Wastewater Treatment Plant and Process

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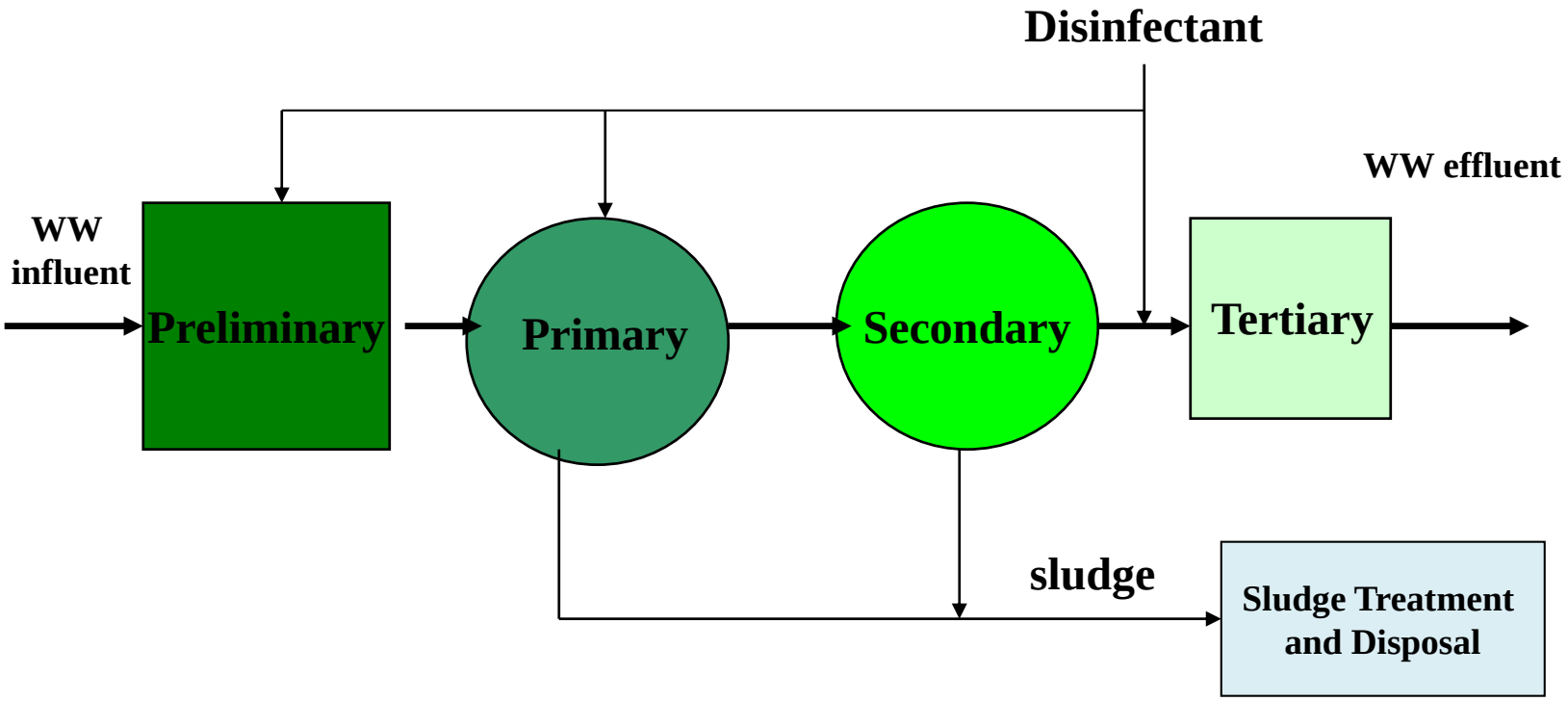
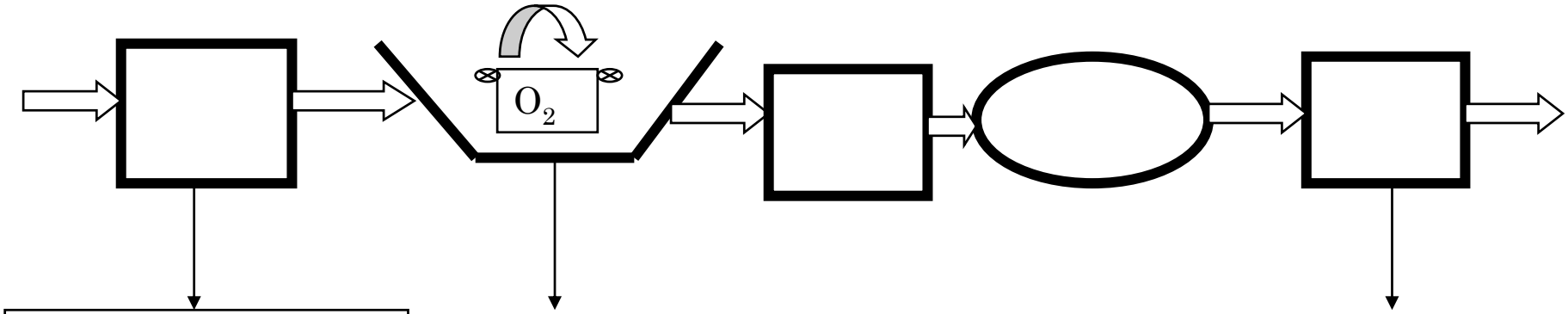
Types of Treatments

- **Mechanical treatment**
  - Influx (Influent)
  - Removal of large objects
  - Removal of sand and grit
  - Primary Sedimentation
- **Biological treatment**
  - Trickling bed filter
  - Activated sludge
- **Chemical treatment**
  - Disinfection

Wastewater treatment stages



Wastewater Treatment Processes



Primary treatment

- screening
- grit removal
- removal of oil
- sedimentation

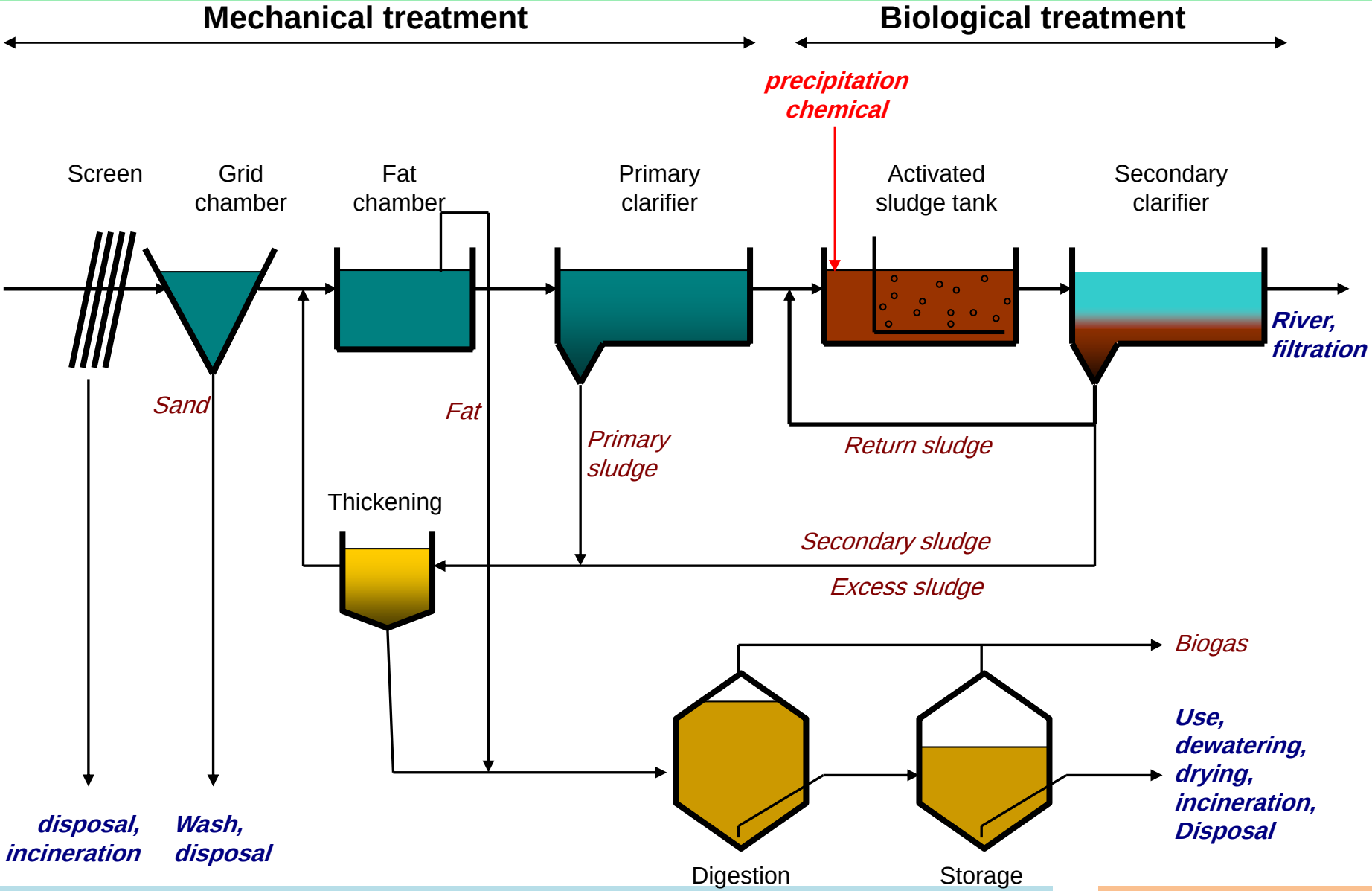
Secondary treatment

- Aerobic, anaerobic lagoons
- Trickling filter- activated sludge-oxidation ditch
- Mostly BOD removal technology

Tertiary treatment

- Nitrate removal
- Phosphorus removal
- Disinfection

Layout of a WWTP

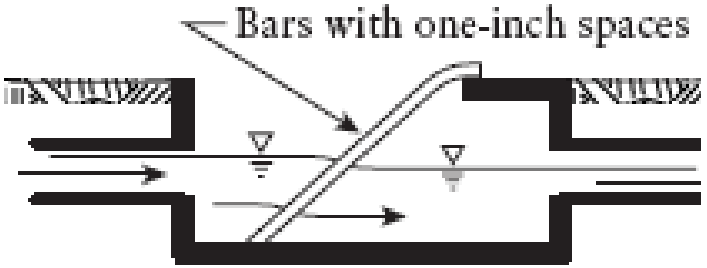


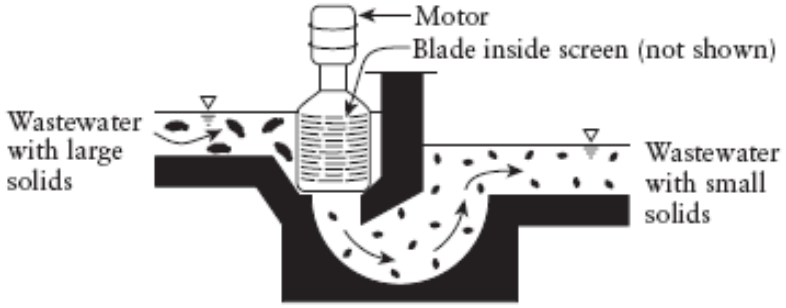
Preliminary Treatment

- removes large objects and non-degradable materials
- protects pumps and equipment from damage
- bar screen and grit chamber

❑ Bar Screen

catches large objects that have gotten into sewer system such as bricks, bottles, pieces of wood, etc

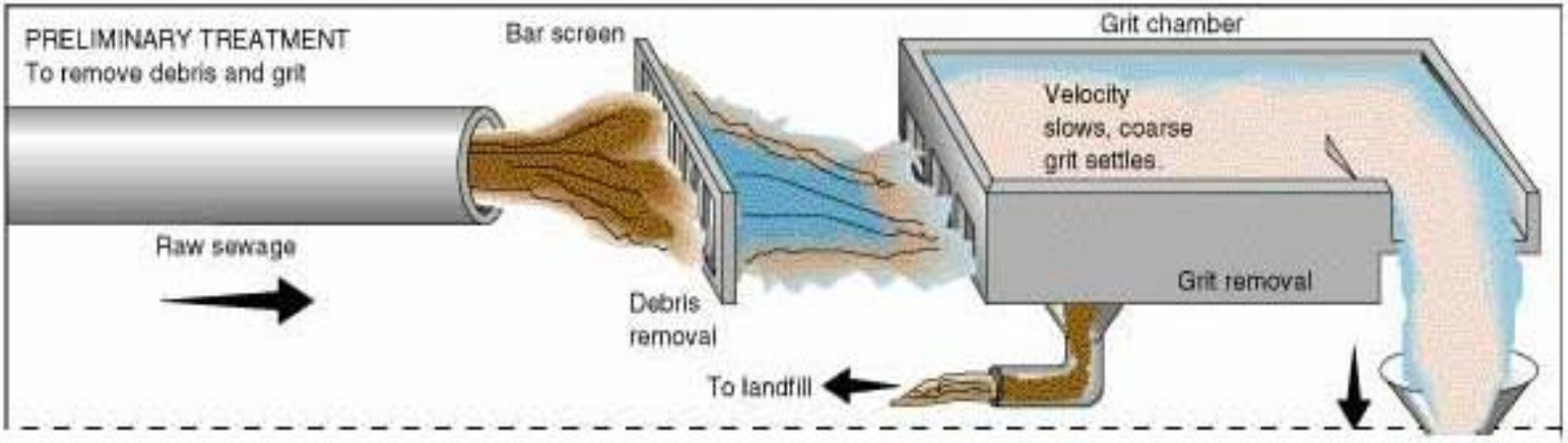




Preliminary Treatment

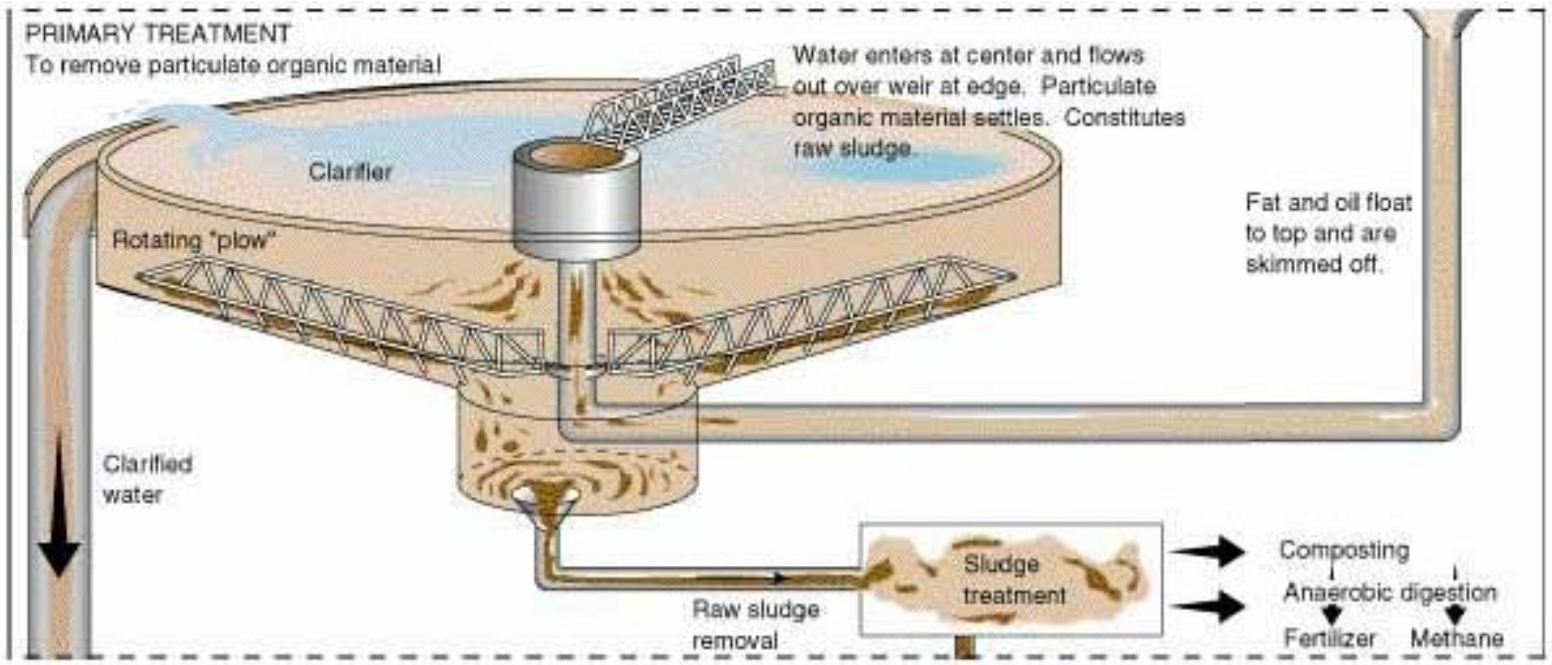
- Grit removal chamber : to removes rocks, gravel, broken glass, etc.

  - Grit is composed primarily of sand, cinders, and gravel
  - Grit causes excessive wear and abrasion in pipes and pumps
  - Grit accumulates in downstream tanks where flow velocities are insufficient to keep it in suspension. As grit accumulates, it reduces the effective tank volumes and thus treatment effectiveness
  - Grit removal is done by gravity settling (the high specific gravity of grit)



Primary Treatment

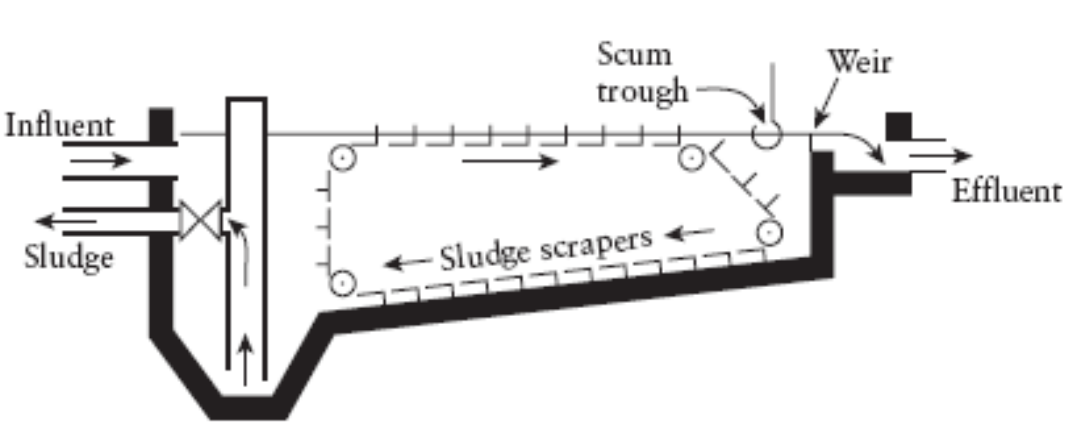
- a physical process
- wastewater flow is slowed down and suspended solids settle to the bottom by gravity
- the material that settles is called sludge or biosolids

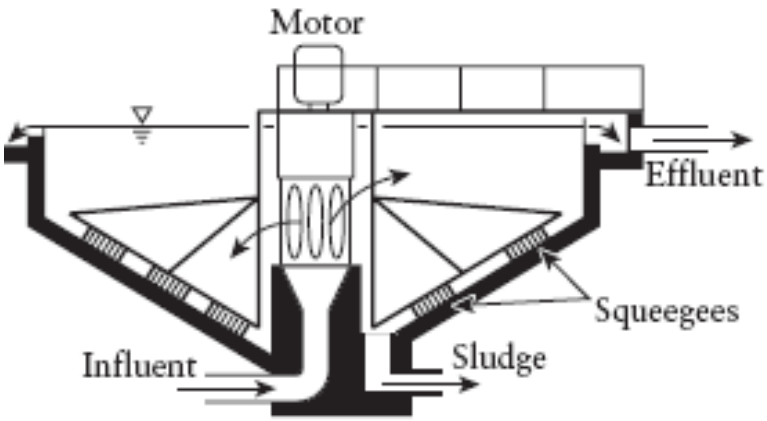


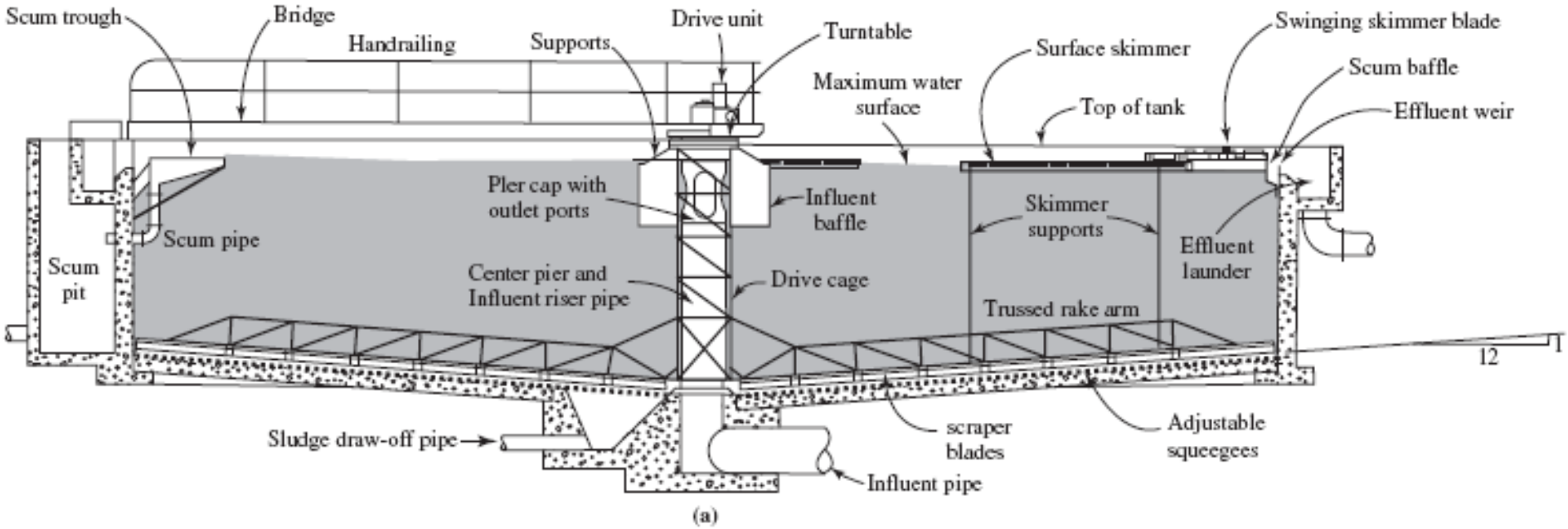
Sedimentation tanks and clarifiers

- The settling tank that follows preliminary treatment, such as screening and grit removal, is known as the *primary clarifier*.

- Primary treatment, in addition to removing about 60% of the solids, removes about 30% of the demand for oxygen and perhaps 20% of the phosphorus (both as a consequence of the removal of raw sludge).






Scum trough
Bridge
Handrailing
Supports
Drive unit
Turntable
Surface skimmer
Swinging skimmer blade
Scum baffle
Effluent weir
Maximum water surface
Top of tank
Pier cap with outlet ports
Influent baffle
Skimmer supports
Effluent launder
Scum pipe
Scum pit
Center pier and Influent riser pipe
Drive cage
Trussed rake arm
12
1
Sludge draw-off pipe
scraper blades
Adjustable squeegees
Influent pipe
(a)

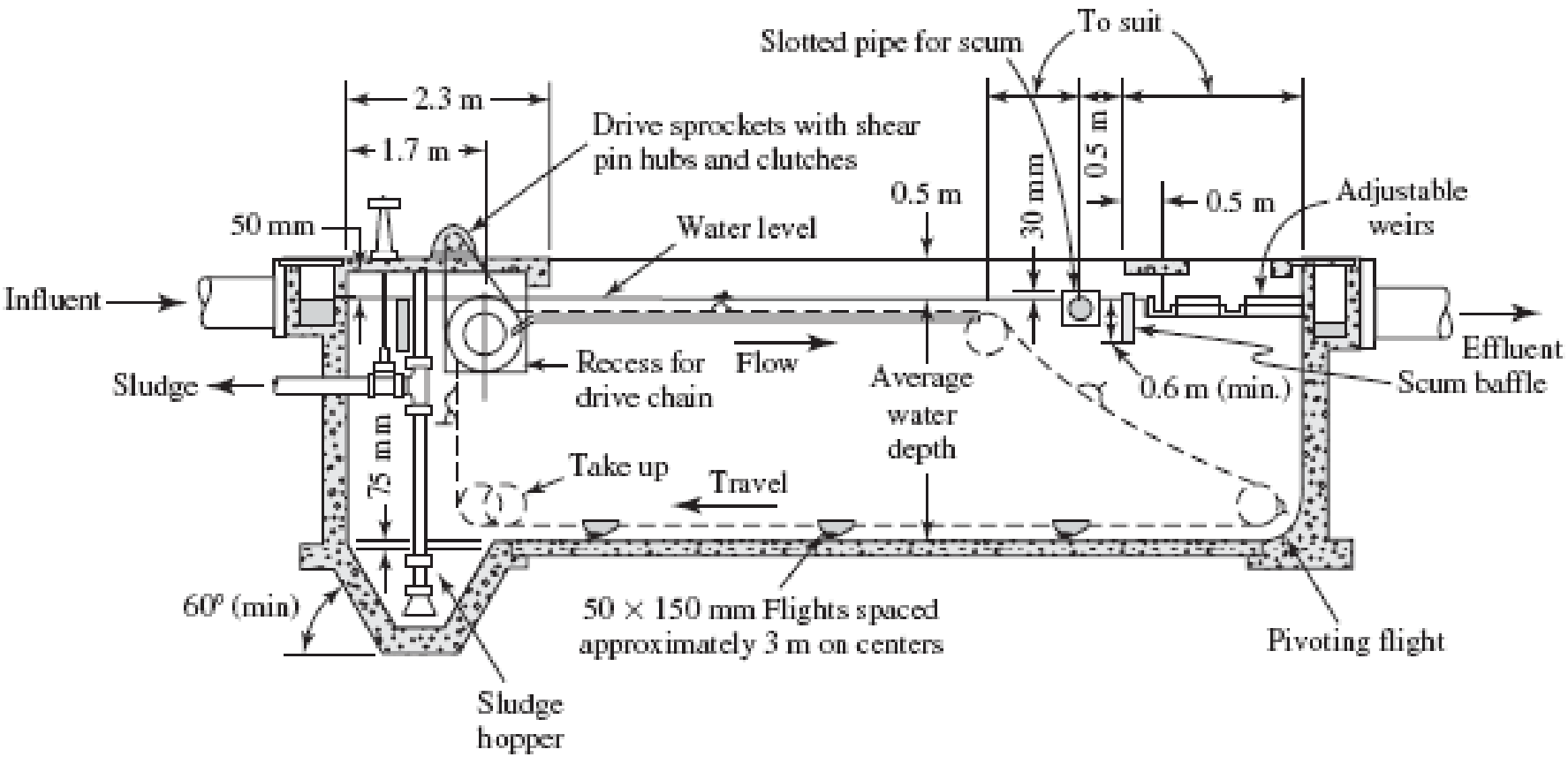
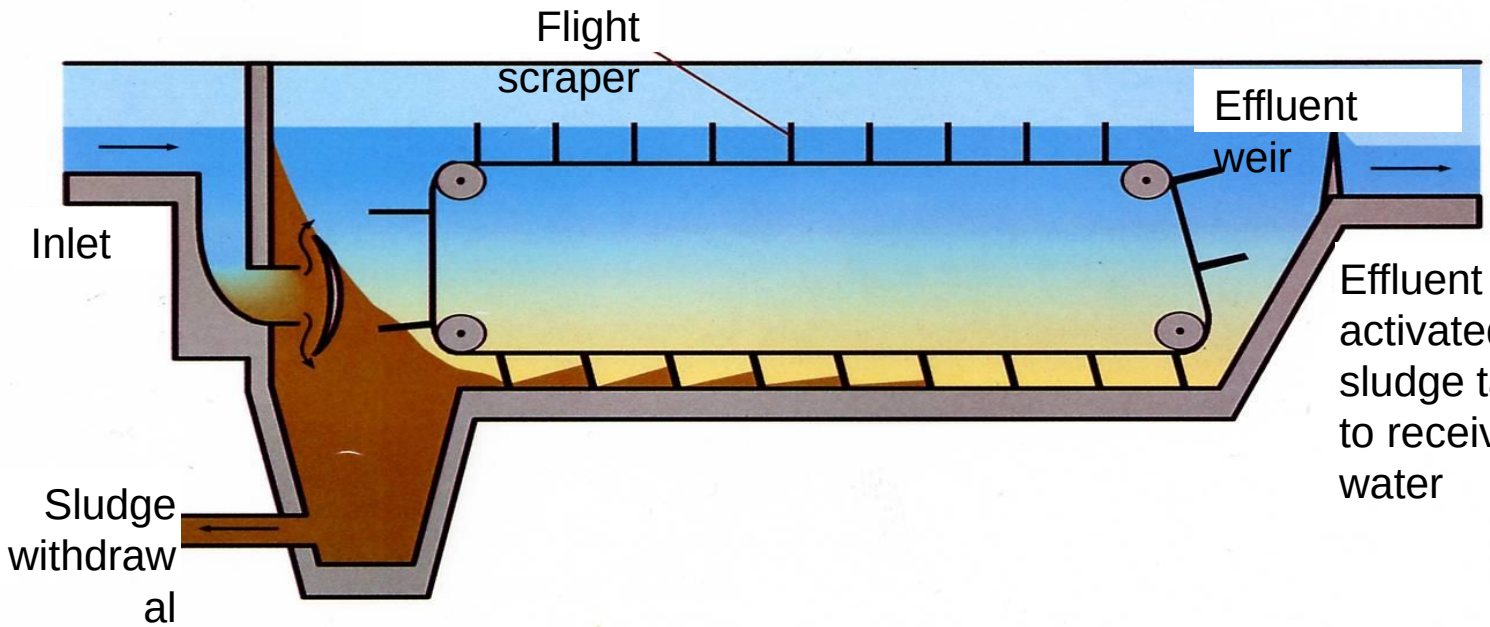


FIGURE 21-3
Rectangular primary settling tank. (*Source:* Davis and Cornwell, 2008.)

Primary / secondary clarifier



13 Umweltbereich Wasser

Primary Settling Tank Design

- Size:
  - rectangular: 3-24 m wide x 15-100 m long
  - circular: 3-90 m diameter
- Detention time: 1.5-2.5 hours
- Overflow rate: 25-60 $m^3/m^2 \cdot day$
- Typical removal efficiencies:
  - solids: 50-60%
  - BOD_5: 30-35%

Effects of primary clarifier on wastewater

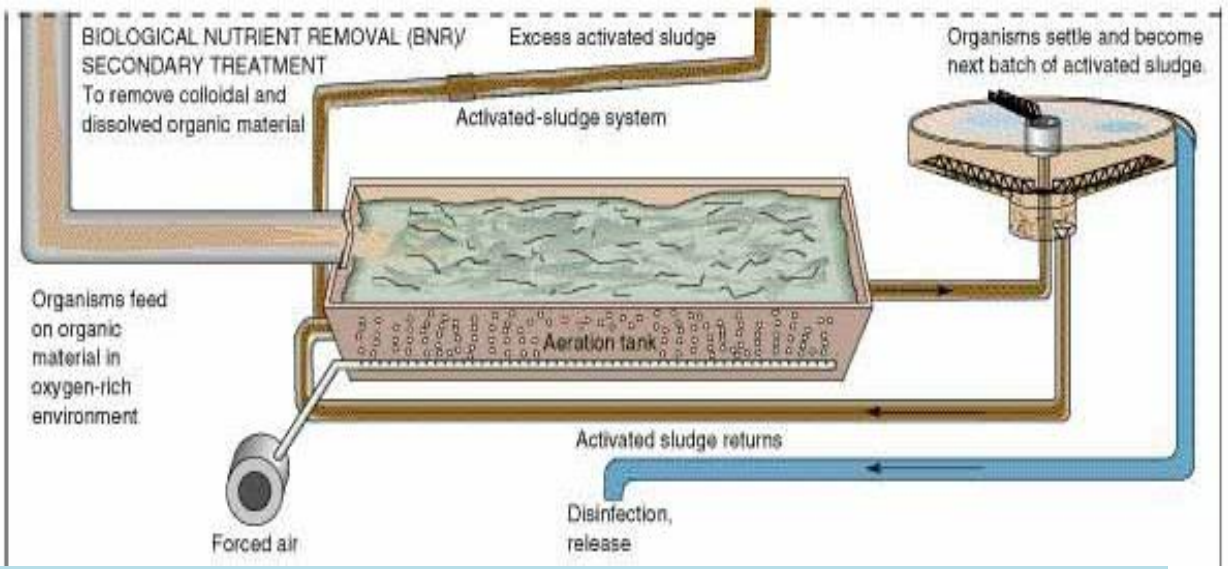
Compound	Unit	Inlet	Outlet*	$\eta = \frac{C_{in} - C_{out}}{C_{in}}$
TSS	g TSS / m^3	360	180	0.5
BOD_5	g O_2 / m^3	300	230	0.23
COD	g O_2 / m^3	600	450	0.25
TKN	g N / m^3	60	56	0.067
NH_4-N	g N / m^3	40	40	0
NO_2-N	g N / m^3	0	0	0
NO_3-N	g N / m^3	1	1	0
P_{tot}	g P / m^3	10	9	0.1
Alkalinity	mol HCO_3^- / m^3	= f(Drinking water) + NH_4-N		

* Short residence time

Secondary Treatment

- A Biological Process
- The objective of secondary treatment is to remove/reduce BOD using microbial action from soluble to suspended solids.

Organic Matter + Bacteria + O_2 → New Cells (Biomass) + H_2O, CO_2, NH_3



Biological wastewater treatment

Classification of biological Wastewater methods

Suspended and attached

Suspended growth process is a biological w.w.t in which microorganisms are maintained in suspension while converting organic matter to gases and cell tissue (Activated sludge).

Attached growth is a biological w.w.t in which microorganisms responsible for the conversion of organic matter to gases and cell tissue are attached to some material such as rocks, sand, or plastic (Trickling filter).

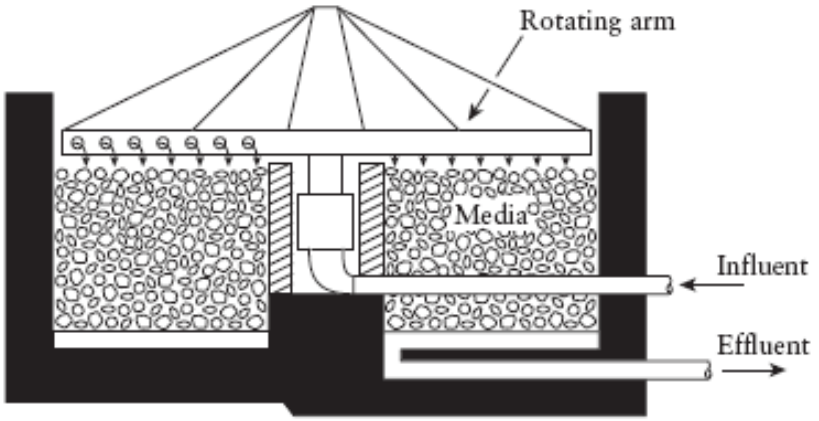
Aerobic and anaerobic

Aerobic: biological treatment is a process in which the pollutants in the waste water (organic matter) are stabilized by microorganisms in the presence of molecular oxygen

Anaerobic: biological treatment is a process in which the pollutants in the waste water (organic matter) are stabilized by microorganisms in the absence of molecular oxygen

Secondary Treatment Method

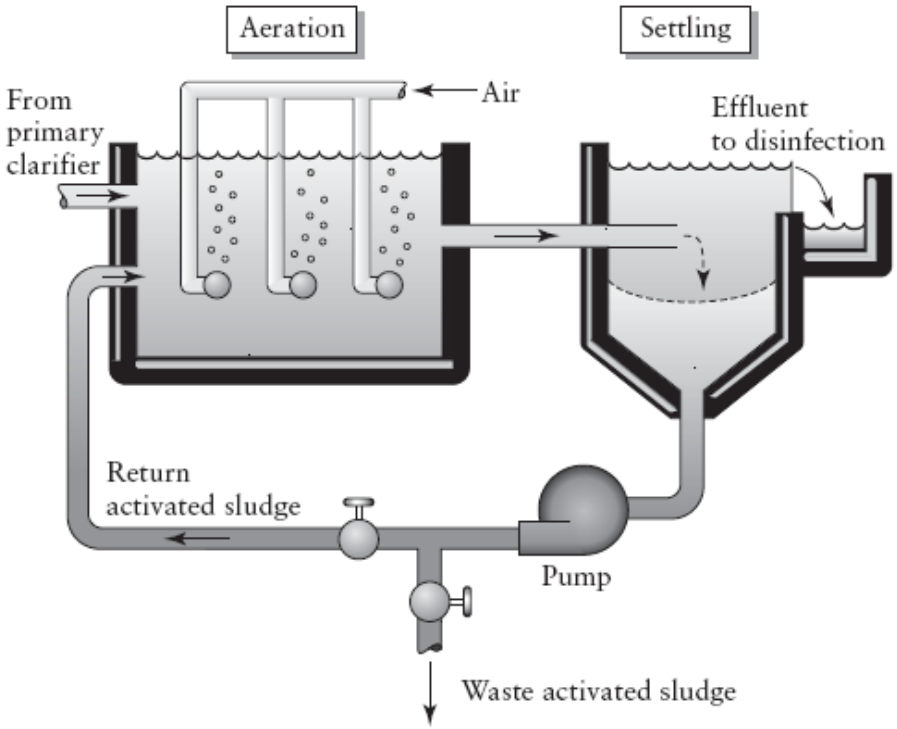
The Trickling filter



- It does not “filter” the water
- It consists of a bed of media (such as fist-sized rocks or various plastic shapes) over which the waste is trickled
- An active biological growth forms on the media, and the organisms obtain their food from the waste stream dripping over the bed.
- Air is either forced through the media
- Wastewater is sprayed and runs over a plastic media and organisms clinging to the media remove organic matter from the wastewater.

Activated sludge system

- Air is bubbled into this tank (called the *aeration tank*)
- The microorganisms use the energy and carbon by decomposing this material to CO_2 and H_2O.
- The microorganisms are separated from the liquid in a settling tank, called a *secondary* or *final clarifier*



- The separated microorganisms exist on the bottom of the final clarifier without additional food and become hungry waiting for more dissolved organic matter. These microorganisms are said to be ***activated.***

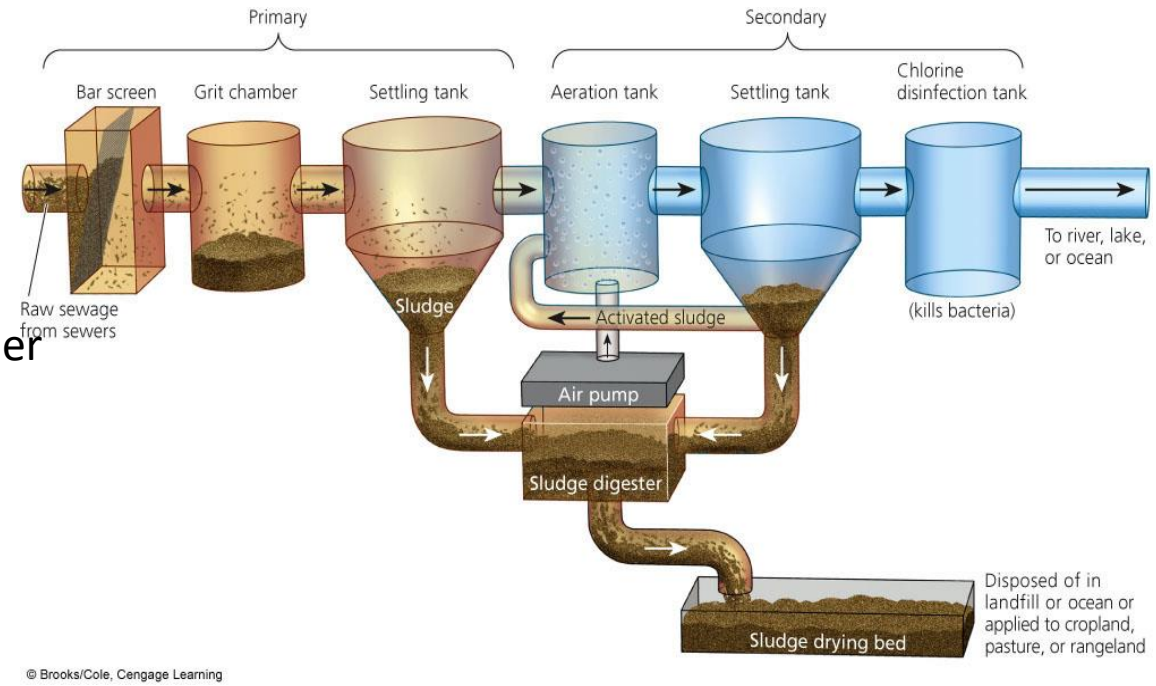
Final Clarifier

- The activated sludge process is a continuous operation
- one of the end products of this process is excess microorganisms. If the microorganisms are not removed, their concentration eventually increases to the point where the system is clogged with solids.

Sludge Sources

Sources of sludge

- Primary sedimentation tank
- Aeration basin or secondary clarifier
- Screening and grinder
- Filter backwash water



Sludge must be treated because:

- they are aesthetically displeasing,
- they are potentially harmful,
- and they contain too much water.

Sludge Types

- No two wastewater sludges are alike in all respects.
- Sludge characteristics change with time.
- There is no “average sludge.”

- **Primary sludge**
  - 3 to 8% solids
  - About 70% organic material
- **Secondary sludge**
  - Consists of wasted microorganisms and inert materials
  - About 90% organic material
  - Trickling filter sludge: 2-5% solids
- **Tertiary sludge**
  - If secondary clarifier is used to remove phosphate, this sludge will also contain chemical precipitates (more difficult to treat)
  - De-nitrification sludges -similar to WAS sludge

Sludge Treatment