Center of Excellence for Water

Wastewater Treatment Session
WEF School

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Exchange, Training, and Scholarships Pillar activities are implemented in cooperation with:

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- Vice Dean for Community Services and Environmental Development. Faculty of Engineering, Alexandria University
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- Board Member, Alexandria Water Company.
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- Former Technical Advisor to the Minister of Environment
- Former Technical Advisor to the Governor of Alexandria
- Former Executive director, Engineering Centre, Faculty of Engineering, Alexandria University, Alexandria, Egypt.
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- Consultant for Ministry of Housing, Utilities and Urban Communities - Ministry of State for Local Development - Ministry of Planning in field of Water Supply and Sanitation.
- Consultant for Industrial Development Authority in field of Water Supply and Sanitation.
- Consultant for United Nations Human Settlements Programme (N-HABITAT) in field of Water Supply and Sanitation.

Wastewater treatment plant overview

Content:

- What major pollutants are present in the wastewater.
- Why we need to treat wastewater.
- The functional units will be briefly discussed.

1. Wastewater treatment plant overview

What is wastewater and where does from?

Wastewater refers to all effluent produced by domestic and commercial properties. There are two main types of sewage: domestic and industrial sewage.

- Domestic : kitchen, bathroom and commercial institution
- Industrial institution (usually require specialized treatment process)

Why Wastewater Treatment is Essential?

- The pollutants in untreated wastewater would negatively affect our waterways and environment, causing problems like oxygen depletion in lakes, streams, and rivers. This can cause premature ageing of our lakes and numerous waterborne diseases.
- Wastewater treatment aims to reduce contaminants in the water to acceptable levels, making clean water safe for discharge. It ensures pollutants are removed to help protect the environment and public health.

Contaminants in wastewater	Description
1- organic waste	Oxygen Demanding Agents
2-Organic Chemicals	Oil, pesticides, detergents
3- Water-soluble Inorganic Chemicals	Acids, toxic metals
4- Inorganic Plant Nutrients	Nitrogen and phosphorus
5- Sediment or Suspended Material	Erosion, soil
6- pathogens	Disease-causing Agents
7- Water-soluble Radioactive Isotopes	Radon- Uranium
8- Thermal	Electric and nuclear power plants

1- Organic Wastes

- It is **matter** composed of **organic compounds** that have come from the remains of organisms such as plants and animals and their waste products in the environment.
- **Living organism** are composed of organic compounds.
- **Organic matter** is very important in the movement of nutrients in the environment and plays a role in water retention on the surface of the planet
- Organic matter is **heterogeneous** and very complex. Carbon, Oxygen , Hydrogen , Nitrogen.
- **Organic pollution** occurs when an excess of **organic** matter, such as manure or sewage, enters the **water**.

2- Organic Chemicals

- **Naturally** occurring organic chemicals produced by aquatic microorganisms.
- Industrial waste containing **artificial chemicals** flows into and contaminates many water areas.
- **Volatile organic** compounds **(VOCs),** pesticides, phenolic compounds, phthalates, and nitrogen-containing compounds, are often detected in polluted water.
- **Dioxins** and **polynuclear** aromatic hydrocarbons **(PAHs)**, produced during combustion of organic materials, are also found in surface water.
- In the WHO Guidelines for Drinking-Water Quality , levels are set for **28 organic** constituents, **33 pesticides**, and **9 disinfectant** by-products, due to their health effects on humans.

3- Water-soluble Inorganic Chemicals

- The major impurity in water are **inorganic compounds**.
- They are residuals of the more **common ions** in feed water – sodium, calcium, iron, magnesium, chloride, sulphate, nitrate – and ions weakly held on ion-exchange resin – silicates and borates.
- **Bicarbonate ions** will usually be present, as well, produced by the dissolution of atmospheric CO_2 in the product water on exposure to the environment.
- The universal method of monitoring for ionic impurities in purified water is by measuring its **electrical conductivity/resistivity**.

Cont'd 3- Heavy Metals

- **Metallic elements** having a density greater than 5 g/cm^3
- Most are extremely **toxic**
- Water soluble
- Readily absorbed into plant or animal tissue (**Bio-concentrate)**
- Combine with **biomolecules:**
    1. Proteins
    2. Nucleic acids

4- Nutrients

The primary sources of excess nitrogen and phosphorus are:

- **Agriculture**: The nitrogen and phosphorus in animal manure and chemical fertilizers are necessary to grow crops.
- **Stormwater**: When precipitation falls on our cities and towns it runs across hard surfaces including nitrogen and phosphorus
- **Wastewater**: Our sewer and septic systems are responsible for treating large quantities of waste, and these systems do not always operate properly or remove enough nitrogen and phosphorus before discharging into waterways.
- **Fossil Fuels**: Electric power generation, industry, transportation and agriculture have increased the amount of nitrogen in the air through use of fossil fuels.
- **Around the Home**: Fertilizers, yard and pet waste and certain soaps and detergents contain nitrogen and phosphorus, and can contribute to nutrient pollution if not properly used or disposed.

5-Sediment or Suspended Material

- **Solids normally contain** 99.9 % water and only 0.1 % of total solids present in the sewage may be in any of the four:
  1. suspended solids,
  2. dissolved solids,
  3. colloidal solids,
  4. and settleable solids.
- **Excessive suspended sediment** can impair water quality for aquatic and human life, impede navigation and increase flooding risks
- **Sedimentation** is a physical water treatment process used to settle out suspended solids in water under the influence of gravity. Sedimentation is often used as a primary stage in modern waste water treatment plant, reducing the content of suspended solids as well as the pollutant embedded in the suspended solids.

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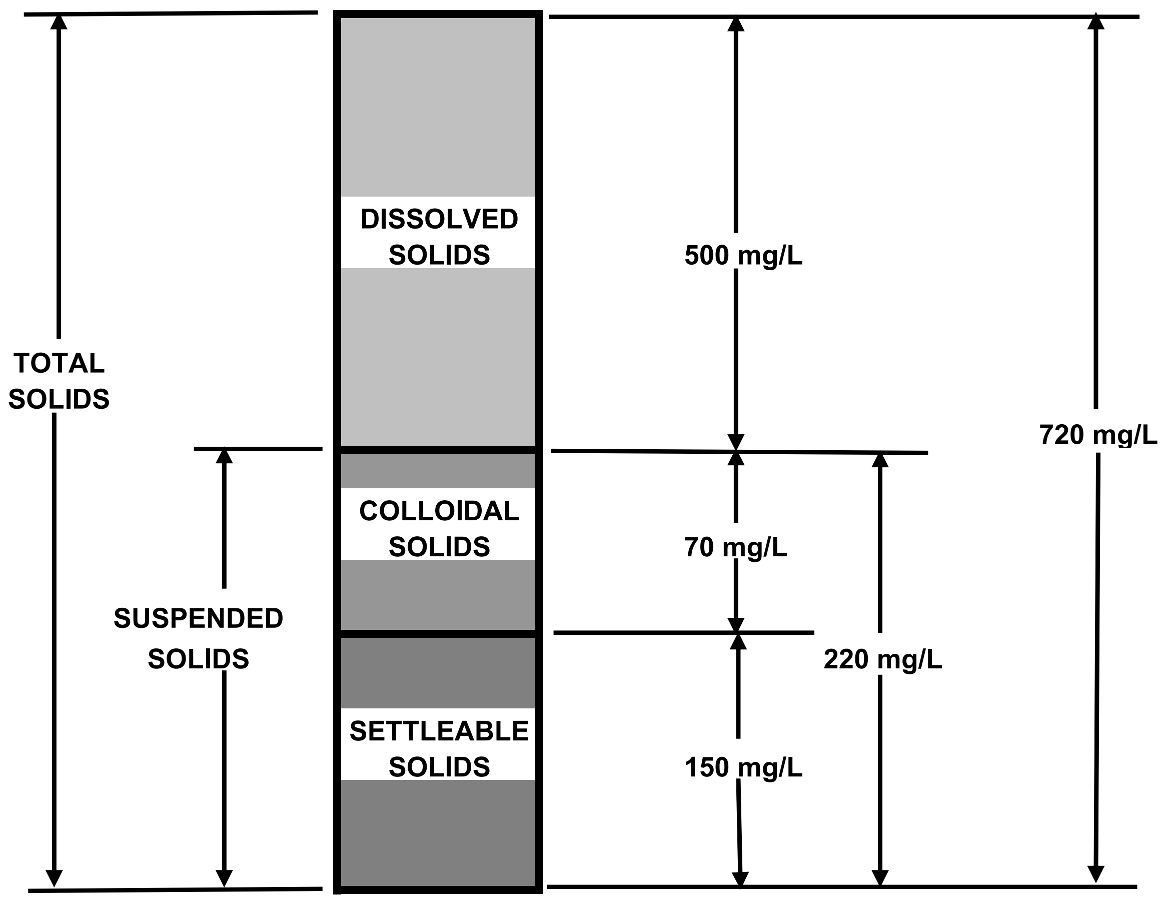
What are Total Suspended Solids?

- Total suspended solids **(TSS)** are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns (average filter size) is considered a dissolved solid.

- Both **organic and inorganic** particles of all sizes can contribute to the suspended solids concentration.

- Some **suspended solids** can settle out into sediment at the bottom of a body of water over a period of time

Typical Composition of Solids in Raw Wastewater



6- pathogens

- Microbial pathogens are among the major health problems associated with water and wastewater
- The most common infectious waterborne diseases are microbial, such as bacterial, viral, protozoa, and helminths infections.

Pathogen: organism that causes diseases

1. Bacteria
2. Viruses

1. **Bacteria :**
   - Living single organisms, spherical, cylindrical and helical
   - Some of them are pathogen, Vibrio, salmonella Shigella and E-coli.
2. **Viruses:**
   - H1N1, H5N1. Hepatitis A, Hepatitis B,C, HIV.

7- Water-soluble Radioactive Isotopes

Sources:

- Two main sources of water-soluble radioactive isotopes: Medical and Waste
- Medically, they can be injected/inhaled into the body, where most of the time the radioactive isotopes are flushed out through the body.
- Half-lives and the ways of decay of the radioactive isotopes determine how dangerous they are to humans

Negatives:

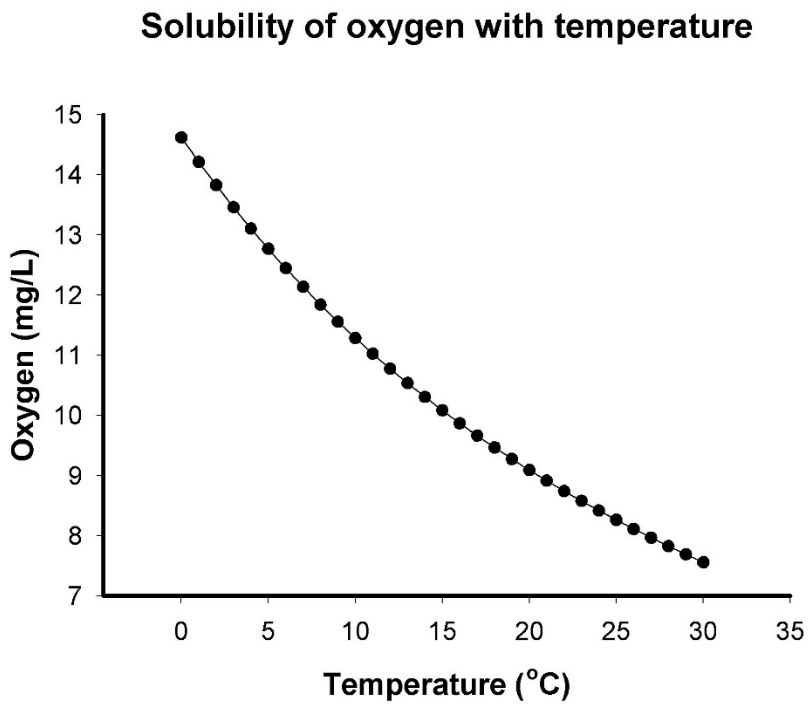
- Can lead to: lung cancer, damage to liver, thyroid cancer, cancer in the blood or bones, asthma, and kidney damage.
- Internal/external contamination can lead to tissue damage

Example:

- Radon- Uranium

8-Thermal

- A common cause of **thermal pollution** is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment
- At a higher **temperature**, the sudden change in **temperature** decreases oxygen supply and affects ecosystem composition.



Effects of Wastewater Discharges

- Oxygen depletion and odor in stream

  DO depends on temperature and flow

  - Cold water can retain MORE dissolved oxygen
  - Warm water can retain LESS
  - Turbulent flow adds more oxygen
  - For aquatic life, DO should be at least 5 mg/L
- Negative human health effects
- Sludge and scum accumulations

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Wastewater Treatment Processes

Preliminary Treatment

- Screening
- Grit removal
- Pre-Aeration
- Flow Metering and Sampling

Primary Treatment

- Sedimentation and Flotation

Secondary Treatment

- Biological Treatment
- Sedimentation

Tertiary (Advanced) Treatment

- Chemical Phosphorous Removal
- Biological Nutrient Removal
- Multimedia Filtration

Disinfection

Solids Treatment

- Digestion
- Disposal

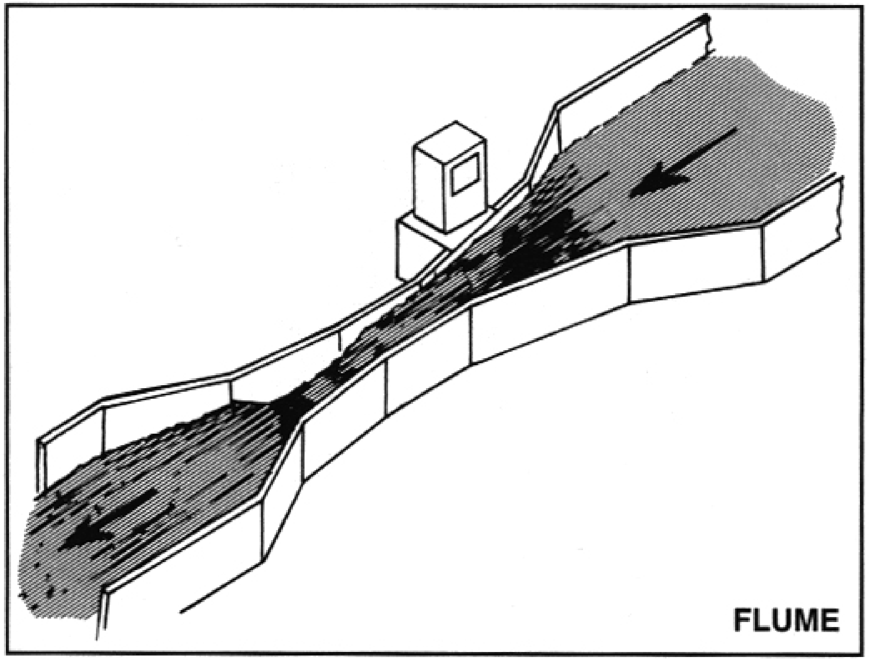
Wastewater Treatment Processes

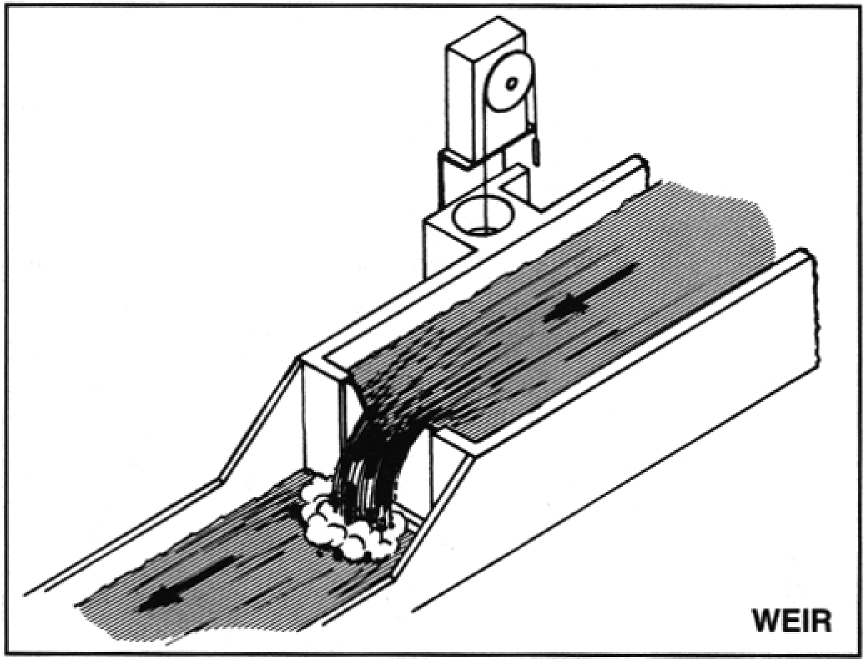
Preliminary Treatment → Primary Treatment → Secondary Treatment → Tertiary (Advanced) Treatment → Disinfection

Solids Treatment

- Flow Metering and Sampling
- Screening
- Grit removal
- Pre-Aeration

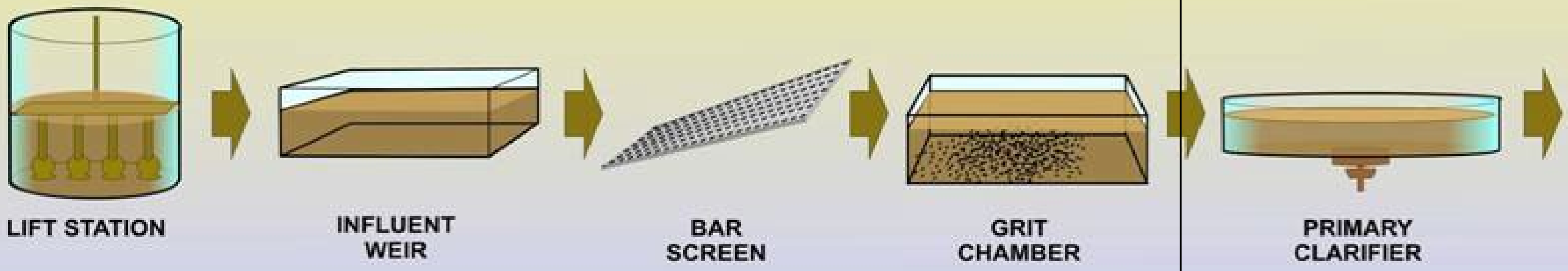
Flow Metering





Flow metering is important as discharge quality limits are based on flow ratio to stream flow.

Preliminary and Primary Treatment



Wastewater Treatment Processes

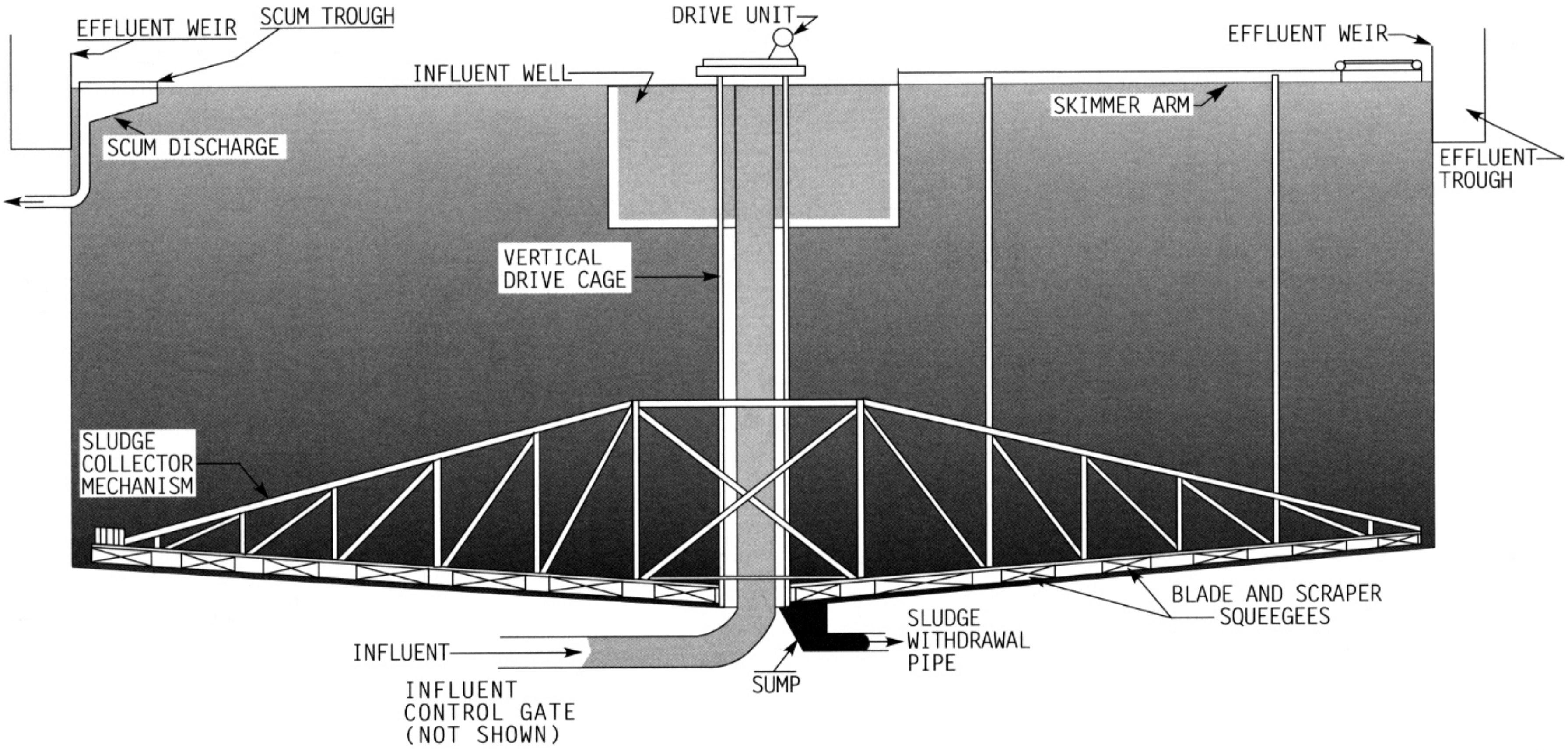
Preliminary Treatment → **Primary Treatment** → Secondary Treatment → Tertiary (Advanced) Treatment → Disinfection

Solids Treatment

Primary Treatment

- Sedimentation and Flotation

Primary Clarifier



Wastewater Treatment Processes

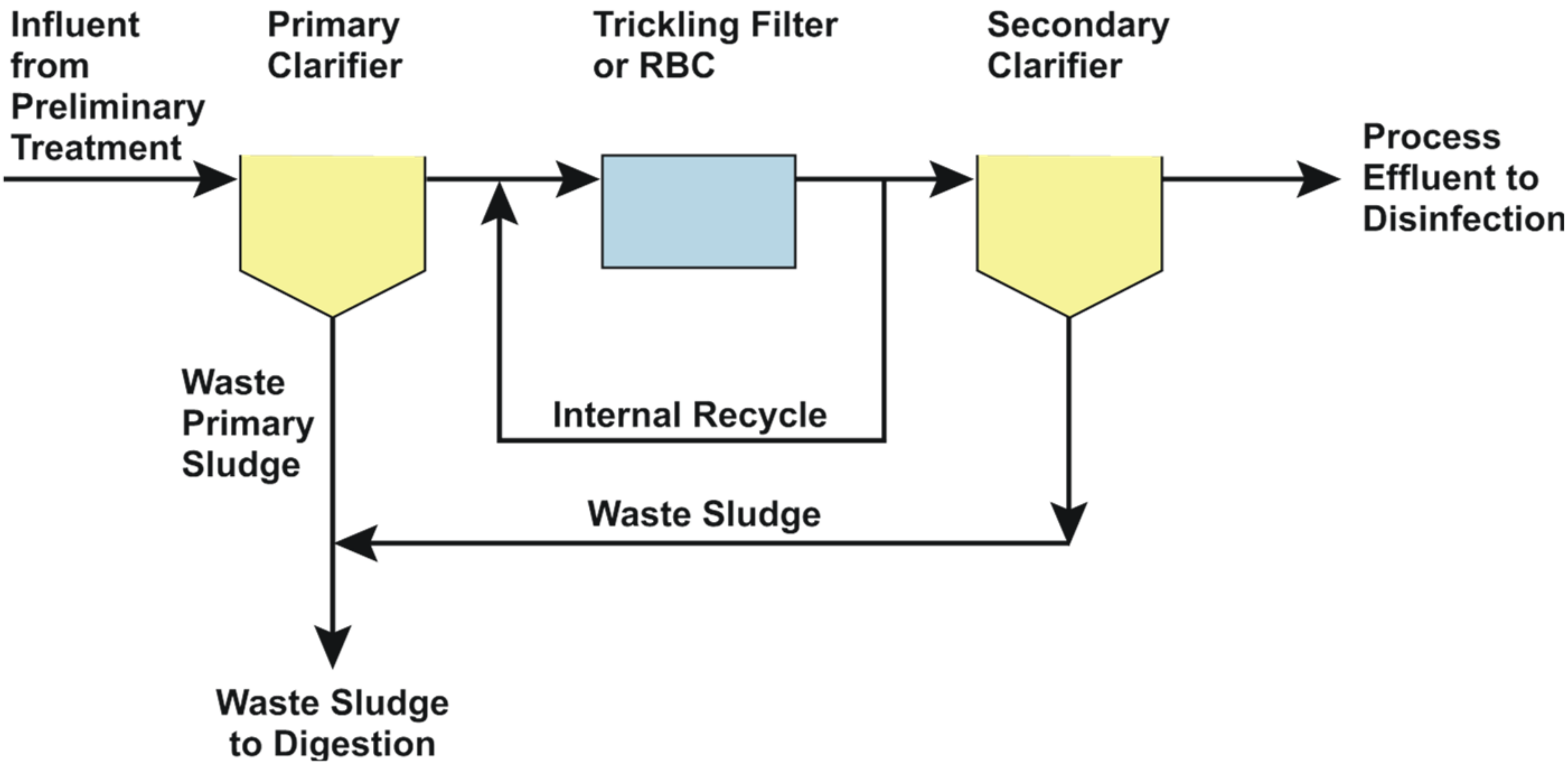
Preliminary Treatment → Primary Treatment → **Secondary Treatment**

- Biological Treatment
- Sedimentation

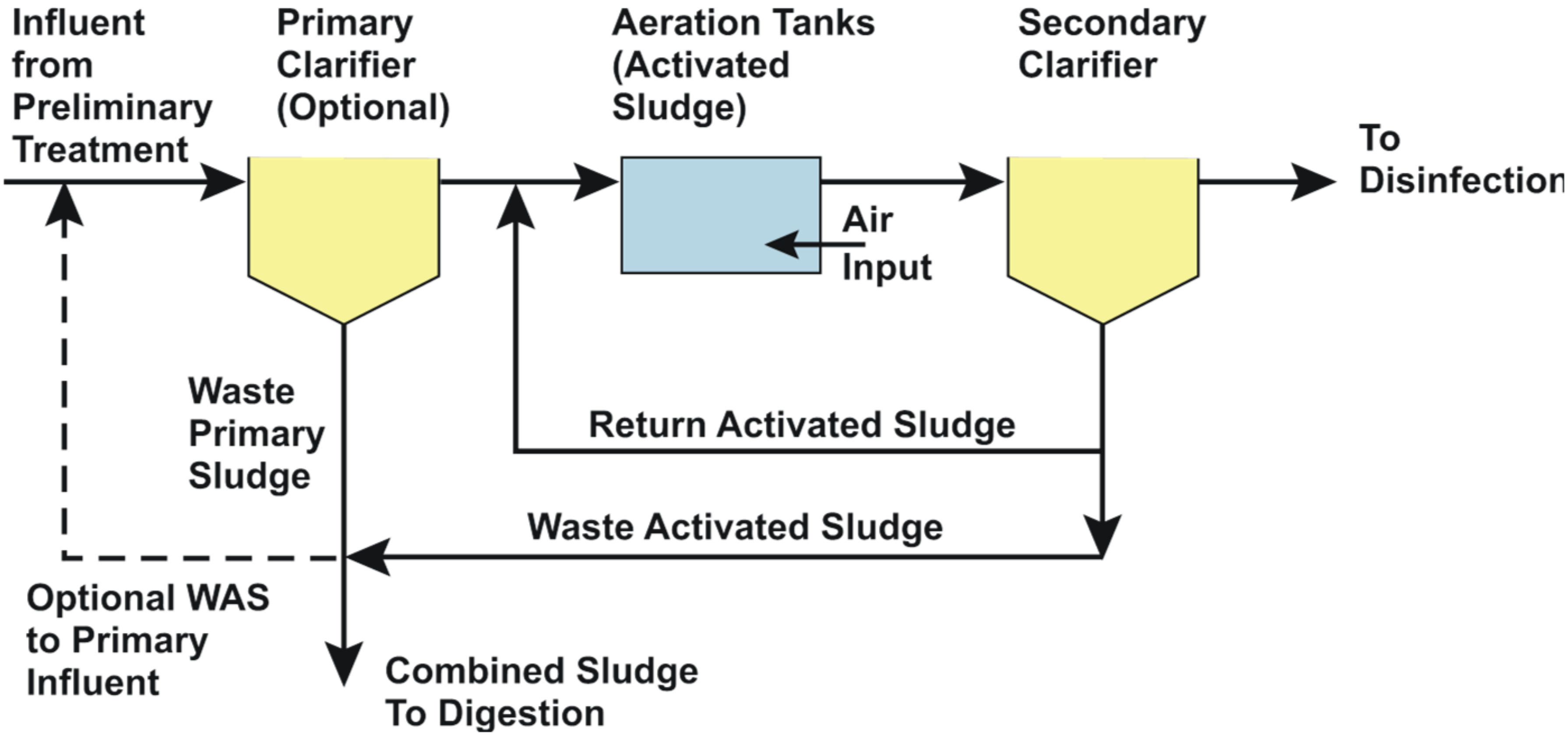
→ Tertiary (Advanced) Treatment → Disinfection

Solids Treatment

Attached Growth Biological Treatment Process



Suspended Growth Process Schematic



Wastewater Treatment Processes

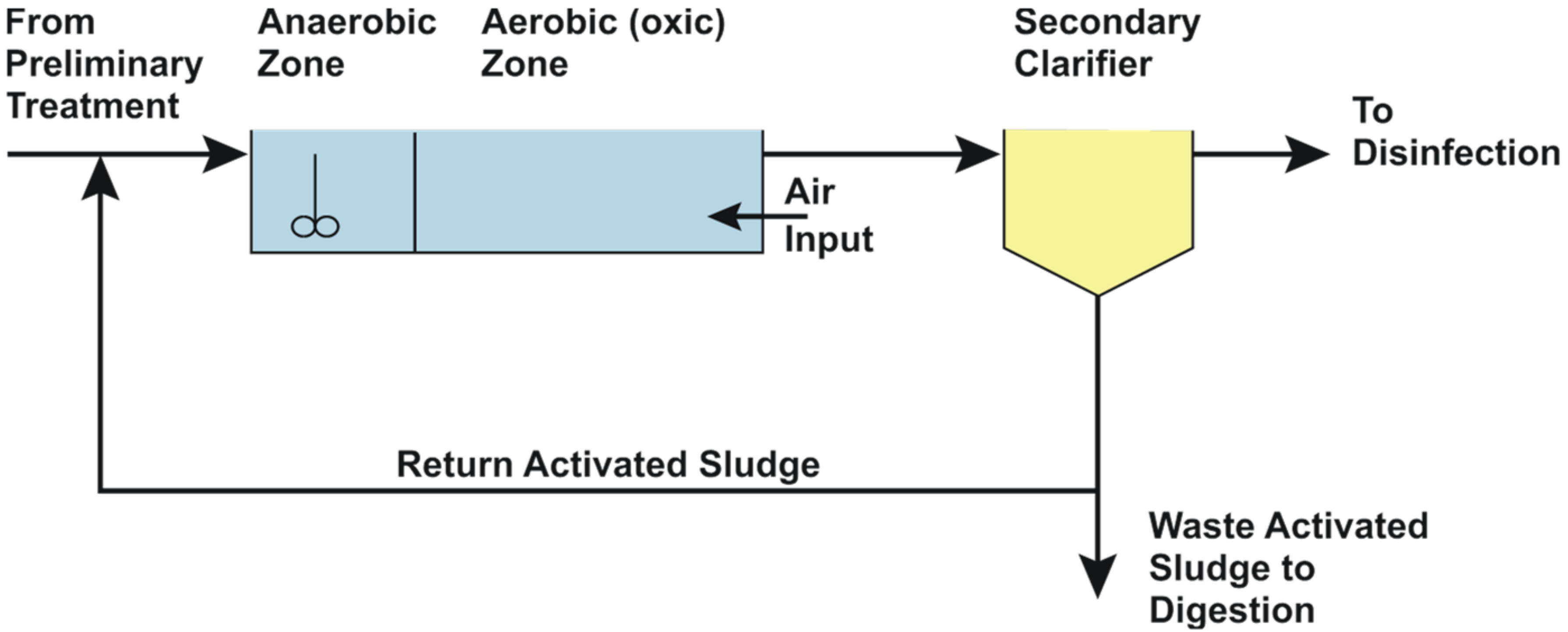
Preliminary Treatment → Primary Treatment → Secondary Treatment → **Tertiary (Advanced) Treatment** → Disinfection

Solids Treatment

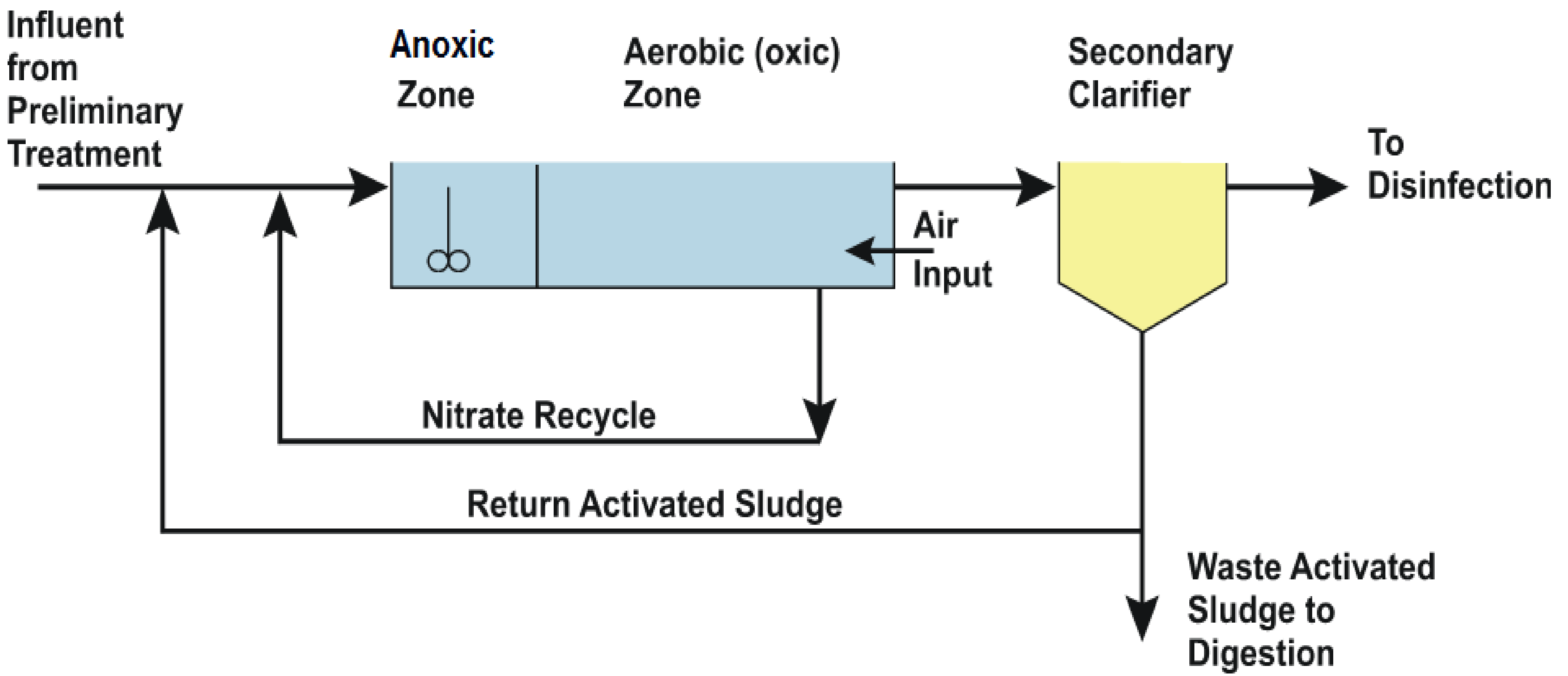
Tertiary (Advanced) Treatment

- Chemical Phosphorous Removal
- Biological Nutrient Removal
- Multimedia Filtration

Biological Phosphorus Removal Schematic



Denitrification Process Schematic



Wastewater Treatment Processes

Preliminary Treatment → Primary Treatment → Secondary Treatment → Tertiary (Advanced) Treatment → **Disinfection**

Solids Treatment

Disinfection

- Necessary to reduce disease causing pathogens
- Majority of plants use some form of chlorination
- Ultra-violet light disinfection becoming more popular due to security and safety issues with chlorine

Solids Treatment

Primary Treatment

Secondary Treatment

Solids Treatment

- Digestion
- Disposal

Solids Management - STABILIZATION

- Digestion
  - Aerobic and anaerobic treatment
- Incineration
- Wet Oxidation
- Lime Stabilization
- Post Lime Stabilization
- Dewatering

Conventional WWTP Design

Contents

- Basic principles of WWTP design.
- General issues in WWTP design.
- Conventional WWTP design.
  - ✓ Pretreatment.
  - ✓ Primary treatment.
  - ✓ Secondary treatment.
  - ✓ Tertiary treatment.

Conventional WWTP Design

Basic principles of WWTP design

- Wastewater characteristics.
- Treated water quality requirements.
- Geographical constraints.
- Social and environmental constraints.
- Economic constraints.
- Available technologies.

Conventional WWTP Design

Wastewater characteristics

- Quantitative characteristics.
  - ✓ Design flowrates. Average, peak and maximum flowrate in rain periods.
  - ✓ Seasonal variation of flowrates.
  - ✓ Estimated future flows.
- Qualitative characteristics.
  - ✓ BOD_5, COD, TSS.
  - ✓ Ph, alkalinity.
  - ✓ N, P.

Conventional WWTP Design

Treated water quality requirements

- Final use of treated water.
- Characteristics of environment.
- Legal constraints.

Conventional WWTP Design

Geographical constraints

- Land availability.
- Relative location of wastewater sources.
- Climatic constraints.

Conventional WWTP Design

Social and environmental constraints

- Proximity to residential areas.
- Measures in order to reduce adverse effects on the environment.
  - ✓ Noise.
  - ✓ Odors.
- Landscape integration.
- Legal constraints.

Conventional WWTP Design

Economic constraints

- Construction costs.
- Operating and maintenance costs.
  - ✓ Annual O&M cost.
  - ✓ Future replacement of equipment.
  - ✓ Implement systems to guarantee income for future operation and maintenance.

Conventional WWTP Design

Available technologies

- Evaluating unit operations and processes.
- Selecting appropriate technologies.
  - ✓ Personnel requirements.
  - ✓ Operation complexity.

Conventional WWTP Design

General issues in WWTP design

- Construction.
- Operation and maintenance.
- Safety of staff.
- Other issues.

Conventional WWTP Design

General issues in WWTP design

- Construction:
  - ✓ Mechanical resistance.
  - ✓ Impermeability of elements.
  - ✓ Structural stability.
  - ✓ Materials resistant to corrosive environments.

Conventional WWTP Design

General issues in WWTP design

- Operation and maintenance:
  - ✓ Several parallel facilities for each process.
  - ✓ Inlet and outlet gates or valves to remove elements from service for maintenance.
  - ✓ Dewatering of tanks and other elements.
  - ✓ Interchangeability of equipment.
  - ✓ Measurement and registration of flowrates.

Conventional WWTP Design

General issues in WWTP design

- Safety of staff.
  - ✓ Avoid, if possible, confined spaces.
  - ✓ Gas monitoring equipment.
  - ✓ Ventilation.
  - ✓ Fences and walls.

Conventional WWTP Design

General issues in WWTP design

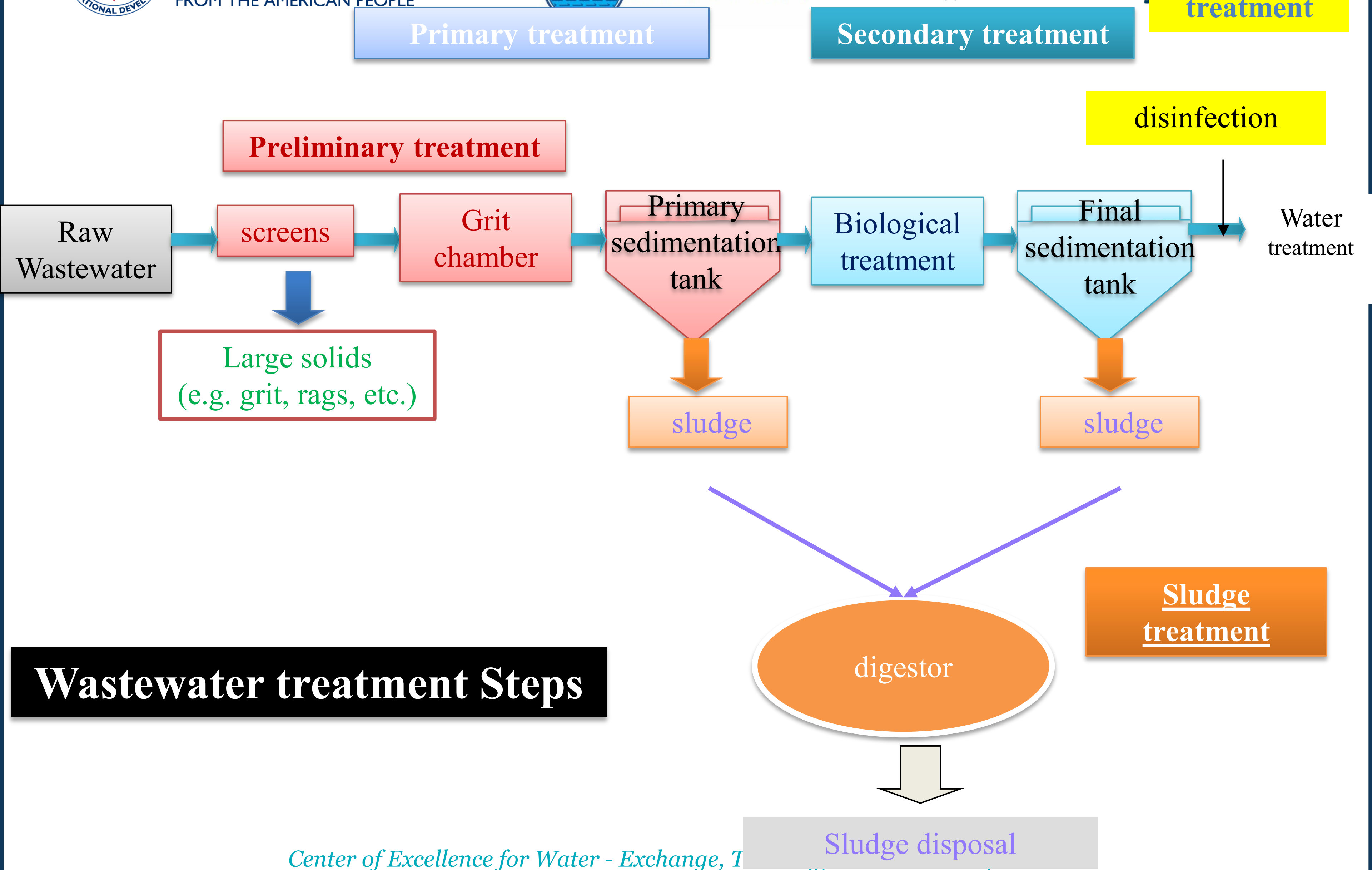
- Other issues.
  - ✓ Odor treatment systems.
  - ✓ Noise reduction.
  - ✓ Energy efficiency.
  - ✓ Emergency electric power generation.
  - ✓ Future treatment needs.

Conventional WWTP Design

Conventional WWTP design

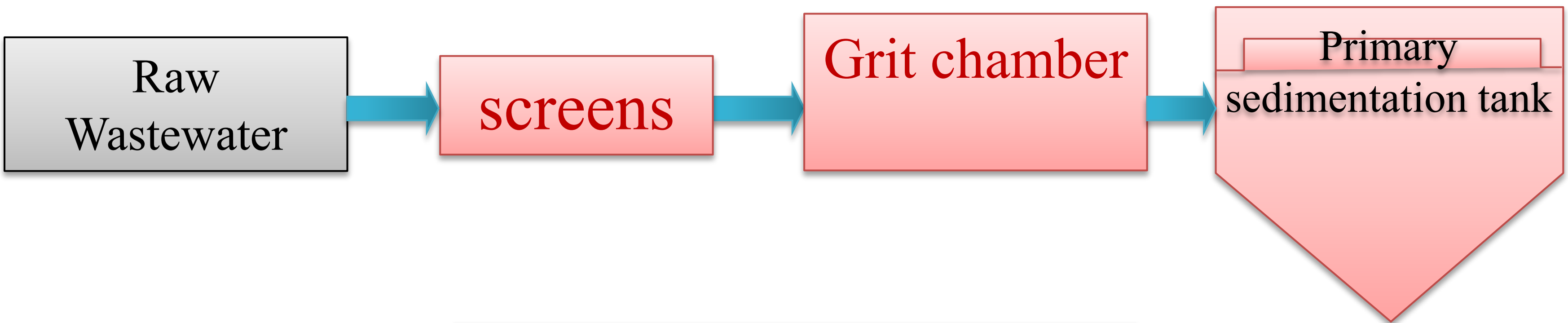
- Basic treatments.
  - ✓ Wastewater treatments.
  - ✓ Sludge treatments.
  - ✓ Gas treatments.

Wastewater treatment Steps

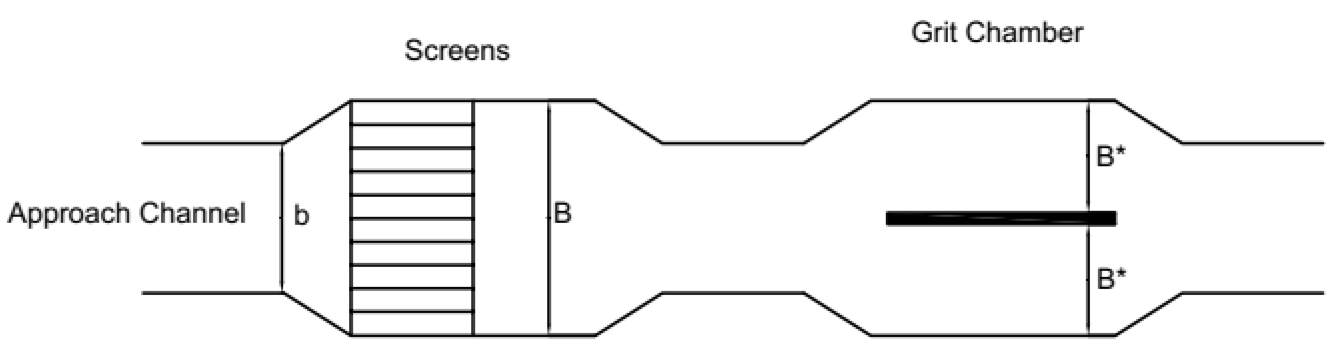


Primary treatment

Preliminary treatment



Preliminary treatment



Primary treatment Design

1) Approach Channel

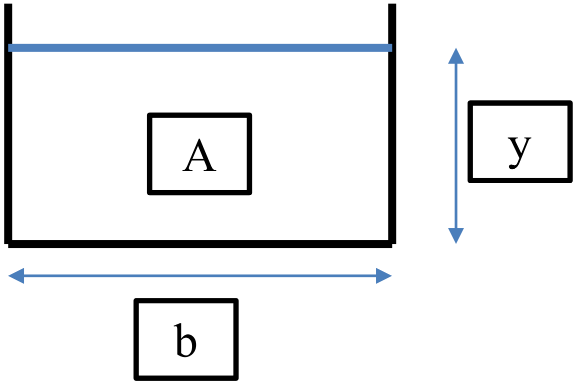
- $A = \frac{Q_{max}}{V} = \checkmark\checkmark\ m^2$
- For B.H.S (Best Hydraulic Section)
- $A = b * y$ ➡ $\because\ b = 2y$
- $\therefore A = 2\ y^2$
- $\therefore y = \checkmark\checkmark\ m$ $\quad \therefore b = \checkmark\checkmark\ m$

Design Criteria

- ✓ $V = 0.6\ m / sec$
- ✓ $Q_d = Q_{max}$

For B.H.S

- ✓ $b = 2\ y$



b	=	✓	m
y	=	✓	m

2) Screens

- Anet = 3 Aapp

- $L = \dfrac{y+0.1}{\sin\theta}$

- $a_1 = S * L = \dfrac{y+0.1}{\sin\theta} * S$

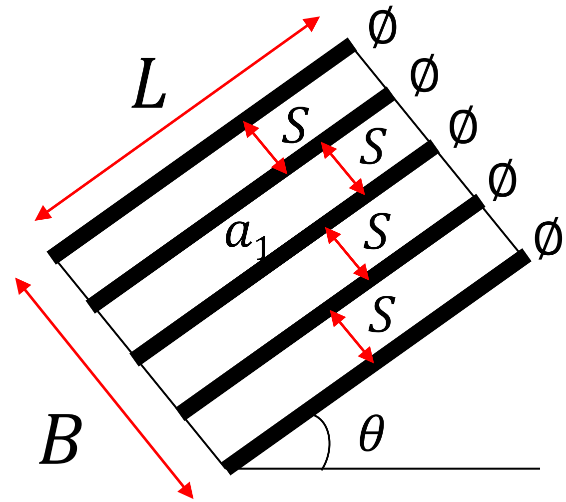
- $N_{spacing} = \dfrac{A_{net}}{a_1}$

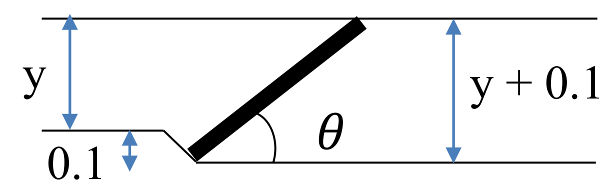
- $N_{bars} = N_{spacing} + 1$

- $B = N_{spacing} * S + N_{bars} * \emptyset$

Design Criteria

- ✓ Anet = 3 Aapp
- ✓ $\emptyset$ = 1.6 cm
- ✓ S = 4 cm
- ✓ $\theta = 45 - 60°$





B = ✓ m

3) Grit Chamber

- $Vol = Qmax * D.t \quad = \checkmark \ m^3$

  ↳ 60 sec

- $A = \dfrac{Qmax}{O.F.R} \quad = \checkmark \ m^2$

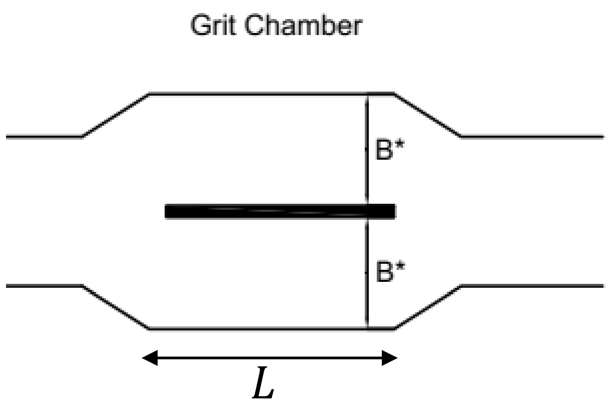
- $d = \dfrac{Vol}{A} \quad = \checkmark \ m$

- $L = V * D.t \quad = 0.3 * 60 = 18 \ m$

- $B^* = \dfrac{A}{2 * L} = \quad \checkmark \ m$

Design Criteria

- ✓ D.t = 60 sec
- ✓ V = 0.3 m / sec
- ✓ O.F.R = 1200 $m^3/m^2/day$



B^* =	✓	m
L =	✓	m
d =	✓	m

Design of Primary Sedimentation tank

Design

1) $Q_d = Q_{avg}$

2) $Vol = Q_{avg} * D.t$ → 3 hr

3) $A = \frac{Q_{m.m}}{O.F.R}$ → 30 $m^3/m^2/day$

4) $d_s = \frac{Vol_s}{A_s}$

Design Criteria

✓ D.t = 2 – 4 hr

✓ O.F.R = 20 – 40 $m^3/m^2/day$

Rectangular	Circler
$L_s = 4 B_s$	
$L_s \ngtr 40\ m$	$D \ngtr 40\ m$
$B_s \ngtr 10\ m$	

A

Rectangular

5) Assume $L_s = 40$ m & $B_s = 10$ m ➡ $a_{one} = 400\ m^2$

6) $N = \frac{A_s}{a_{one}} = ✓ \approx$ يقرب للاكبر $= N_{act}$

7) $a_{act} = \frac{A_s}{N_{act}} = L_s * B_s = 4 B_s^2$

$B_s =$ ✓ & $L_s = 4 B_s =$ ✓

Circler

5) Assume D = 40 m ➡ $a_{one} = 1256\ m^2$

6) $N = \frac{A_t}{a_{one}} = ✓ \approx$ يقرب للاكبر $= N_{act}$

7) $a_{one} = \frac{A_t}{N_{act}} = \frac{\pi D_t^2}{4}$ ➡ D = ✓

Example

A city with a population of 500,000 Capita, water consumption (q) = 200 L/capita/day, it's required to design the unites of the primary treatment.

1) Screens,
2) Grit Champers,
3) primary sedimentation tank.

- **annual average wastewater flow ($Qavg_{w.w}$):**

$$Qavg_{w.w} = 0.85 * Qavg\ water = 0.85 * P * q$$

$$Qavg_{w.w} = 0.85 * 500{,}000 * 0.2 = 85{,}000\ m^3\ /day$$

P > 80,000

$$Qmax_D = \left(1 + \frac{14}{4 + \sqrt{\frac{100{,}000}{1000}}}\right) x\ 85{,}000 = 130{,}143\ m^3\ /day$$

$$Qmax = Qmax_D = 130{,}143\ m^3\ /day$$

$= 5{,}423\ m^3\ /hr$
$= 90.38\ m^3\ /min$
$= 1.51\ m^3\ /sec$

Primary treatment Design

1) Approach Channel

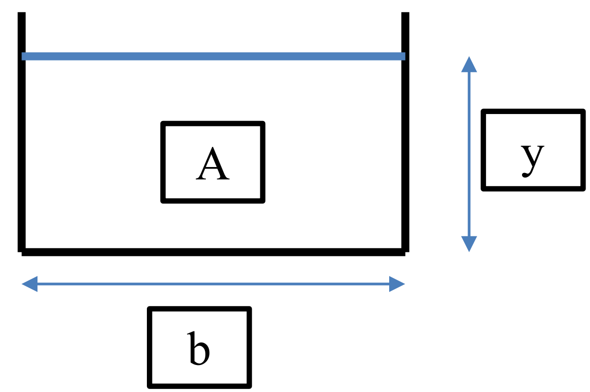
- $A = \frac{1.51}{0.6} = 2.52 \ m^2$
- For B.H.S (Best Hydraulic Section)
- $A = b * y$ ➡ $\because \ b = 2y$
- $\therefore A = 2 \ y^2 = 2.52$
- $\therefore y = 1.15 \ m \quad \therefore b = 2.3 \ m$

Design Criteria

- ✓ $V = 0.6 \ m / sec$
- ✓ $Q_d = Q_{max}$

For B.H.S

- ✓ $b = 2 \ y$



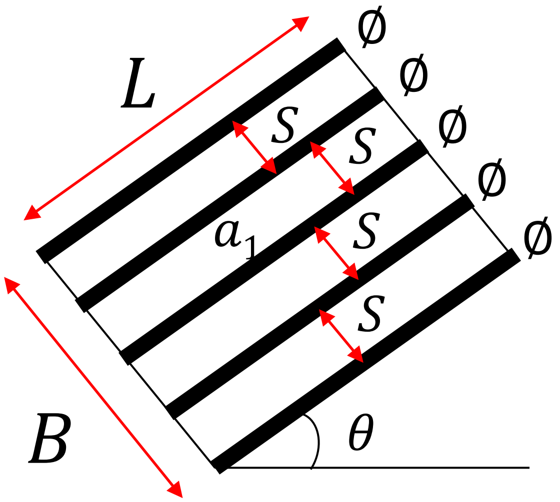
b	=	2.3	m
y	=	1.15	m

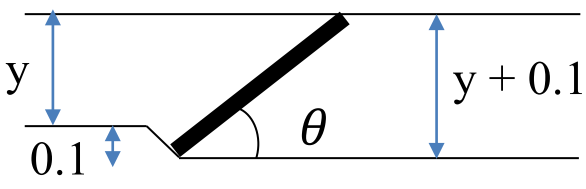
2) Screens

- $A_{net} = 3\ A_{app} = 3*1.15*2.3 = 7.935\ m^2$
- $a_1 = 0.04 * \frac{1.15+0.1}{\sin 60} = 0.058$
- $N_{spacing} = \frac{7.935}{0.058} = 138$
- $N_{bars} = 138 + 1 = 139$
- $B = 138 * 0.04 + 139 * 0.016 = 7.75$

Design Criteria

- ✓ $A_{net} = 3\ A_{app}$
- ✓ $\varnothing = 1.6$ cm
- ✓ $S = 4$ cm
- ✓ $\theta = 45 - 60°$





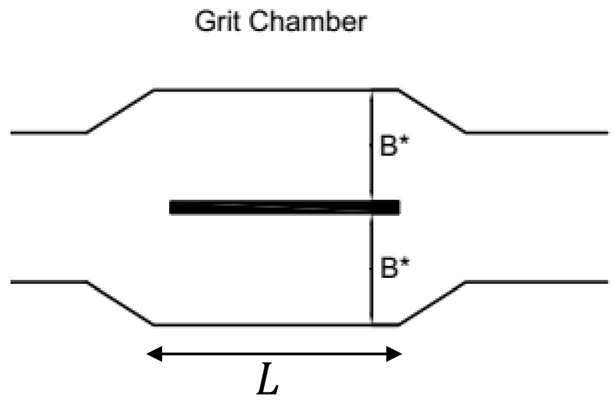
B = 7.75 m

3) Grit Chamber

- $Vol = 1.51 * 60 = 90.6\ m^3$
- $A = \dfrac{130,143}{1200} = 108.5\ m^2$
- $d = \dfrac{90.6}{108.5} = 0.84\ m$
- $L = V * D.t = 0.3 * 60 = 18\ m$
- $B^* = \dfrac{108.5}{2 * 18} = 3\ m$

Design Criteria

- ✓ $D.t = 60$ sec
- ✓ $V = 0.3$ m / sec
- ✓ $O.F.R = 1200\ m^3/m^2/day$



$B^* = 3$ m
$L = 18$ m
$d = 0.84$ m

Design of Primary Sedimentation tank

Design

1) $Q_d = Q_{avg} = 85{,}000\ m^3/day$

2) $Vol = 85{,}000 * \frac{3}{24} = 10{,}625\ m^3$

3) $A = \frac{85{,}000}{30} = 2{,}833\ m^2$

4) $d = \frac{10{,}625}{2{,}833} = 3.75\ m$

5) Assume $L_s = 40\ m$ & $B_s = 10\ m$ ➡ $a_{one} = 400\ m^2$

6) $N = \frac{2{,}833}{400} = 7.08 \approx 8 = N_{act}$

7) $a_{act} = \frac{2{,}833}{8} = L_s * B_s = 4\,B_s^2$

$B_s = 9.4$ & $L_s = 37.6$

Design Criteria

D.t = 2 – 4 hr

O.F.R = 20 – 40 $m^3/m^2/day$

Rectangular

$L_s = 4\,B_s$

$L_s \ngtr 40\ m$

$B_s \ngtr 10\ m$

Bs =	9.4	m
Ls =	37.6	m
ds =	3.75	m
N =	8	tank

Secondary treatment

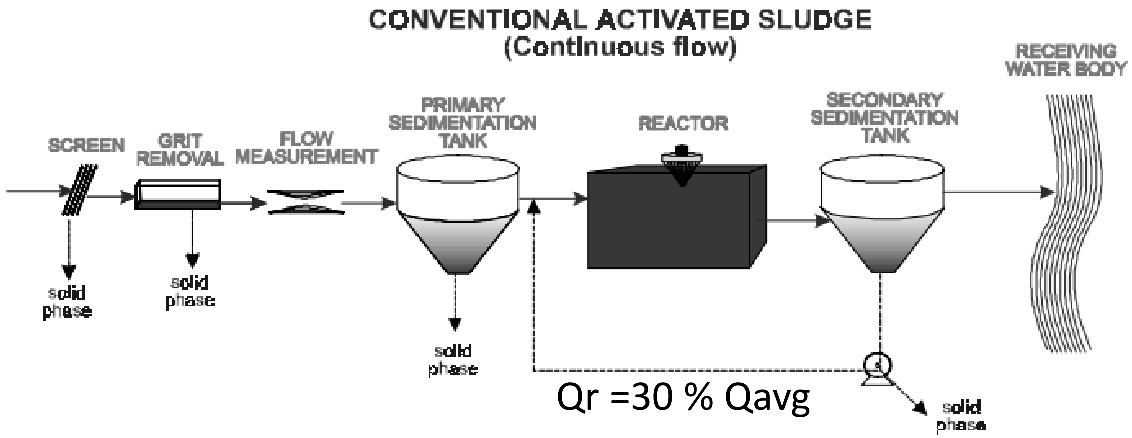
Biological treatment → Final sedimentation tank →

Biological treatment

1) Activated Sludge

2) Trickling Filter

1) Activated Sludge



Design

1) $Qd = Q_{avg}$

2) $Vol = Q_{avg} * D.t$ → 8 hr

3) Check O.L.R

$$O.L.R = \frac{Qavg * Bod_{in}}{Vol}$$ ➡ $Bod_{in} = 0.7\ Bod_{raw}$

4) Assume L = 90 m & B = 5 m & d = 4 m

5) $N = \frac{Vol}{L * B * d} = \checkmark \approx$ يقرب للأكبر $= N_{act}$

6) $L_{act} = \frac{Vol}{N_{act} * B * d}$

Design Criteria

D.t = 6 – 12 hr

O.L.R ≤ 560 gm $Bod/m^3/day$

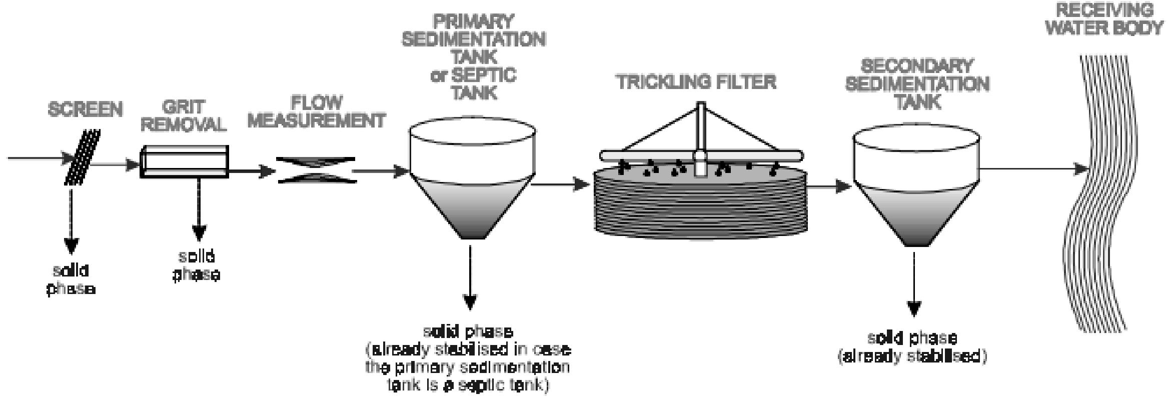
L = 30 – 120 m

B = 5 m

d = 4 m

N =	✓	tank
L =	✓	m
B =	5	m
d =	4	m

2) Trickling Filter



Design

1) $Qd = Q_{avg}$

2) $Vol = \dfrac{Qavg * Bod_{in}}{O.L.R}$ ➡ $Bod_{in} = 0.7\ Bod_{raw}$

O.L.R → 120 gm Bod/m3/day

3) $A = \dfrac{Qavg}{H.L.R}$

H.L.R → 3 m3/m2/day

4) $d = \dfrac{Vol}{A}$

5) Assume D = 40 m ➡ $a_{one} = 1256\ m2$

6) $N = \dfrac{A}{a_{one}} = \checkmark \approx$ يقرب للأكبر $= N_{act}$

7) $a_{act} = \dfrac{A}{N_{act}} = \dfrac{\pi D_t^{\,2}}{4}$ ➡ $D = \checkmark$

Design Criteria

$H.L.R = 2 - 4.5\ m^3/m^2/day$

$O.L.R = 60 - 180\ gm\ Bod/m^3/day$

$D \ngtr 40\ m$

N = ✓ tank
D = ✓ m
and d = ✓ m

Design of Final Sedimentation tank

Design

1) $Q_d = Q_{avg}$

2) $Vol = Q_{avg} * D.t$ → 3 hr

3) $A = \frac{Q_{avg}}{O.F.R}$ → $30\ m^3/m^2/day$

4) $d_s = \frac{Vol_s}{A_s}$

5) Assume $D = 40\ m$ ➡ $a_{one} = 1256\ m^2$

6) $N = \frac{A_t}{a_{one}} = \checkmark \approx$ يقرب للاكبر $= N_{act}$

7) $a_{one} = \frac{A_t}{N_{act}} = \frac{\pi D^2}{4}$ ➡ $D = \checkmark$

Design Criteria

$D.t = 2 - 4\ hr$

$O.F.R = 20 - 40\ m^3/m^2/day$

$D \ngtr 40\ m$

$N = \checkmark$ tank

$D = \checkmark$ m

$d_s = \checkmark$ m

Example

Raw sewage with a BOD concentration = 200 gm/m^3 , Design the following system to treat this wastewater if Q = 8,000 m^3/day .

1) Activated Sludge System
2) Trickling Filter System

1) Activated Sludge

Design

1) $Vol = 8{,}000 * \frac{8}{24} = 2667 \ m^3$

2) Check O.L.R ➡ $Bod_{in} = 0.7 \ Bod_{raw} = 0.7 * 200 = 140$

$$O.L.R = \frac{8000 * 140}{2667} = 420 \leq 560 \ gm \ Bod/m^3/day$$ OK

4) Assume L = 90 m & B = 5 m & d = 4 m

5) $N = \frac{2667}{90*5*4} = 1.48 \approx 2 = N_{act}$

6) $L_{act} = \frac{2667}{2*5*4} = 66.7 \ m$

Design Criteria

D.t = 6 – 12 hr

O.L.R $\leq$ 560 gm Bod/m^3/day

L = 30 – 120 m

$B = 5 \ m$

$d = 4 \ m$

N = 2 tank
L = 66.7 m
B = 5 m
d = 4 m

2) Trickling Filter

Design

1) $\text{Vol} = \dfrac{8000 * 140}{120} = 9333 \text{ m}^3$

2) $A = \dfrac{8000}{3} = 2667 \text{ m}^2$

4) $d = \dfrac{9333}{2667} = 3.5 \text{ m}$

5) Assume $D = 40$ m ➡ $a_{one} = 1256$ m2

6) $N = \dfrac{2667}{1256} = 2.12 \approx 3 = N_{act}$

7) $a_{act} = \dfrac{2667}{3} = \dfrac{\pi D^2}{4}$ ➡ $D = 33.65$ m

Design Criteria

H.L.R = 2 – 4.5 $m^3/m^2/day$

O.L.R =60 - 180 gm Bod/m^3/day

D $\ngtr 40\ m$

N = 3 tank
D = 33.65 m
d = 3.5 m

Design of Final Sedimentation tank

Design

1) $Vol = 8{,}000 * \frac{3}{24} = 1{,}000\ m^3$

2) $A = \frac{8{,}000}{30} = 266.7\ m^2$

3) $d = \frac{1000}{266.7} = 3.75$

4) Assume $D = 40\ m$ ➡ $a_{one} = 1256\ m^2$

5) $N = \frac{266.7}{1256} = 0.21 \approx 1 = N_{act}$

6) $a_{one} = \frac{266.7}{1} = \frac{\pi D_t^{\ 2}}{4}$ ➡ $D = 18.45\ m$

Design Criteria

D.t = 2 – 4 hr

O.F.R = $20 - 40\ m^3/m^2/day$

$D \ngtr 40\ m$

N =	1	tank
D =	18.45	m
d_s =	3.75	m

WWTP Power Consumption

Plant Capacity	Power Consumption
Up to 5000 m^3/day	0.87 kWh/m3
5000 – 15000 m^3/day	0.41 kWh/m3

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