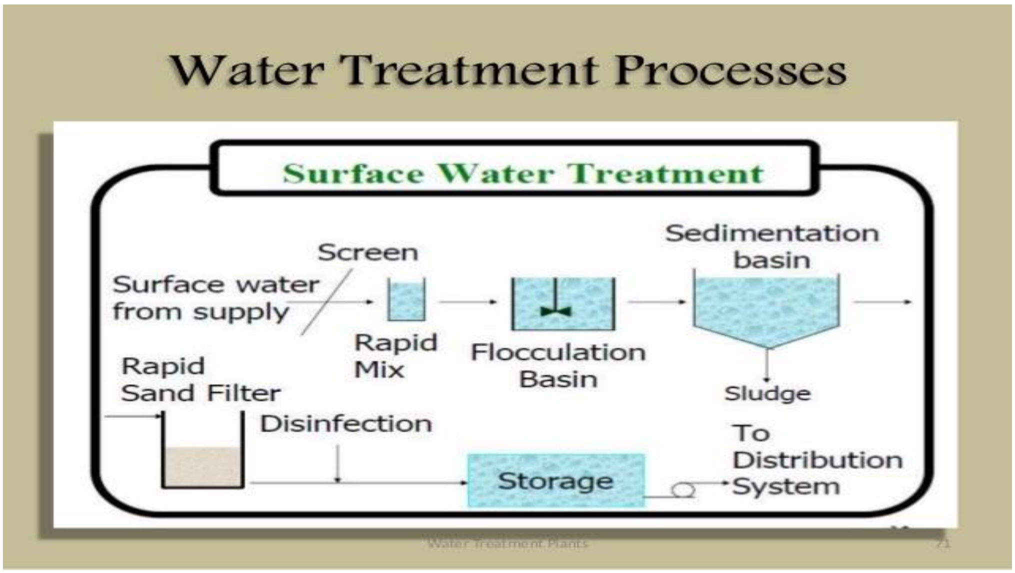
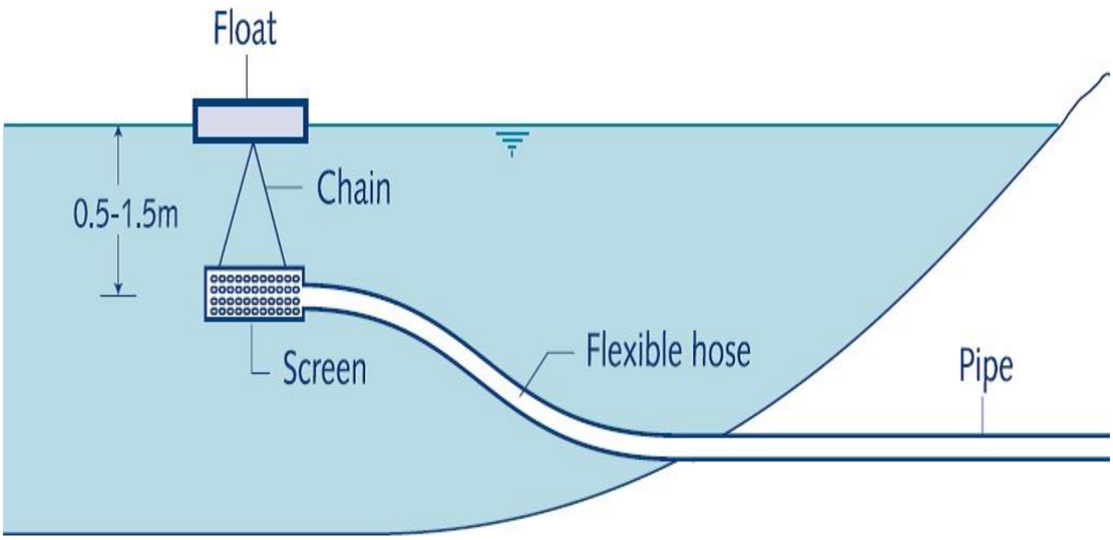
1. Distribution works.



1.1 Intakes

Intakes consist of the opening, strainer, or grating through which the water enters, and the conduit conveying the water, usually by gravity, to a well or sump. From the well the water is pumped to the mains or treatment plant. Intakes should be so located and designed that possibility of interference with the supply is minimized and where uncertainty of continuous serviceability exists, intakes should be duplicated.



The following must be considered in designing and locating intakes:

1- The source of supply, whether impounding reservoir, lake, or river (including the possibility of wide fluctuation in water level).
2- The character of the intake surroundings, depth of water, character of bottom, navigation requirements, the effects of currents, floods, and storms upon the structure and in scouring the bottom.
3- The location with respect to sources of pollution.
4- The prevalence of floating material such as ice, logs, and vegetation.

2. Type of Intakes

2.1 Intakes from Impounding Reservoirs

The water of impounding reservoirs is likely to vary in quality at different levels, making it usually desirable to take water from about a meter below the surface. This, with the fluctuations of water level which may be expected in reservoirs, makes it advisable to have ports at various heights. Where the dam is of earth, the intake is usually a concrete tower located in deep water near the upstream toe of the dam. Access to the tower so that the gates of the various openings may be manipulated is obtained by means of a footbridge. The ports may be closed by sluice gates or by gate valves on short lengths of pipe. Where the dam is of masonry, the intake may be a well in the dam structure itself, also with openings at various heights.

2.2 Lake Intakes

If the lake shore is inhabited, the intake should be so located that danger of pollution will be minimized. This may require study of currents and effects of winds with particular attention to movement of sewage or industrial wastes, if these are discharged into the lake. It is also advisable to have the intake opening 2.5 m or more above the bottom so that large amounts of silt will not be carried in with the water. *Entering velocities must be low*, or excessive amounts of floating matter, sediment, fish, and frazil ice may be carried in. Entering velocities less than 0.15 m/s have been used successfully. Offshore winds tend to stir up sediment which will be carried out for long distances. Water depth (6-9 m).

2.3 River Intakes

Small cities may use pipe intakes similar to those described under lake intakes. The bottom *must be sufficiently stabl*e, and the *water deep enough to allow a submergence* of at least 1 m at all times with a clear opening beneath the pipe so that any tendency to form a bar is overcome. Intakes of this type should have provision for reversing flow to clear the strainer openings or screens. On *rock bottoms* where it is inadvisable, on account of navigation requirements, to have the intake project above the river bottom, an intake box of steel plates has been placed in a trench.

On *soft bottoms* intake boxes have been supported on piles. Where the river bottom changes considerably, a shore intake is used. It is located on the low-water bank and may consist of a trench or tunnel paralleling the stream with one or more ports leading the river water in. The ports may be protected by bar gratings. It may be advisable to provide facilities for quick removal of silt from the vicinity of the ports. To prevent such silting, low diversion dams have been built to deflect the main current past the intake during low-river stages. River intakes are especially likely to need screens to exclude large floating matter which might injure pumps. Submerged crib intakes may use wood bars for this purpose; other intakes employ vertical gratings of steel bars. Automatically cleaned bar screens can be obtained from various manufacturers and are sometimes used. It may not be necessary to operate the automatic cleaning feature at all times. Movable fine screens, if installed, are usually placed in the more accessible pump well at the entrance to the suction pipes.

2.4 The Intakes Conduit

A shore intake may also be the supply well for the suction pipe leading to the pumps. Intakes located long distances from the pumps usually deliver their water to the pump well at the shore end by gravity. This necessitates a large pipe or conduit so that velocities will be low but not low enough to allow sedimentation. The conduit may be a submerged pipe or a tunnel. Tunnels are expensive but less likely to be damaged than are pipes. A submerged pipe should be protected by burying it in a trench or by surrounding it with rock or holding it in place with piling.

2.3 Intake Structure parts

1. Intake structure.

2. Intake conduits.

3. Raw water lift pump station.

4. Transmission lines.

2.4 Purpose of intake structure

1. Collect the water from the source.

2. Protect the embankment sides slopes from failure.

3. Prevent clogging of intake conduits (because the intake structure consists of screen prevent the entrance of the undesired matters).

2.5 Factors affecting the location of intake

1. Located on straight part of the water source (hydraulic and structural stability) to prevent settling and scoring.

2. The site should be near the treatment plant so that the cost of convying water to the city is less.

3. The intake must be located in the purer zone of the source to draw best quality water from the source, thereby reducing load on the treatment plant.

4. The intake must be upstream the served city to prevent the direct pollution and never be located at the downstream or in the vicinity of the point of wastewater disposal.

5. The site should permit greater withdrawal of water, if more quantity is need in a future.

6. The intake must be located at a place from where it can draw water even during the driest period of the year, and it should remain easily accessible during floods and should not get flooded.

2.6 Factors affecting the choice of intake structure type

1. Water source dimensions (width – depth) (Narrow or wide) (Shallow or deep).

2. Character of bottom.

3. Effect of currents, floods and storms upon the structure.

4. Water source pollution (on shore – on surface).

5. Navigation requirements.

6. Fluctuation in water level.

The distance between the centerline (Φ) of the pump and the low water level elevation (L.W.L) not exceed 5 m .

2.7 Design of Intake

2.7.1 Intake conduit

Purpose: To transmit raw water from source to low left pump (L.L.P).

Design criteria:

1. Units should be in duplication.

2. Detention time (15−30) min.

3. The effective depth effect by L.W.L.

4. Bottom of the well is 1 m below the river bed.

5. Provide enough space inside well for repair and maintenance.

6. Clearness between check valve and the well bottom = 0.6 m to prevent the settling inside basin which may effect on the pump performance.

7. Flow velocity through the gravity pipe is 0.6–1.5 m/sec, maximum ≤ 2 m/s.

8. Flow velocity through wash pipe is 3 m/sec.

9. Discharge for the wash pipe= 1/3 discharge for gravity pipe.
10.Number of pipes n ≥ 2

10. Friction losses $hf = \frac{4\,f\,l\,v^2}{2gd}$

f = Mody chart
l = 30 – 50 m (for shore intake).
l = 50 – 100m (for pipe intake).

2.7.2 Suction well (sump – wet well)

Purpose: Distribute the raw water uniformly on the total number of pumps.

Design criteria:

1. Well (Sump) should be water tight.

2. Length ≥ 5 times the diameter of the intake conduit.

3. Length = number of pumps x (1.5 – 2.5).

4. Width= 1 – 3 m.

5. Depth (m) ≥ (H.W.L – bed level) – hf + 0.5
6. t (min.) = 5
V (m^3) = Q design x t

A (m^2) = V/d, A = B x L

2.7.3 Low lift pump

Purpose: It is used to raise the raw water from the source level to water level in the first tank in water treatment plant.

Design criteria:

Qdesign = Qmax= f*Qavg.

$H_{total} = H_S + hf + h_S$

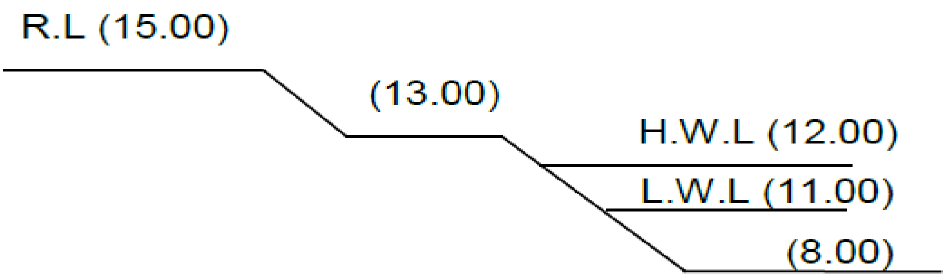
Hs = static head it is the difference between L.W.L. and the water level (W.L) in the first tank in the water treatment plant (W.T.P) ~ 5m above land level.

= (G.L – L.W.L) + 5

hf = friction losses = $hf = \frac{4\, f\, l\, v^2}{2gd}$

Hs = secondary losses = 10 % hf

Example: It is required to design the collection works for a city of population 24,000 capita and average water consumption 180 l/c/d if pumps work 20 hr/d. The source of water is narrow and navigable canal, its dimensions as shown in figure. Calculate the intake conduit.



Solution:

Qave. = pop x consumption rate

$$= \frac{24000 \times 180}{1000 \times 20 \times 60 \times 60} = 0.6\ m^3/s$$

Qdesign = Q max. monthly x 1.1

= 1.5 x Qave x 1.1 = 1.5 x 0.06 x 1.1 = 0.099 m^3/s

Qmin = 0.7 x Qave x 1.1 = 0.7 x 0.06 x 1.1 = 0.046 m^3/s

Intake conduit

Q design = A x v (v= 0.6 – 1.5 m/s)

Take v = 1 m/s

A = Qdesign / v = 0.099 / 1 = 0.099 m^2

$A = n(\pi D^2/4$,   n: pipes number

Take n = 3 ∴ D = 0.205 m

$V_{act} = Q_{design} / A_{act}$
$= 0.99 / 3\pi (0.6)^2 /4 = 1.167$ m/s   <1.5 and < 0.6 ∴SAFE

When one pipe is broken
$V_{max} \leq 2.5$ m/s , n=2 ,

$V_{max} = Q_d / (n-1)\, \pi\, \varphi^2 /4$

$= 0.99/2\pi (0.6)^2 /4 = 1.75$ m/s <2.5 safe

At Q_{min}

$V_{min} = Q_{min}/n\, \pi\, \varphi^2 /4$
$=0.64/3\, \pi\, (0.6)2 /4 = 0.54$ m/s <0.6 unsafe

Close one pipe at the month of Q_{min}

$V_{min} = Q_{min}/(n-1)\, \pi\, \varphi^2 /4$

$=0.46/2\, \pi\, (0.6)^2 /4 = 0.81$m/s >0.6 Safe

Sump

$V = Q_d \times T$
$= 0.99 \times 5 \times 60 = 297 m^3$
$V = B \times L \times d$
d = H.W.L – bed level –hf +0.5
= 12- 8 - 0.18 + 0.5 =4.32m
B= 1-3 m   take B=2m
$L = 297/2 \times 4.32 = 34.375$m
Check
Length ≥ 5 times the diameter of the intake conduit
$L = 5 \times 3 \times 0.6 = 9$m Safe

L.L.P

H_{total} = Hs + hf +hs

Hs = (G.L – L.W.L) + 5 =7m

$hf = \frac{4\ f\ l\ v^2}{2gd} = \frac{4\ 0.008\times50\times(1.167)^2}{2\times9.81\times0.6}$ =0.18m

hs =10% hf = 0.1×0.18 = 0.018m

HT = 7+0.18+0.018 = 7.198m