

FIGURE C13.27 House tank and downfeed water distribution system.

lated flow will be exceeded occasionally but not permit wasteful oversizing because the estimate will be rarely exceeded.

The method used to calculate the maximum probable demand is based on water fixture units (WFU). Refer to Table C13.1 for WFU values for typical fixtures. Table C13.19 permits determination of the estimated flow rate in gpm for accumulated WFUs at any point in the system. Interpolate to find intermediate values.

Table C13.19 is divided into two columns, one for systems containing flush valve operated water closets in addition to other fixtures, and the other for flush tank water closets and any other fixtures. Use the appropriate column for the specific branch or system under design, with a value of 75 percent of the WFU value for fixtures using both hot and cold water.

Design of the Water Supply Distribution System

The water supply system must achieve the following basic objectives:

1. Deliver an adequate volume of water to the most hydraulically remote fixture during minimum pressure and maximum flow conditions

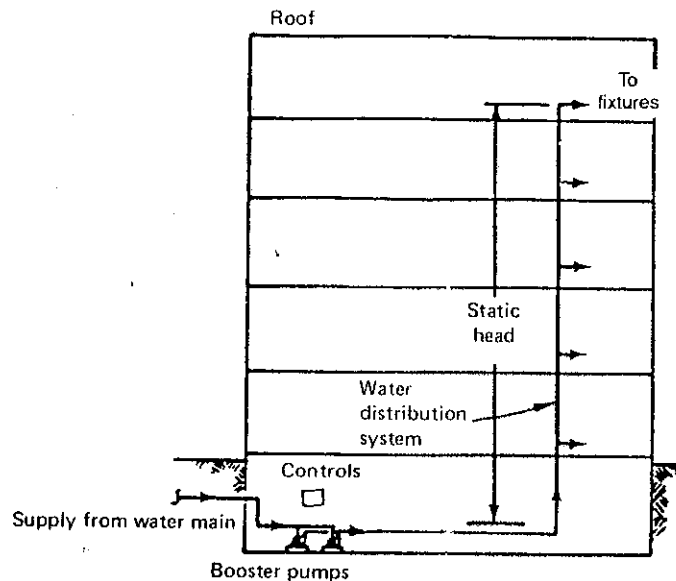


FIGURE C13.28 Booster pump system and upfeed water distribution system.

2. Provide adequate water pressure to the most hydraulically remote fixture during minimum pressure and maximum flow conditions
3. Prevent excessive water velocity during maximum flow conditions

The process of pipe sizing and component selection is an iterative one, requiring the design engineer to first assume initial values, and recalculate if necessary using new values if the initial assumptions prove wrong. Use the following simplified method as a guide to sizing. Additional criteria regarding system components are presented later in this chapter.

The basic method of system design is to first establish values that are fixed, such as fixture operating pressure and the difference in static height of that fixture from the pressure source. The pipe size, which is adjustable, would then be selected so that the remaining system pressure, in the form of friction loss of the water flowing through the pipe, will be used while not exceeding recommended velocity figures. For a pumped system, the design engineer has the ability to increase the total dynamic head of the pump in order to provide additional pressure to the piping network if desired. Simplified design of a street pressure system is as follows:

1. Find the static and residual source water pressure and the elevation at which the pressures are obtained. The residual pressure is the basis of the sizing procedure.
2. Determine by rough calculation if water pressure booster or reducing systems are necessary. If pressure adjustment is required, select the appropriate system.
3. Locate main runs and route the water distribution system piping.
4. Calculate pressure losses in the distribution system as follows:

TABLE C13.19 Maximum Probable Demand, gpm

Water supply fixture units	Maximum probable flow, gpm		Water supply fixture units	Maximum probable flow, gpm	
	Tank-type water closets	Flushometer- type water closets		Tank-type water closets	Flushometer- type water closets
1	1		120	25.9	75.7
2	3		125	26.5	76.5
3	5		130	27.1	77.3
4	6		135	27.7	78.1
5	7	27.2	140	28.3	78.8
6	8	29.1	145	29.0	79.6
7	9	30.8	150	29.6	80.3
8	10	32.3	160	30.8	81.6
9	11	33.7	170	32.0	82.9
10	12.2	35	180	33.3	84.2
12	12.4	37.3	190	34.5	85.3
14	12.7	39.3	200	35.7	86.5
16	12.9	41.2	220	38.1	88.6
18	13.2	42.8	240	40.5	90.5
20	13.4	44.3	260	43.0	92.3
22	13.7	45.8	280	45.4	94.0
24	13.9	47.1	300	47.7	95.6
26	14.2	48.3	400	59.6	102.0
28	14.4	49.4	500	71.2	108.0
30	14.7	50.5	600	82.6	113.0
35	15.3	53.0	700	93.7	117.0
40	15.9	55.2	800	105.0	120.0
45	16.6	57.2	900	115.0	123.0
50	17.2	59.1	1000	126.0	126.0
55	17.8	60.8	1500	175.0	175.0
60	18.4	62.3	2000	220.0	220.0
65	19.0	63.8	2500	259.0	259.0
70	19.7	65.2	3000	294.0	294.0
75	20.3	66.4	3500	325.0	325.0
80	20.9	67.7	4000	352.0	352.0
85	21.5	68.8	4500	375.0	375.0
90	22.2	69.9	5000	395.0	395.0
95	22.8	71.0	6000	425.0	425.0
100	23.4	72.0	7000	445.0	445.0
105	24.0	73.0	8000	456.0	456.0
110	24.6	73.9	9000	461.0	461.0
115	25.3	74.8	10000	462.0	462.0

- a. Estimate the maximum flow in the building water service. This is done by adding all WFUs and converting them to gpm using Table C13.19.
- b. Calculate the loss of pressure in the building water service from the source into the building. Add (or subtract) the height difference between source and height of main distribution piping inside building, friction loss of the service line, meter, BFP, valves, and all equipment contributing to the loss.

- of pressure. Allow 5 to 10 psi for future losses in water supply source pressure, if applicable.
- c. Find the height of the most hydraulically remote fixture from the height of main distribution piping.
 - d. Find the pressure required to operate the most hydraulically remote fixture from Table C13.20.
5. Add the result of Steps b, c, and d together, and subtract from the figure obtained from Step 1.
 6. Calculate the total equivalent run of water piping to the farthest fixture.
 7. Divide the pressure calculated in Step 3 into the pipe run calculated in Step 4 to find the friction loss allowable for the piping system.
 8. Using appropriate pipe friction loss charts or tables and the estimated water demand, size the piping at each design point.

For a pumped system, Steps 1, 3, 4a, and 4b will determine the suction pressure at the inlet to the pump. Steps 4c and 4d will establish the fixed pressure requirements, and the design engineer would then select a pump with enough pressure to allow a reasonable friction loss in the piping system.

Adjusting Water Pressure

If the pressure in the water source is sufficient to supply the most hydraulically remote fixture in a building, a street pressure system is the most economical selection.

When the pressure is not adequate, it must be increased. Systems used are elevated water tank, booster pumps, or hydropneumatic tank systems. Sizing should be based on accepted practices, such as those published by the ASPE. If the pressure is excessive, it must be reduced to an acceptable level.

TABLE C13.20 Minimum Acceptable Operating Pressures for Various Plumbing Fixtures

Fixture	Pressure, psi
Basin faucet	8
Basin faucet, self-closing	12
Sink faucet, $\frac{3}{8}$ in (0.95 cm)	10
Sink faucet, $\frac{1}{2}$ in (1.3 cm)	5
Dishwasher	15-25
Bathtub faucet	5
Laundry tub cock, $\frac{1}{4}$ in (0.64 cm)	5
Shower	12
Water closet ball cock	15
Water closet flush valve	15-20
Urinal flush valve	15
Garden hose, 50 ft (15 m), and sill cock	30
Water closet, blowout type	25
Urinal, blowout type	25
Water closet, low-silhouette tank type	30-40
Water closet, pressure tank	20-30