SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

SWIM-H2020 SM Regional Activities 14

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SWIM and Horizon 2020 SM REG-14: Refugee Emergency: Fast track project Design of wastewater

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Preliminary & Primary Treatment

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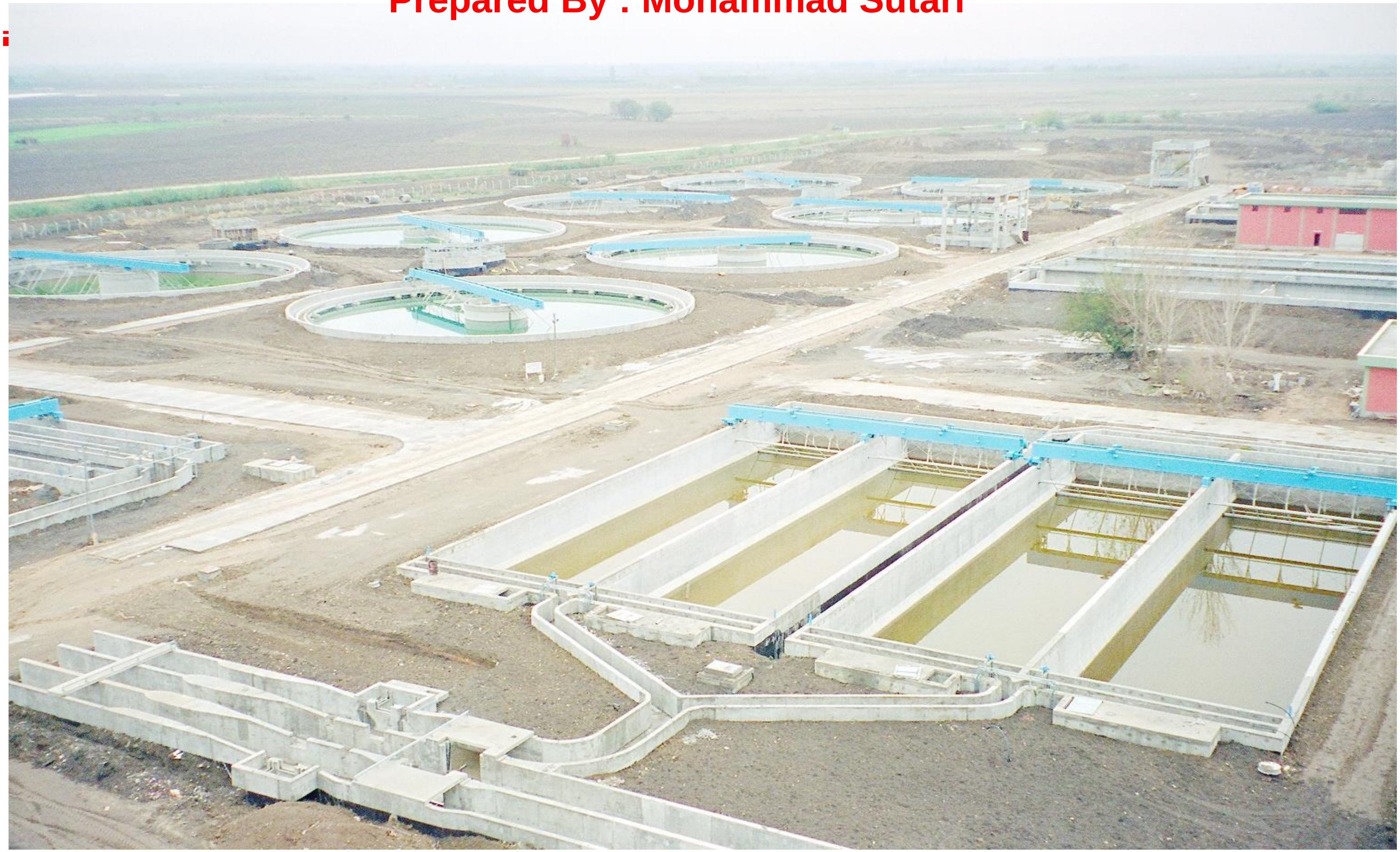

Preliminary & Primary Treatment

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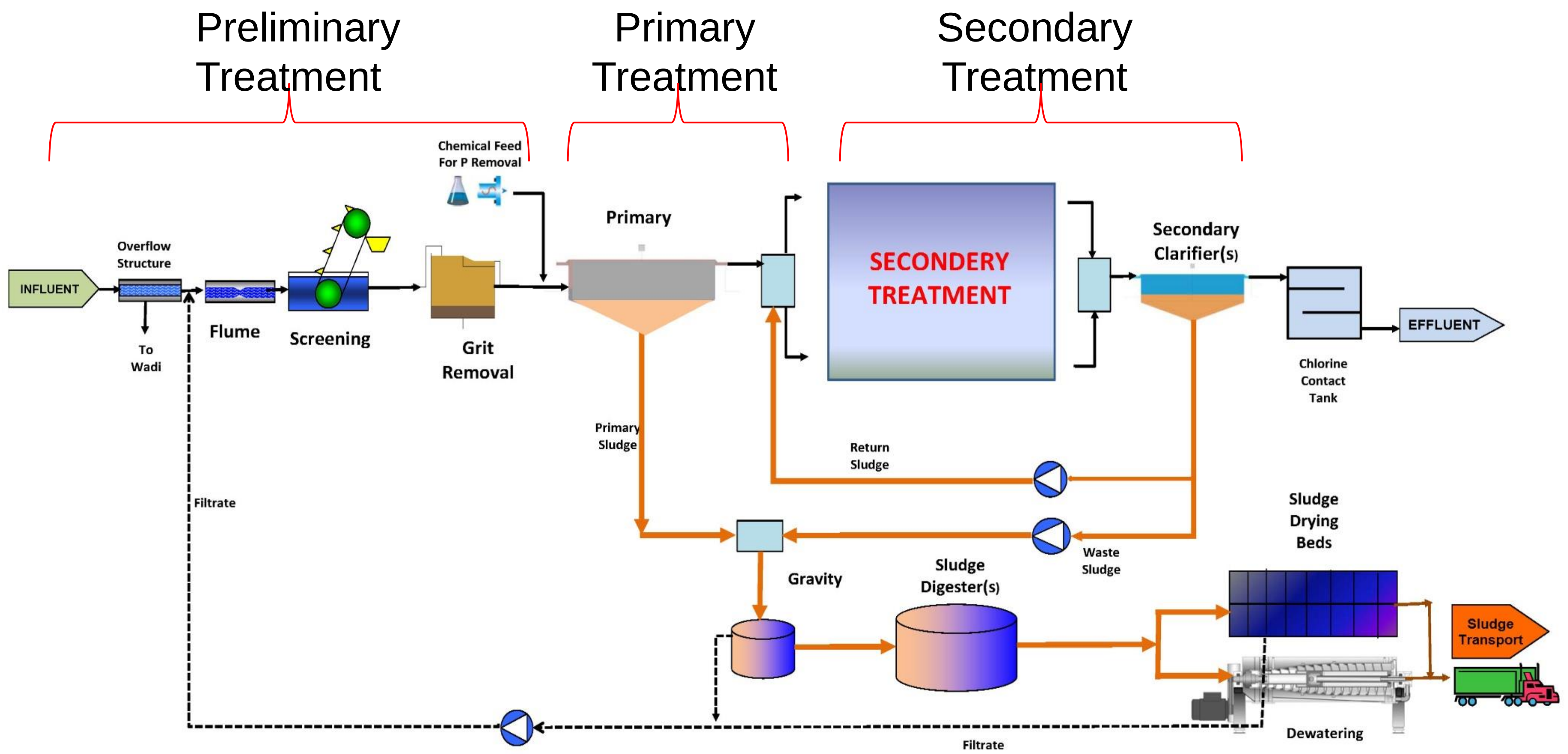
SCHEMATIC TREATMENT PROCESS



Preliminary Treatment

- Designed to remove settleable solids and reduce the organic load (BOD) on the secondary units.
- Primary treatment includes
  - Bar screen
  - Grit chamber
  - Primary clarifier
- What Does It Remove
  - Untreatable Solid Materials
    - Boards, rocks, rags, plastics and other materials
    - Sand, eggshells, grit

FLOW TO TREATMENT

- Average Flow
- Max Month Flow
- Max Day Flow
- Peak Dry weather flow (PDWF)
- Peak Wet weather flow (PWWF)

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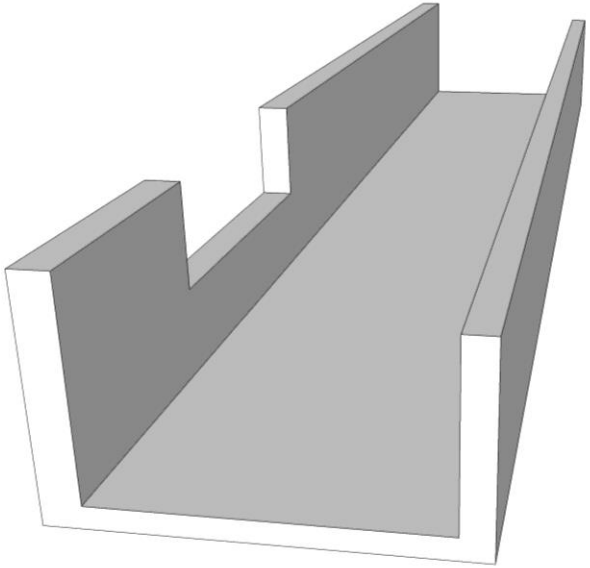
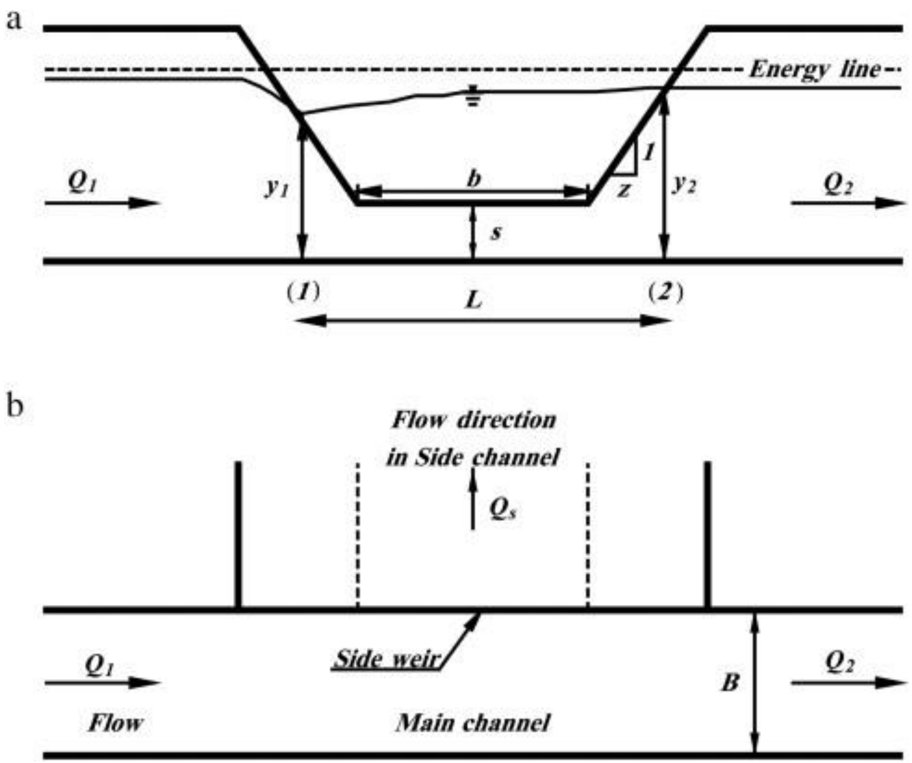
OVER FLOW STRUCTURE

The intent of the overflow structure is to protect the treatment plant from overloading and flooding due to high wet weather flow



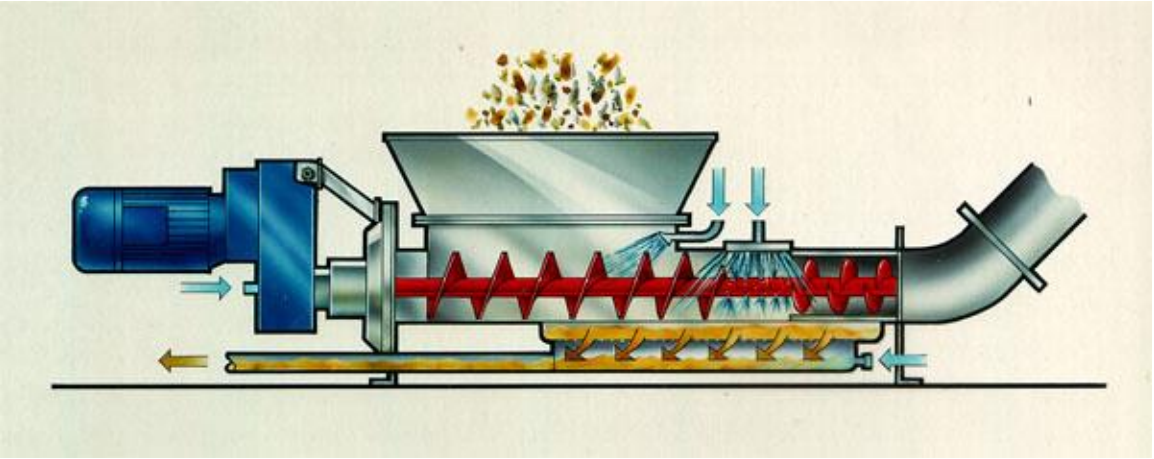


SCREENS

- Coarse Screens
  - Clear Bar spacing 6-150 mm.
  - Common uses are to remove large solids, rags and debris that may clog or damage downstream components such as fine screens , pumps, valves and piping.
  - Can either be hand or mechanically cleaned.
- Fine Screens
  - Clear bar spacing <6 mm.
  - Remove finer particles that get through the coarse screen and that can cause damage to downstream components.
  - Mechanically cleaned

SCREENING WASHER COMPACTOR

- The purpose of the washed/compactor is to provide for washing , dewatering and compaction of the material removed from the screens.
- The unit washes the organic material from the screenings and reintroduces the organics to the main influent flow downstream of the screen.
- Additional advantage includes reduction of the screenings volume and weight and elimination of odors caused by the organics.



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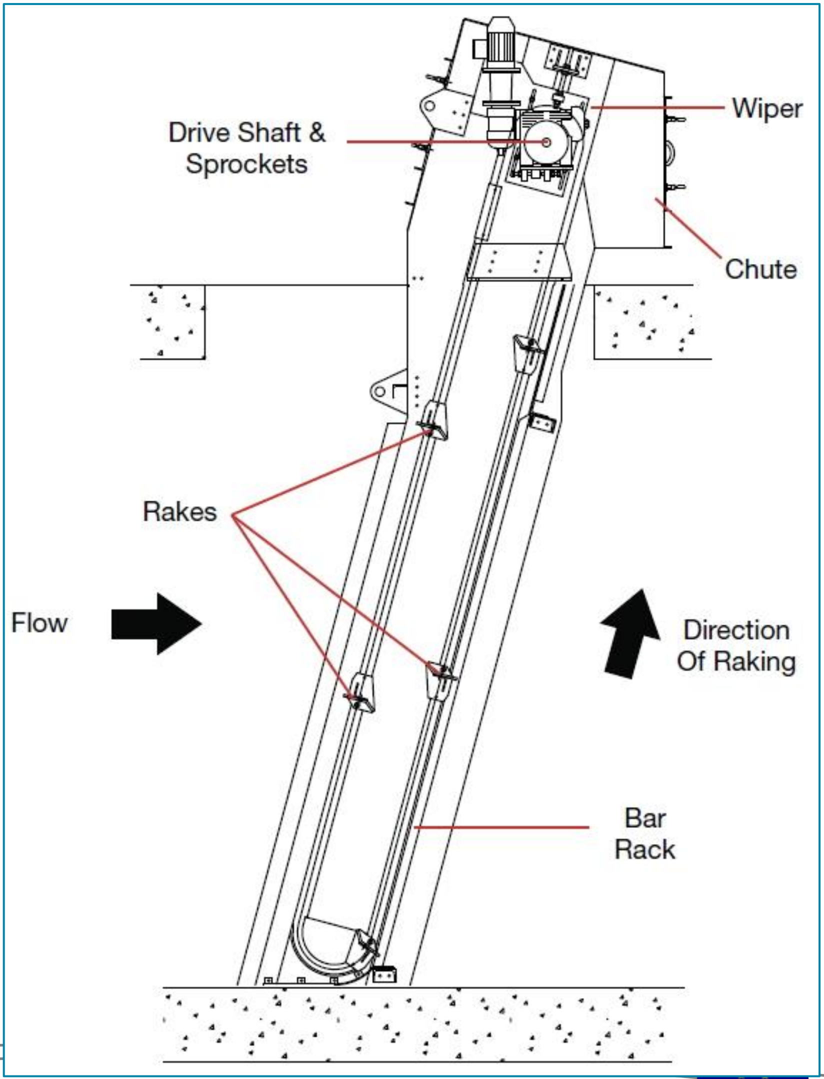
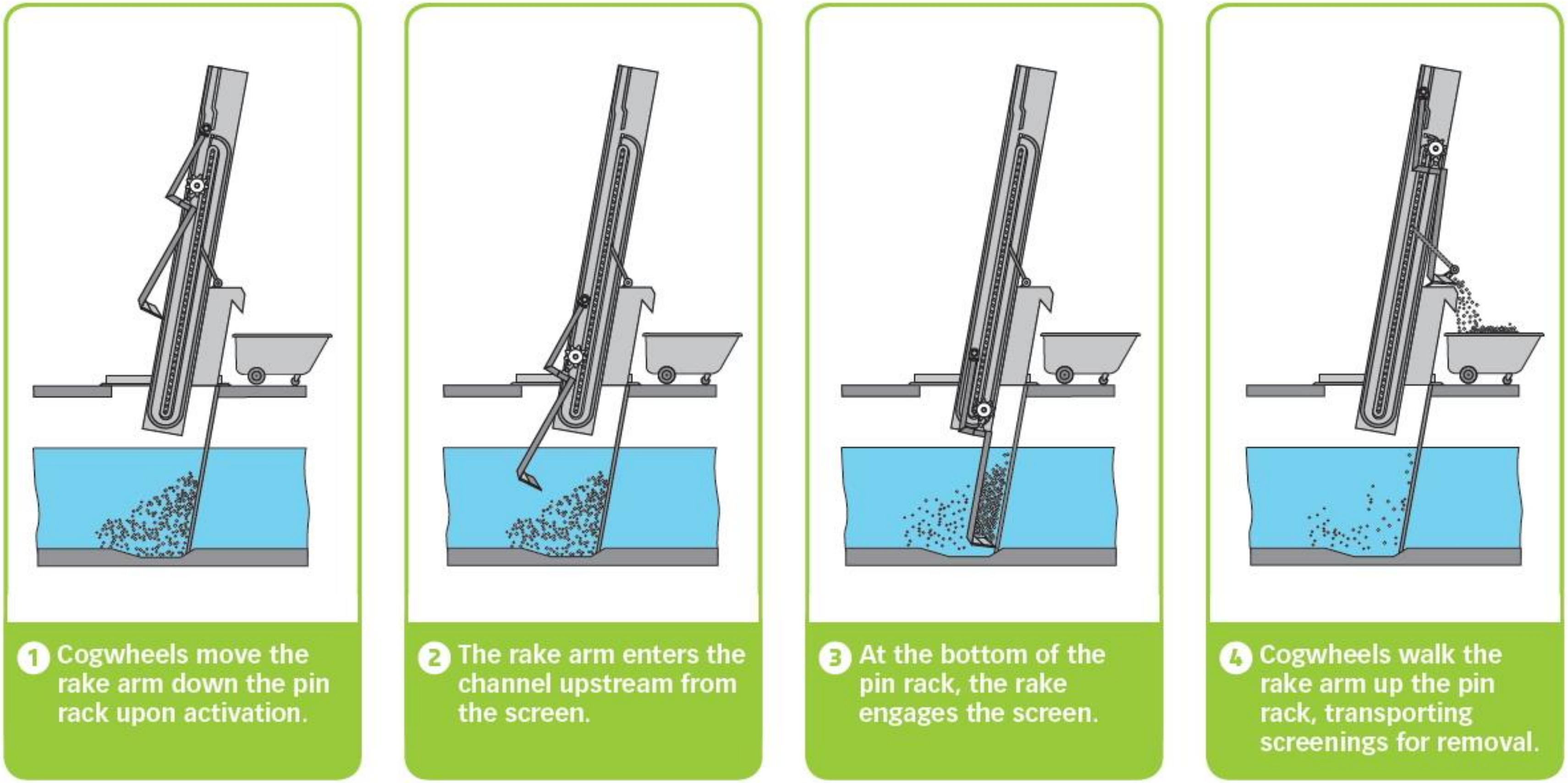
QUANTITY OF REMOVED SCREENINGS

Size of opening between bars (mm)		Volume of Screenings ($L/1000\ m^3$)	
		Range	Typical
<6	Fine	44-110	75
12.5	Coarse	37-74	50
25		15-37	22
37.5		7-15	11
50		4-11	6

MULTIPLE RACK SCREEN

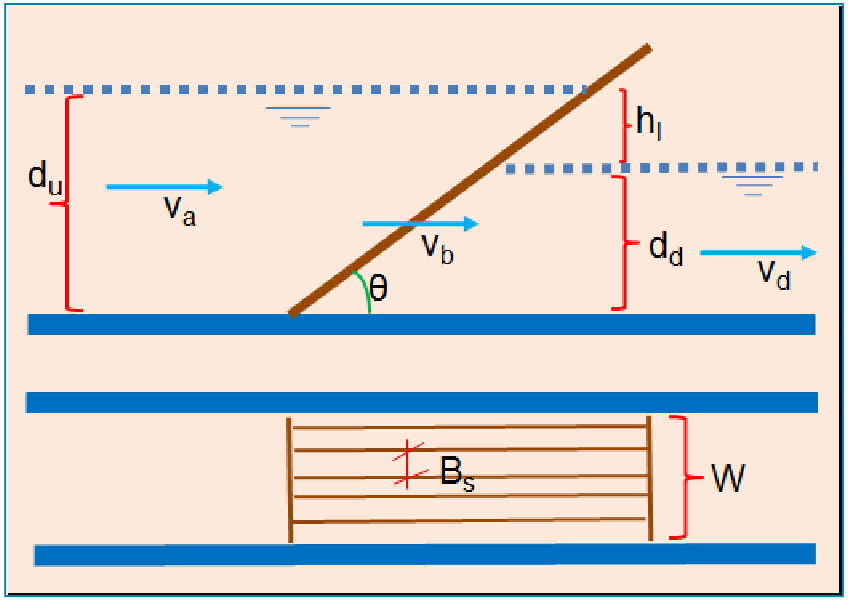


CLIMBER SCREEN



DESIGN OF THE BAR SCREEN CHANNEL

- The cross section of the bar screen channel is determined from the continuity equation:



$$Q_d = A_c \times V_a$$

$$A_c = \frac{Q_d}{V_a}$$

$$A_c = W \times d$$

$$\frac{d}{W} = 1.5$$

Where:

Q_d = design flow, m3/s

A_c = channel cross section, m2

V_a = velocity in the approach channel, m/s

d = water depth in the channel, m

Typical Design Information for Manually & Mechanically Cleaned Coarse Screens(Bar Racks)

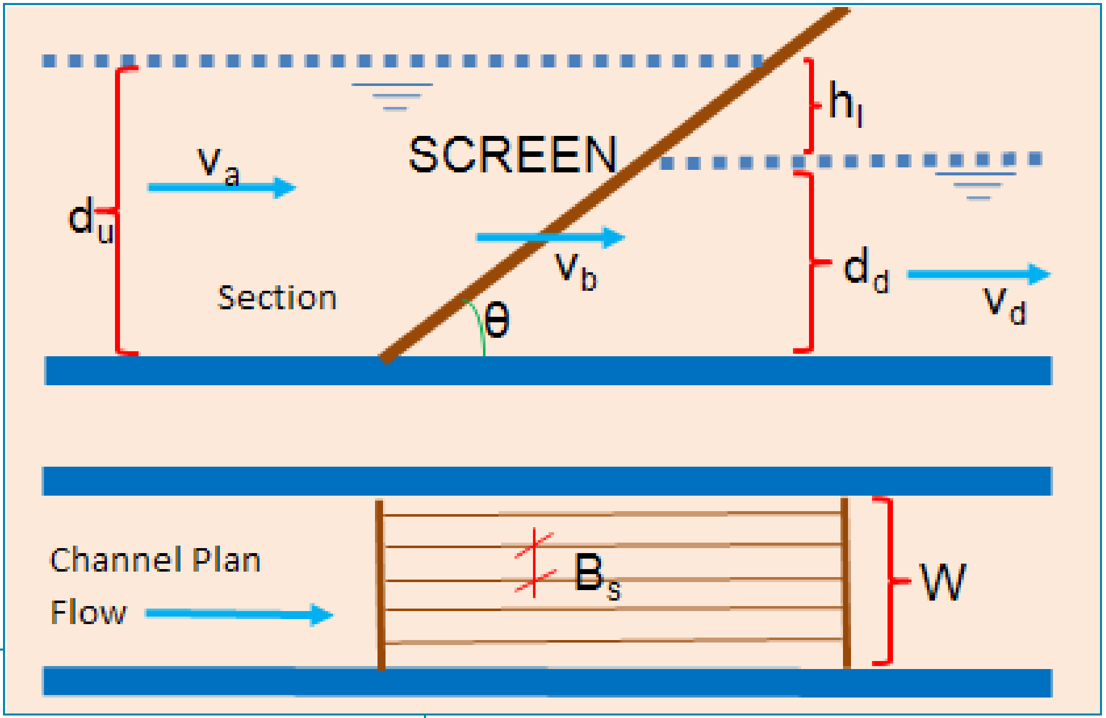
Parameter	Unit	Manual	Mechanical
Bar Width	mm	5-15	5-15
Bar Depth	mm	25-38	25-38
Bar Spacing	mm	25-50	15-75
Slope from Vertical	°	30-45	0-30
Maximum Approach Velocity	m/s	0.3-0.6	0.6-1
Minimum Approach Velocity	m/s		0.3-0.5
Maximum velocity through bar screen	m/s	-	0.9
Allowable headloss	mm	150	150-600

To prevent deposition of grit in the channel

To prevent forcing of screenings through the openings

HEAD LOSS THROUGH THE BAR SCREEN(COARSE SCREEN)

$$h_l = \frac{(V_b^2 - V_a^2)}{2 \times g} \times \frac{1}{C}$$



Where:

h_l = head loss, m

V_a = approach velocity in upstream channel, m/s

V_b = velocity through the opening, m/s

g = acceleration due to gravity, 9.81 m/s^2

C = empirical discharge coefficient

0.7 for a clean screen

0.6 for a clogged screen.

VELOCITY THROUGH THE SCREEN(V_b)

$$V_b = \frac{Q}{A_{net}}$$

$$A_s = \frac{A_c}{Sin\theta}$$

$$\%OpenArea = \frac{B_S}{B_s + B_t}$$

$$A_c = d_u \times W$$

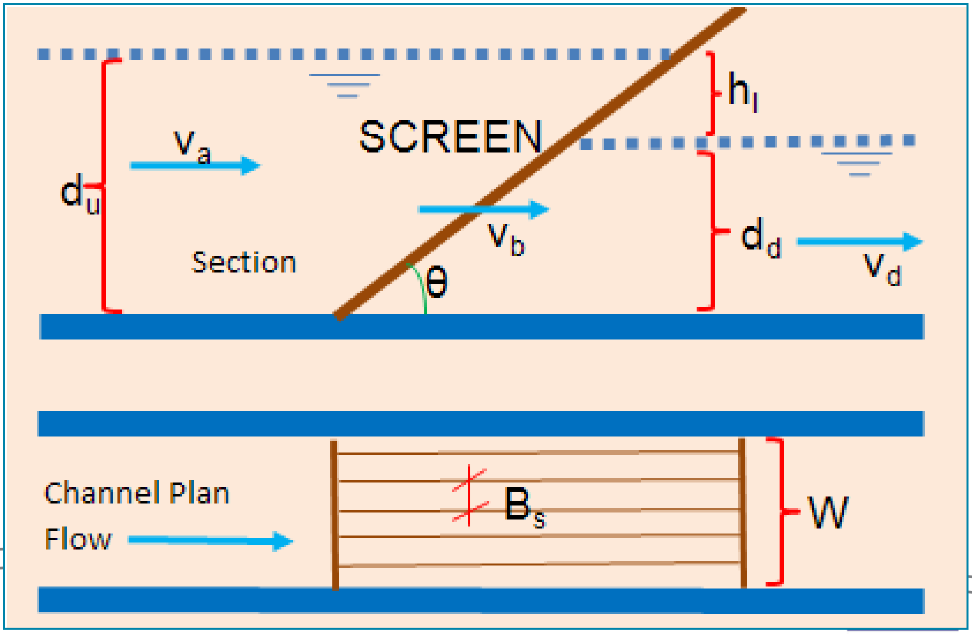
$$A_{net} = A_s \times f \times \%OpenArea$$

$$V_b = \frac{Q \times (B_s + B_t) \times \sin\theta}{d_u \times W \times B_s \times f}$$

$$A_{net} = \frac{d_u \times W \times f \times \frac{B_s}{(B_s + B_t)}}{Sin\theta}$$

Where:

V_b = velocity through screen, m/s.
Q = flow rate, m3/s
A_{net} = net area of screen , m2
θ = angle of inclination, degree.
Ac = channel area, m2.
A_s = area screen, m2
d_u = depth of water in the channel, m.
W = channel width, m.
Bs = bar spacing, m.
Bt = bar thickness , m.
f = solid build-up coefficient, 0.80.

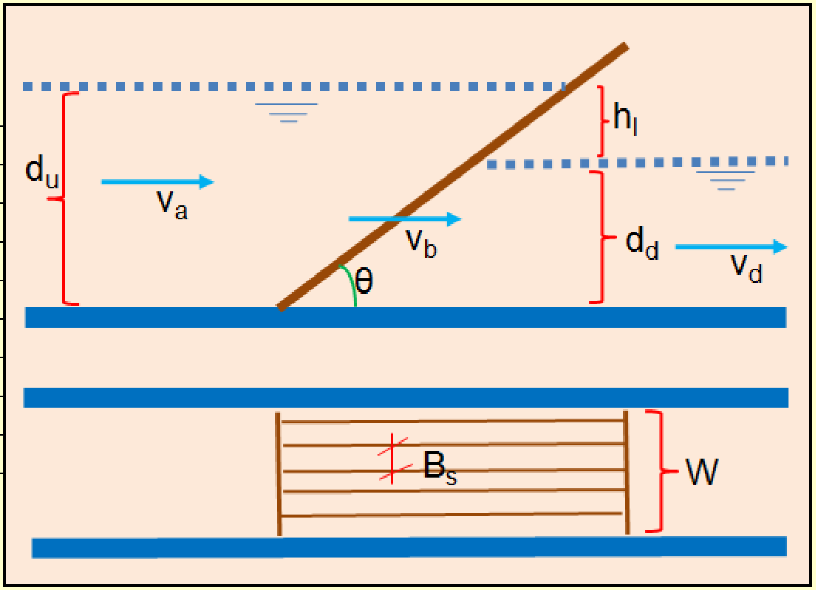


SCREEN CALCULATOR

SCREENS CALCULATOR

Given Data

Q(Flow to each channel)	1.05	m3/s
W(Width of channel)	1.5	m
d_d(Downstream Depth of water)	0.85	m
Bs(Bar spacing)	8	mm
Bt(Bar Thickness)	5.5	mm
θ (Degree)(Screen slope)	60	
θ (Radian)	1.05	
C(Discharge coefficient)	0.7	
f(Solids built up coefficient)	1	



Calculation

%OpenArea of screen	0.59	
assumed Head loss(h_l)	0.050	m
d_u(Upstream water depth)	0.90	m
V_a(Upstream velocity)	0.78	m/s
V_b(Velocity through screen)	1.14	m/s
Calculated Head loss(h_l)	0.050	m
Tolerance	0.00003	

$$V_a = \frac{Q}{W \times d_u}$$

$$d_u = d_d + h_l$$

$$V_b = \frac{Q \times (B_s + B_t) \times \sin\theta}{d_u \times W \times B_s \times f}$$

$$h_l = \frac{(V_b^2 - V_a^2)}{2 \times g} \times \frac{1}{C}$$

Screen Calculator

HEAD LOSS THROUGH THE FINE SCREEN

$$h_l = \frac{1}{2 \times g} \times \left(\frac{Q}{C \times A} \right)^2$$

Where:

h_l = head loss, m

Q = discharge through screen, m^3/s

A = effective open area of submerged screen, m^2

C = empirical discharge coefficient

0.6 for a clean screen

FLOW EQUALIZATION

- Definition
  - Damping of flow rate variations to achieve a nearly constant flow rate.
  - Accomplished by storing excess wastewater during high flow periods
  - Excess wastewater is released during low flow periods

- Purpose
  - Overcome the operational problems caused by flow rate variations.
  - Improve performance of downstream processes.
  - Biological treatment is enhanced because shock loadings are eliminated/minimized.
  - Reduce the size and cost of the downstream treatment facilities.

Balancing Tank

GRIT REMOVAL

- Grit Composition
  - Sand and gravel.
  - Solid materials that have specific gravities greater than organic solids.
  - Common spec' is to remove grit particles down to 0.2mm dia. with an SG of 2.65
- How?
  - Grit is removed from flow by reducing velocity within the containment zone but not too much otherwise organics will drop out too.
- Purpose
  - Protect downstream mechanical equipment from excessive wear and clogging.
  - Reduce solids accumulation in tanks and pipelines.
  - Improve biological treatment and reduce sludge quantities..
- Types of Grit Chambers
  - Horizontal-flow grit chambers.
  - Aerated grit chambers
  - Vortex-type grit chambers

AERATED GRIT CHAMBERS

- Air is introduced along one side of a rectangular tank to create a spiral flow pattern perpendicular to the flow through the tank.
- The heavier grit particles that have higher settling velocities settle to the bottom of the tank. The lighter particles remain in suspension and pass through the tank.
- The velocity of roll governs the size of particles of a given specific gravity that will be removed. High velocities would cause the grit to be carried out of the chamber. Smaller velocities would cause the organic material to be removed.
- Aerated grit chambers are designed to remove 0.21 mm diameter (65-mesh) or larger particles.