Plumbing system design for 10th floor building:

OBJECTIVE

The objective of plumbing system design is to design components of water supply system and drainage system of ten storied building. For the design of water supply system down feed water supply is considered. The design components; size of water distribution pipes, size of underground water reservoir and overhead water tank, riser size and pump capacity are calculated for the building. The elements like drainage pipes, building drains and sewers, including connections, devices and other appurtenances are designed for building drainage system. Plumbing includes the practice, materials and fixtures used in the installation, maintenance, extension and alteration of all piping, fixtures, appliances and accessories in connection with sanitary drainage or storm drainage facilities, the venting system and the public or private water supply systems/within or adjacent to any building, structure or conveyance. Major elements in plumbing systems

- Water supply and distribution pipe: up feed or down feed distribution pipes, underground water reservoir (UGWR), overhead (OH) tank.
- Plumbing fixtures and traps
- Soil, waste and vent pipes
- Building drains and building sewers, including-their respective connections, devices, and appurtenances within the property lines of the premises

DESIGN OF DOWN FEED WATER SUPPLY SYSTEM

Design components:

1. Sizing of water distribution pipes within the building.

2. Dimension of UGWR.

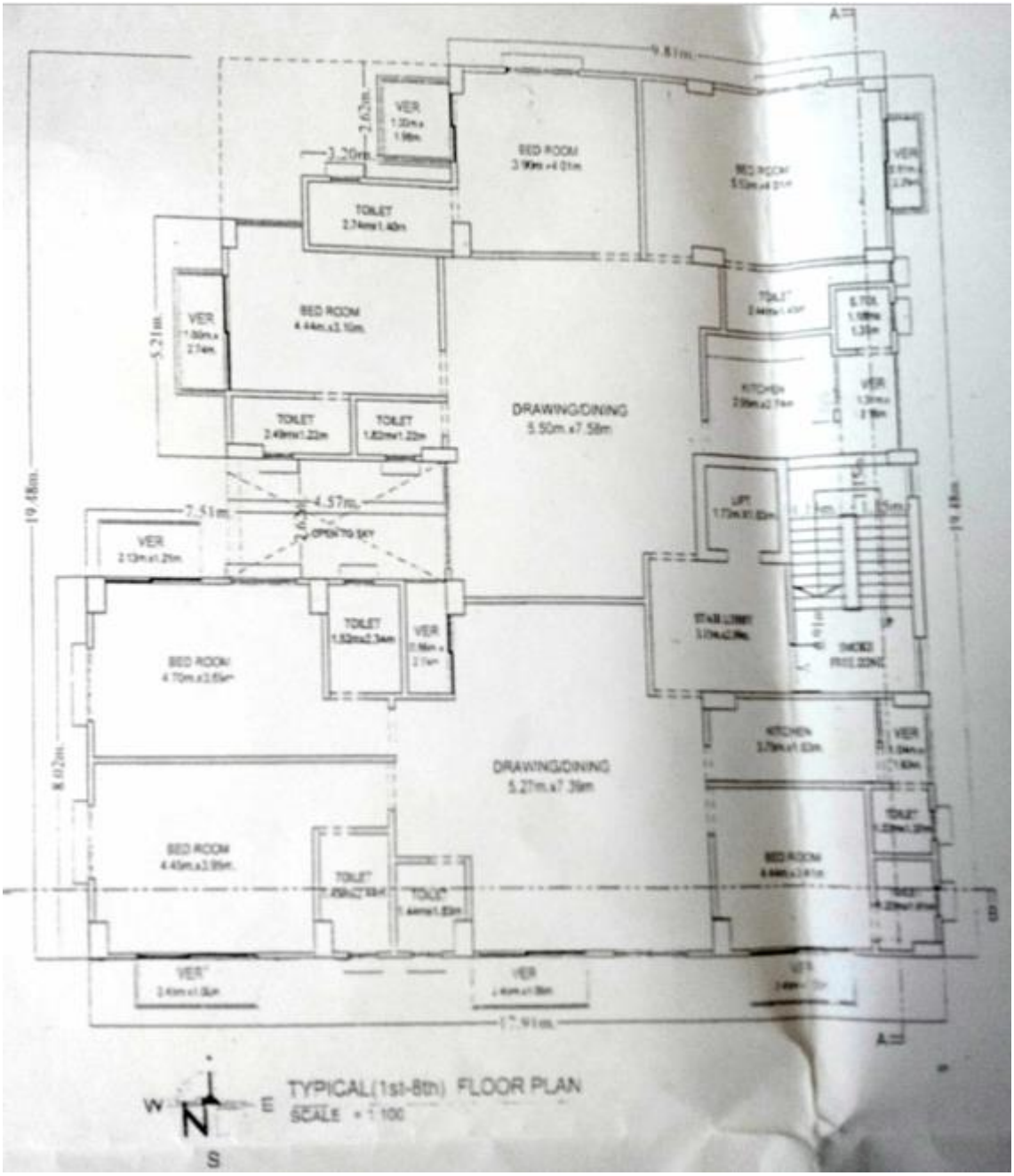
3. Dimension of OH tank.

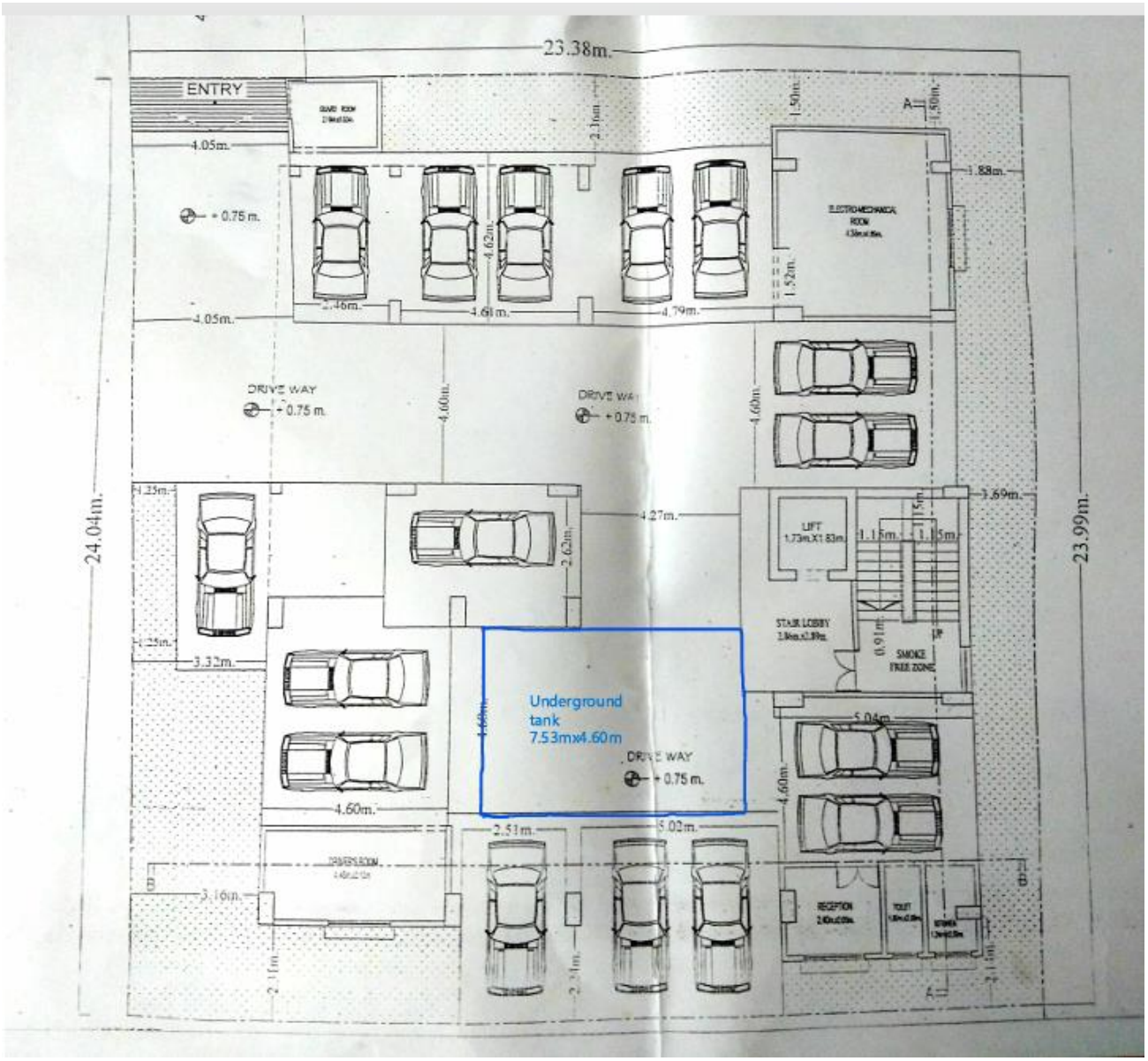
4. Calculation of pump capacity.

DESIGN OF A TYPICAL PLUMBING SYSTEM

Given Data

- 10 storied Building – Per floor 10ft
- Water Pressure = 50 Psi at Public main
- 8 Water Closets,8 Lavatories and 2 kitchen sink on each floor.
- Flush tank fixtures are used through out the building.
- Maximum Pressure at any fixture is not to exceed 50 psi.
- Service Pipe (Main to the floor of the riser) Length = 70 ft.
- Minimum fixture Pressure :
    a. Lavatory = 8 psi
    b. Water closet = 8psi (Flush tank)
- Fixture Unit (FU) :
    a. Lavatory = 2FU
    b. Water Closet = 5 FU (Flush tank)
    c. Kitchen sink= 2FU
- Assume, Pressure drop for branch = 1psi.
- Overhead water tank distance above roof = 24ft.


A
VER
BED ROOM
TOILET
BED ROOM
VER
TOILET
TOILET
DRAWING/DINING
5.50m.x7.58m
KITCHEN
VER
LIFT
4.57m.
7.51m.
OPEN TO SKY
VER
TOILET
VER
BED ROOM
KITCHEN
VER
DRAWING/DINING
5.27m.x7.39m
BED ROOM
TOILET
TOILET
BED ROOM
VER
VER
B
A
W
E
N
S
TYPICAL(1st-8th) FLOOR PLAN
SCALE = 1:100


23.38m.
ENTRY
4.05m.
+ 0.75 m.
4.62m.
2.46m.
4.61m.
4.79m.
1.52m.
1.50m.
1.88m.
ELECTROMECHANICAL ROOM
4.05m.
DRIVE WAY
+ 0.75 m.
4.60m.
DRIVE WAY
+ 0.75 m.
4.60m.
24.04m.
1.25m.
2.62m.
4.27m.
3.69m.
LIFT
1.73m.X1.83m.
1.15m.
1.15m.
1.15m.
STAIR LOBBY
0.91m.
UP
SMOKE FREE ZONE
1.25m.
3.32m.
Underground tank 7.53mx4.60m
1.66m.
DRIVE WAY
+ 0.75 m.
5.04m.
4.60m.
4.60m.
2.51m.
5.02m.
3.16m.
RECEPTION
TOILET
2.31m.
2.31m.
23.99m.

For 10th floor building:

For flush tank:

8 water closet= 8*5=40 FU

8 lavatory= 8*2=16 FU

2 Kitchen sink= 2*2= 4 FU

Total Fixture unit= 60FU

For all floors(2nd-9th)= 60*8=480FU

For guard and roof:

2 water closet= 2*5=10FU

2 Lavatory= 2*2=4 FU

2 Kitchen sink= 2*2=4FU

Total Fixture unit= 18 FU

So, Total fixture unit for the building= 480+18= 498 FU

Zoning:

- Upfeed:

  From the “Demand vs Fixture unit ” graph: Demand, Q= 120gpm

  From the “ Flow vs Friction loss/100 ft ” graph (Using 120 gpm)

  If we use, 3 in pipe = 2.5 psi pressure drop/ 100 ft

  4 in pipe = 0.6 psi pressure drop/100 ft

  We select 4 in pipe = 0.6 psi pressure drop /100 ft for friction

  From “ Pressure loss vs Flow graph using 120 gpm, Drop in water meter

  p = 1.4 psi ” and 50 % extra length is considered for fitting friction

  For Upfeed zone,

  (Assuming pressure at main pipe=50psi)

Min fixture pressure,f =8 psi

Drop for branch,b = 1 psi

➢ P= p + 0.434h + f+b

➢ 50 = 1.4 + 1.5(70+ h)* 0.6/100 + 0.434h +8 +1

➢ h = 88 ft

Riser length=88-10=78ft(7 floor, from Ground to 7^{th} floor)

Downfeed:

Max height for downfeed = P/0.434= 50/0.434 = 115 ft

Given, Water tank 24 ft above roof [Max Fixture pressure = 50 psi]

Available height = 115-24 = 91 ft

So, 91/10 =9.1 ~9 floors

But only 2 floor and a roof is remaining (8^{th},9^{th} and roof)

So, the downfeed pipe will cover only 8^{th},$9^{th\ floor}$ and roof.

Design of Up feed zone:

Pressure remaining for piping and fitting friction,p=P-(0.434h+f+b)

= 50 – (1.4+ 80 *0.434+8+1)

= 4.88psi

Main to Riser Length = 70 ft

Riser Length = 80 ft(7 floor(70ft) + 10 ft under ground)

Total =150 ft

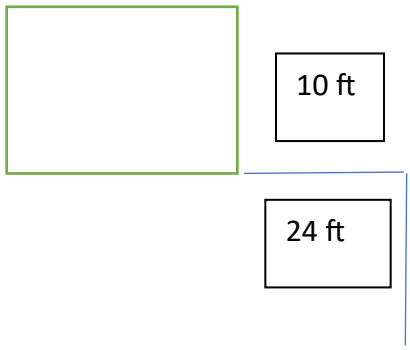
Now, considering 50% extra length for fitting friction

Total length = 1.5* 150 = 225 ft

∴ Pressure loss for friction / 100 ft = (4.88*100)/ 225= 2.17 psi / 100 ft

Floor	FU	Accumulated FU	Demand(gpm)	Pressure drop	Pipe size(inch)
Ground	18/2=9	369	100	2.17	3
2nd	60	360	98	2.17	3
3rd	60	300	80	2.17	3
4th	60	240	68	2.17	3
5th	60	180	58	2.17	2.5
6th	60	120	45	2.17	2.5
7th	60	60	35	2.17	2.5

Design of Down feed zone:



One downfeed zone:

Let the vertical height of the tank is 24 ft and the horizontal

Pipe length is 10 ft.

For flush tank permissible pressure is 8 psi.

So, p=0.434h-f-b = 0.434*24-8-1= 1.4psi

Assuming 50% length extra for fitting friction length of the pipe would be 1.5*34=51 ft

So, the fitting friction is:(1.4*100)/51= 2.8psi per 100 ft(for top floor or roof)

For 9th and 8th floor:

Pressure available for overcoming pipe friction in 9th and 8th floor:

(8+1)+0.434*20-(8+1)=8.68 psi

Adding 50% extra length the pipe length would be= 1.5*20=30 ft

The permissible pressure drop is: 8.68*100/30= 28.93 psi

Floor	FU	Accumulated FU	Demand(gpm)	Actual length(ft)	Equivalent pipe length(ft)	Pressure drop(psi)	Pipe size(inch)
Roof	18/2=9	129	50	34	51	2.8	2.5
9th	60	120	47	10	15	28.93	1.5
8th	60	60	33	10	15	28.93	1.5

Over head tank design:

Total daily demand for downfeed zones = 50gpm=272.05m^3/day

1 hour pumping 5 times daily. So, the tank volume should be 272.05/5 = 54.41 m^3

Water requirement for firefighting= 1000 lpm * 30 min (building type: light hazard-1)

= 30 m^3

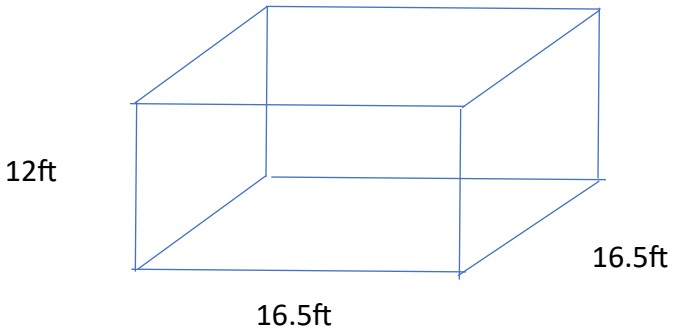
Total tank volume, V = (54.41 + 30) m^3 = 84.41 m^3

From the floor plan the length and width of the overhead tank used is 5.02m=16.5ft.

So, the depth of the overhead tank=84.41/(5.02*5.02)=3.35m=11ft

Freeboard=1ft

Total depth of the overhead tank=12ft



Underground tank:

Total water volume for all 498 fixture units=120gpm=654.53m^3/day

1 hour pumping 6 times daily. So, the tank volume should be 654.53/6 = 109.08 m^3

Water requirement for firefighting= 1000 lpm * 30 min (building type: light hazard-1)

= 30 m^3

Total tank volume, V = (109.08 + 30) m^3 = 139.08 m^3

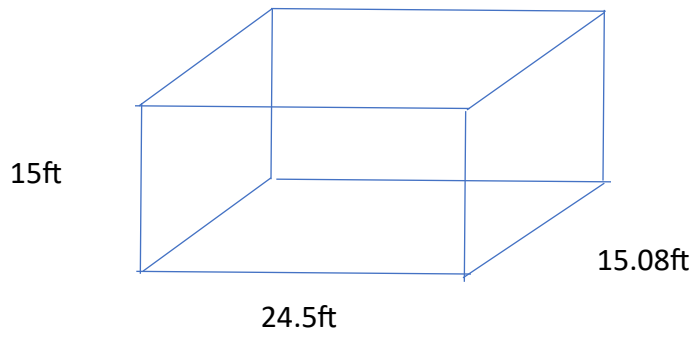
From the floor plan the length and width of the underground tank used is 7.53m=24.5ft

and 4.60m=15.08ft

So, the depth of the overhead tank=139.08/(7.53*4.60)=4.015m=13.17ft

Let, Freeboard=1ft

Total depth of the underground tank = 13.17 + 1 = 14.17 ft = 14 ft



Pump capacity:

Total length of Riser = Total building height + (UGWR depth) + OH tank inlet height Above rooftop surface

➢ L=90ft(Ground floor+2nd to 9th floor)+14+24=128ft

Total frictional head, H_L = (h_L*L/100) + 8 psi required at OHT + 5 psi minor loss due to bend

= (2.17*128/100)+8+5

= 15.78 psi

Frictional head in ft = H_L*144/62.4 = 15.78*144/62.4

=36.42ft

Velocity Head = $v^2/2g = 8^2/2*32$ = 1 ft

So, Total head, H = Static head + Velocity head + Friction head = 128 + 1 + 36.42 = 165.42ft

Assuming efficiency, E = 60%

The overhead tank demand is 50gpm.

In, overhead tank design 1 hour pumping daily 5 times was considered

So, Demand, Q=50/5=10gpm

I want to fill the tank under 30 minutes.

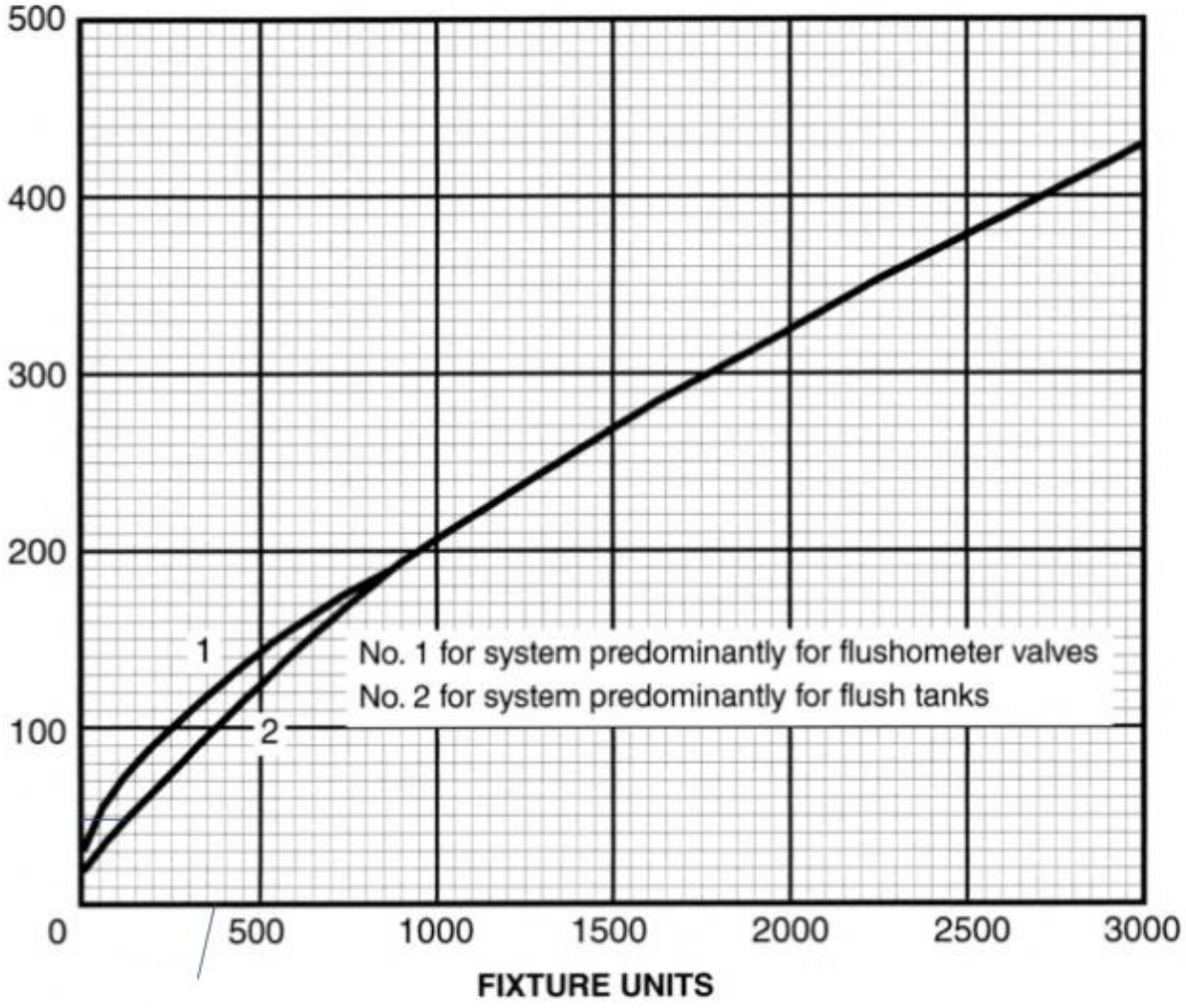
So, the demand for the pump is 10*2=20gpm=Q

Required Capacity of the pump = HQ/ (3960*E) = (165.42*20)/ (3960*0.60) = 1.39HP = 2 HP

So, a Pump of 2 HP will be provided

Figures:

Fixture of Group[b]	Occupancy	Type of Supply Control	Weight in Fixture Units[c]
Water closet	Public**	Flush valve*	10
Water closet	Public	Flush tank*	5
Pedestal urinal	Public	Flush valve	10
Stall or wall urinal,	Public	Flush valve	5
Stall or wall urinal,	Public	Flush tank	3
Lavatory	Public	Faucet	2
Bathtub	Public	Faucet	4
Shower head	Public	Mixing valve	4
Service sink	Office, etc.	Faucet	4
Kitchen sink	Hotel or restaurant	Faucet	4
Water closet	Private**	Flush valve	6
Water closet	Private	Flush tank	3
Lavatory	Private	Faucet	1
Bathtub	Private	Faucet	2
Shower head	Private	Mixing valve	2
Bathroom group	Private	Flush valve for closet	8
Bathroom group	Private	Flush tank for closet	6
Separate shower	Private	Mixing valve	2
Kitchen sink	Private	Faucet	2
Laundry machine	Private	Automatic	2
Laundry machine	Commercial (8 lb)	Automatic	3
Laundry machine	Commercial (16 lb)	Automatic	4


500
400
300
200
100
0
500
1000
1500
2000
2500
3000
1
2
No. 1 for system predominantly for flushometer valves
No. 2 for system predominantly for flush tanks
FIXTURE UNITS

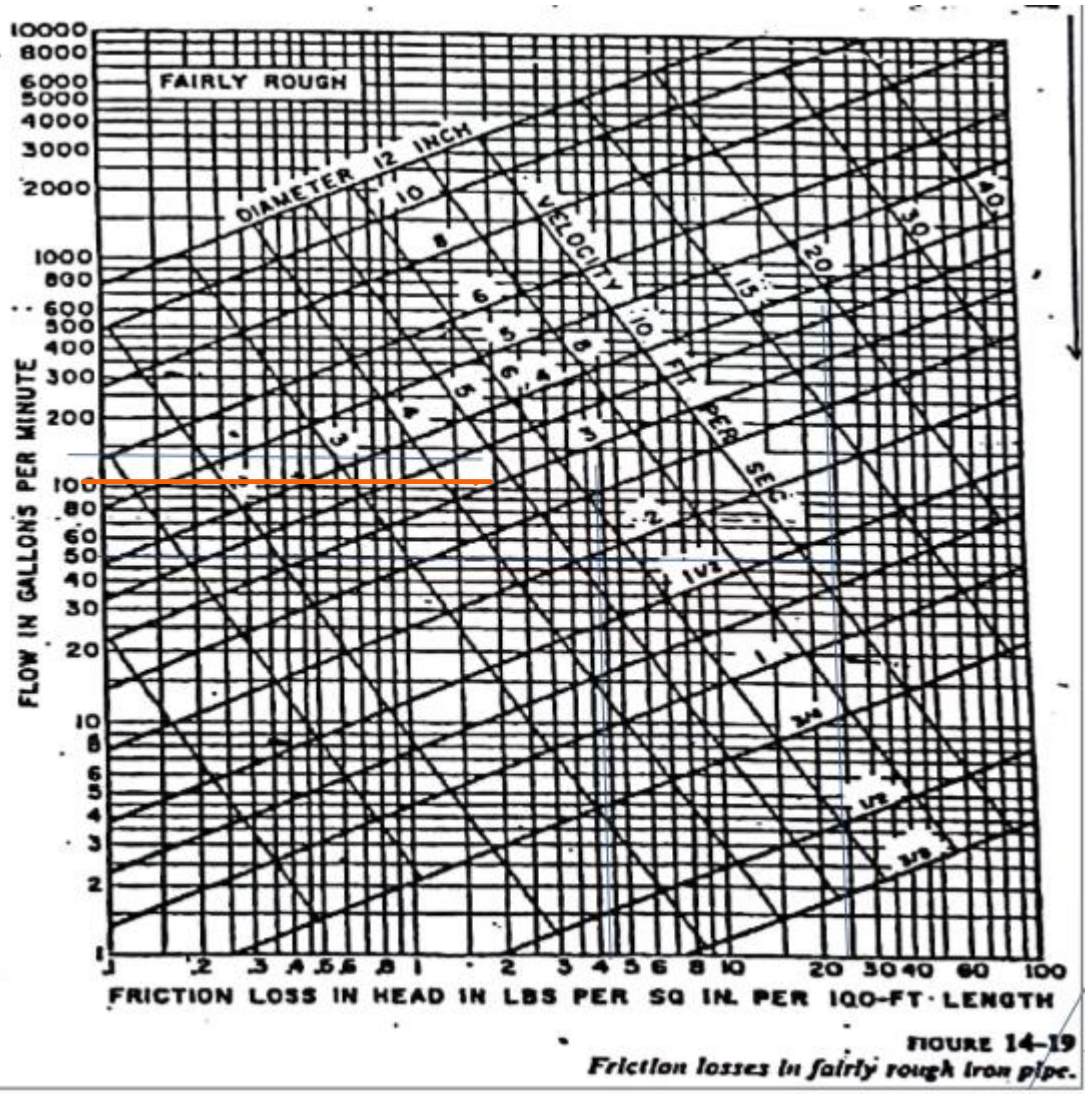
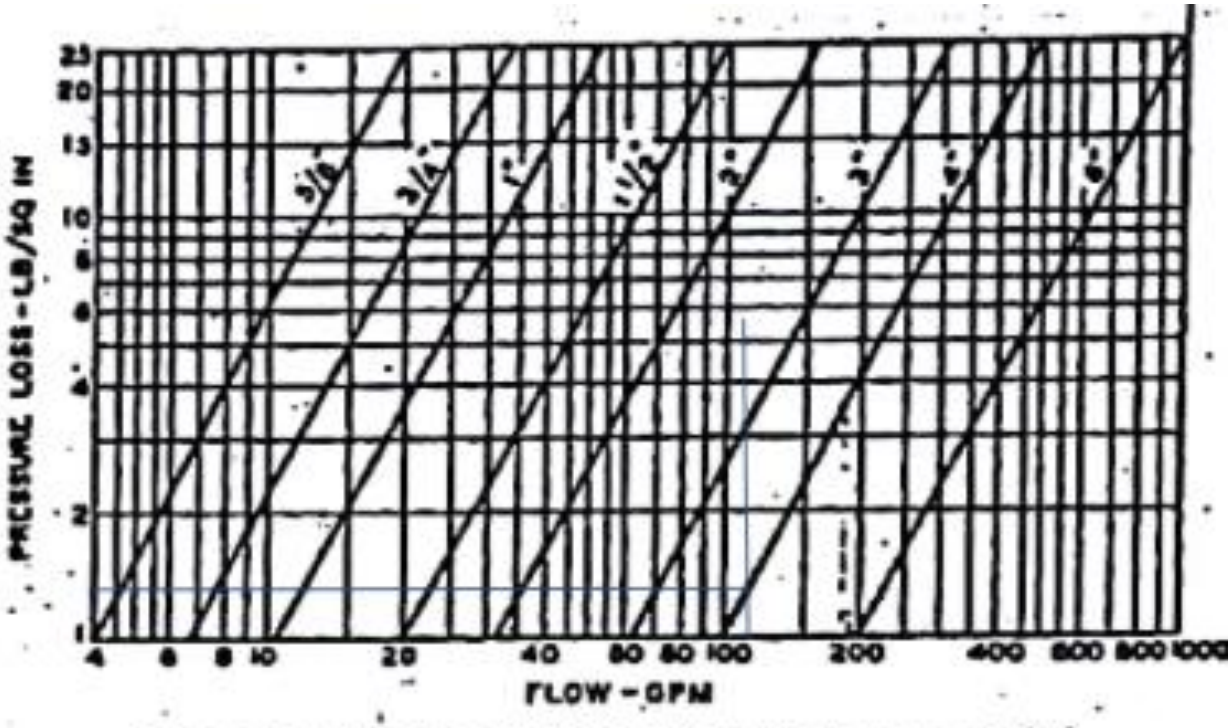


FIGURE 14–19
Friction losses in fairly rough iron pipe.



(See manufacturer's data for exact value for meter used)