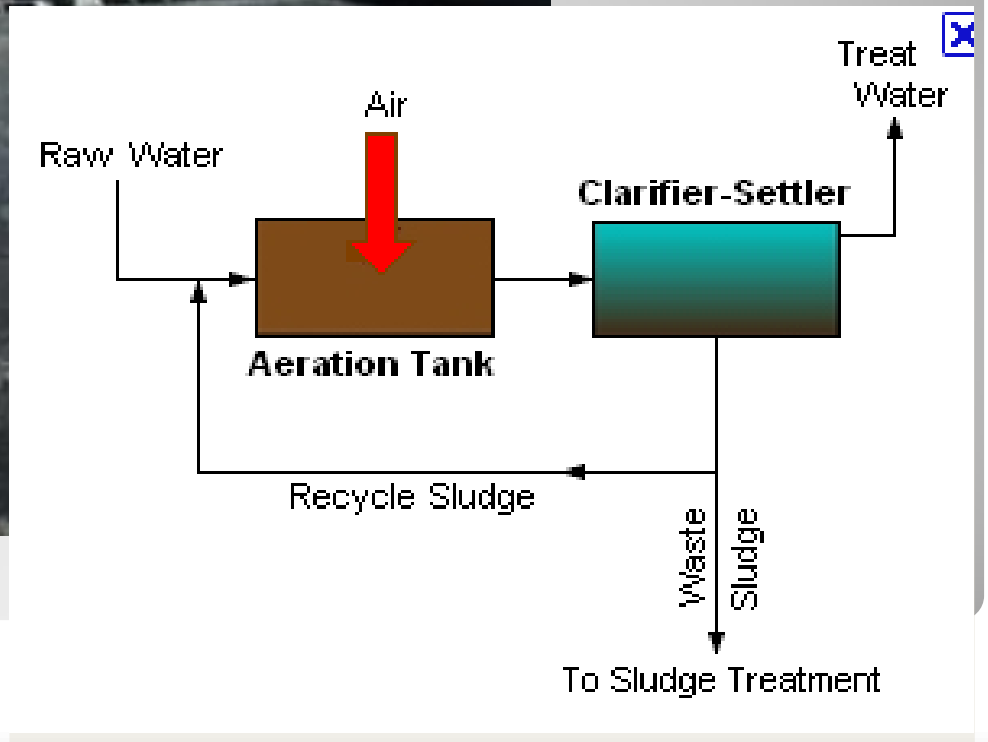


Figure 8.4

Primary Sewage Treatment