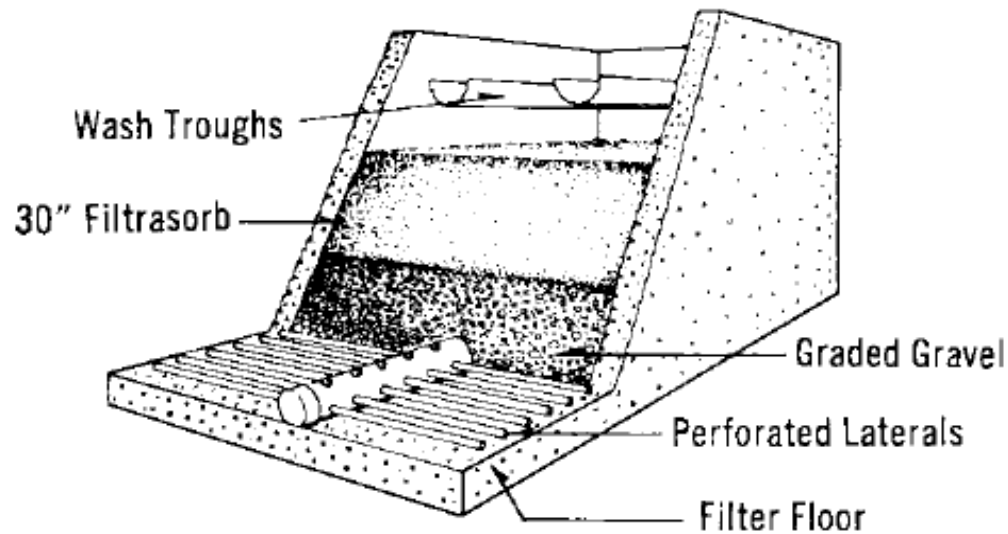


# FILTER DESIGN EXAMPLE

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**FIGURE 8.8** Rapid gravity filter with manifold and lateral underdrain system. (Source: After C. P. Hoover, Water Supply & Treatment, National Lime Assoc.)

## USA -Rapid Sand Filter Design

### Inputs

Design a rapid sand filter to treat

Allowing filtered water for backwashing:

Time used for bakwashing per day =

Assume the rate of filtration =

Number of Filters

Length/ Width of Filters=

Depth of Sand Media=

Q=	20000	m <sup>3</sup> /d
Q <sub>BW</sub> =	2%	
t <sub>BW</sub> =	0.50	hours
	10	m/h
	2.00	
	1.30	
	1.00	m

## Solution:

Total filtered water =  $20\,000 \times 1.02 \times 24 / (24 \times (24 - 0.5)) =$

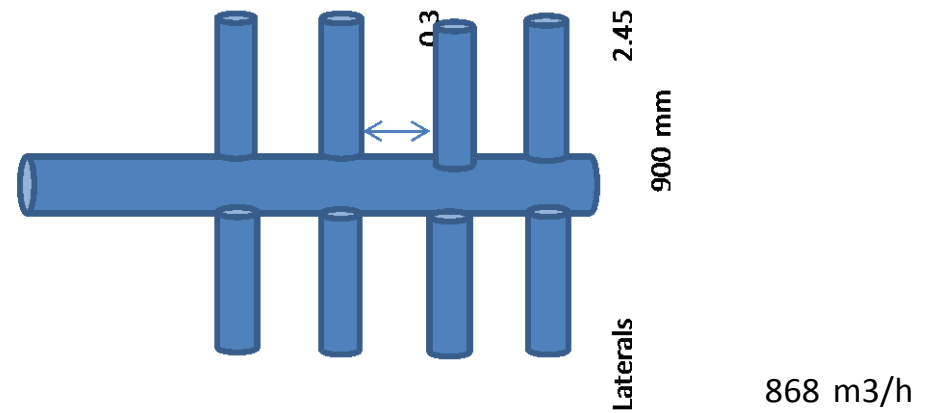
Area of filter =  $\frac{20\,000 \times 1.02}{23.5 \times 10} = 86.8 \text{ m}^2$

Each bed area  $86.8 / 2 = 43.4 \text{ m}^2$

Let the length of the filter as:  $L/B = 1.3$ ;  $1.3B^2 = 43.4 \text{ m}^2$

Width =

Length =  $5.78 \times 1.3 = 7.51 \text{ m}$



868 m<sup>3</sup>/h

86.8 m<sup>2</sup>

43.4 m<sup>2</sup>

5.78 m

7.51 m

## Underdrainage system:

Total area of holes = 0.2 to 0.5% of bed area.

Assume 0.3% of bed area =  $\frac{0.3}{100} \times 43.4 = 0.13 \text{ m}^2$

XSS Area of lateral = 2 (Area of holes of lateral)

XSS Area of manifold = 2 (Area of laterals)

Diameter of **manifold** =  $(4 \times 0.52 / \pi)^{1/2} = 81.4 \text{ cm}$

Choose a standard diameter =

Assume c/c (center to center) of lateral = 30 cm.

0.35% (0.2-0.5 % of bed area)

0.152 m<sup>2</sup>

0.304 m<sup>2</sup>

0.608 m<sup>2</sup>

0.880 m

0.9 m

0.3 m

900

## Holes

Take dia of holes = 13 mm

Number of holes:  $n_{pi} \frac{(1.3)^2}{4} = \text{Total Area of holes} = 860 \text{ cm}^2$

$$n = \frac{4 \times \text{Total Hole Area}}{3.14(\text{Hole Diam})^2}$$

Choose total number of holes

Number of holes per lateral = No of holes/number of laterals = 13

Area of perforations per lateral =  $13 \times p \frac{(1.3)^2}{4} = 17.24 \text{ cm}^2$

Spacing of holes =  $L_{\text{lateral}}/\text{no of holes per lateral} = 19.5 \text{ cm}$ .

XSS. area of lateral =  $2 \times \text{area of perforations per lateral} = 2 \times 17.24 = 34.5 \text{ cm}^2$ .

Diameter of lateral =  $(4 \times 34.5/p)^{1/2} = 6.63 \text{ cm}$

Choose a standard pipe diameter=

Check:( Length of lateral < 60\* Diam of Lateral)  $60 \times 6.63 = 3.98 \text{ m}$ .  $l = 2.545 \text{ m}$ .

10.00 mm

0.01 m

0.152 m<sup>2</sup>

1934

2000

40

0.00314 m<sup>2</sup>

31.4 cm<sup>2</sup>

0.061

6.13 cm

0.0063 m<sup>2</sup>

62.73 cm<sup>2</sup>

0.0894 m

90.00 mm

0.0900 m

5.40 OK > L\_Lateral

## BW Trough Design

Number of BW troughs=

3

Distance between BW troughs lengthwise at  $5.75/3 = 1.9$  m c/c.

1.93 m c/c

Discharge of each trough =  $Q/3 = 0.36/3 = 0.12$  m<sup>3</sup>/s.

0.12 m<sup>3</sup>/s

$Q = 1.71 \times b \times h^{3/2}$

Assume width of BW Trough=

0.3 m

h =

0.381 m

= 40 + (free board) 5 cm = 45 cm; slope 1 in 40

## Clear water reservoir for backwashing

Duration of BW

0.50 h

For 4 h filter capacity, Capacity of tank =  $\frac{4 \times 5000 \times 7.5 \times 5.75 \times 2}{1000} = 1725$  m<sup>3</sup>

1302 m<sup>3</sup>

Depth of BW Storage Tank=

5 m

Surface area =  $1725/5 = 345$  m<sup>2</sup>

260 m<sup>2</sup>

L/W =

2

L/B = 2;  $2B^2 = 345$ ; B = 13 m & L = 26 m.

11.4 Roundup= 12.0

L=

22.8 Roundup= 23.0

Volume=

1380.0 m<sup>3</sup>

Dia of inlet pipe coming from two filter = 50 cm.

0.5 m

Velocity in filter effluent pipe during filtration=

0.59 m/s

Diameter of the BW water pipe=

0.70 m

700

BW Water flowrate=

0.362 m<sup>3</sup>/s

Velocity in the BW tank=

0.94 m/s

OK

## Air BW

Air Velocity 1000 l of air/ min/ m<sup>2</sup> bed area (1 m/min = 60 m/h)

Time of air BW=

Air required During BW =  $1000 \times 5 \times 7.5 \times 5.77 \times 2 = 4.32 \text{ m}^3$  of air.

Blower Capacity=

60 m/h

5 min

434 m<sup>3</sup> Air

86.81 m<sup>3</sup>/min =