# Quantity of Water Required for Designing a Water Supply Scheme

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***Abstract*** **- While designing the water supply scheme for a particular city or town it is important to determine the total quantity of water required for various purpose by the city. During planning of water supply scheme first to determine the various types of water demand of the city and to find out the suitable water sources from where demand can be met. The paper contains the various types of water demand, different method of population forecasting and the factors affecting the water demand which is helpful for designing the water supply scheme to determine the quantity of water required.**

***Key words*** **- Population forecasting, quantity of water, water demand**

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**1. Introduction:**

It is very difficult to ascertain the quantity of water required for a particular city. It involves the assumptions of many variable factors and the engineer play an important role in arriving at this quantity. It is also necessary to determine the monthly demand variations in the demand rates. The problem of estimating the quantity of water may be tackled by studying in detail the following three factors:

- Types of demand
- Factors affecting the water demand
- Population forecasting

**2. Types of demands:**

There are so many factors involved in demand of water; it is not possible to determine the actual demand. Based on certain empirical formula and thumb rules are employed in determining water demand which may be nearly to the actual demand. Following are the various types of water demand of a city or town.

**Domestic water demand:**

The total domestic water consumption may amount to 55 to 60 % of the total water demand. This includes the water required in the houses for cooking, washing, bathing, drinking, gardening and sanitary purpose etc. The domestic demand depends upon the living conditions of consumer such as habits, social status, climate condition etc. As per IS-1172-1993 water requirement for domestic purposes for India is about 135 liters/day/capita under normal conditions.Table-1 shows the details of water requirement for domestic purpose.

Table-1 Average domestic water consumption in an Indian city

| Use of Water | Consumption in liters/day/per person |
|---|---|
| Bathing | 55 |
| Washing clothes | 20 |
| Drinking | 5 |
| Cooking | 5 |
| Washing of utensils | 10 |
| Cleaning of houses | 10 |
| Flushing of W.C. | 30 |
| Total | 135 |

**Industrial and commercial water demand:**

This consumption includes water used in factories, hotels, offices, hospital etc. The water requirements of industrial needs of a city are generally taken as 50 liter/day/person. This demand depends upon the nature of the city and types of industries. Generally 20 to 25% of the total water demand may be allowed for industrial water demand. The approximate quantity of water required for industries other than residences as per IS-1172-1993 is given in Table-2.

Table-2 Water supply requirements for building other than residence

| Type of Building | Water requirements liters/day/person |
|---|---|
| Factories | 30-45 |

| | |
|---|---|
| Hospitals (including laundry) per bed | 340-450 |
| Hotel (per bed) | 180 |
| Hostel | 135 |
| Restaurants (per seat) | 70 |
| Offices | 45 |
| Cinema hall and theatres (per seat) | 15 |
| Garden, Sport grounds | 3.5 Per sq.mt. |

**Fire Demand:**

It is the quantity of water required for fighting a fire outbreak. The quantity of water required for fire should be easily available and kept stored in storage reservoir. In the city area fire hydrants are provided on the water mains at 100 to 150 mt apart. The minimum water pressure available at fire hydrants should be 1.0 to 1.5 kg/cm$^2$.The quantity of water required for fire can be found by using some following empirical formula.

- Kuichling's Formula:

  $Q = 3182\sqrt{P}$

  Where Q=amount of water required in liters/minute
  P=Population in thousands
- National Board of fire under Writers formula:

  $Q = 4637\sqrt{P}\left[1 - 0.01\sqrt{P}\right]$

  The formula gives high fire demand, which is not suitable for Indian conditions.
- Freeman's formula

  $Q=1136.5\left[\frac{P}{10} + 10\right]$
- Buston's formula

  $Q = 5663\sqrt{P}$

  For residential cities generally the following fire demand should be adopted as far as possible-Table-3.

Table-3 Fire demand generally adopted for residential cities

| Type of building | Water requirements |
|---|---|
| For town having low building | 2200 liters/minute |
| For town having higher building | 4500 liters/minute |
| For costly market and public places | 7650-13500 liters/minute |
| For three storied colonies | Up to 27000 liters/minute |

**Demand for public use:**

Public demand includes the quantity of water required for public utility purpose such as watering of public parks, gardening, sprinkling on roads, use in public fountains etc. To meet the water demand for public use provision of 5% of the total consumption is made while designing the water works for a city. The requirements of water for public purpose shall be taken as given in Table-4.

Table-4 water requirements for Public purpose

| Purpose | Water requirements |
|---|---|
| Public parks | 1.4 liters/m$^2$/day |
| Street washing | 1.0 -1.5 liters/m$^2$/day |
| Sewer cleaning | 4.5 liters/m$^2$/day |

**Compensate losses demand:**

All the water which goes in the distribution pipe does not reach the consumers. Some water is wasted in the pipe line due to leakage, defective pipe joints, faulty valves and fittings. In some cases, quantity of water is lost due to unauthorized and illegal connections. While estimating the total quantity of water some allowances for these losses and wastages should be done. Which is generally adopted 15% of the total quantity of water is made to compensate for losses, thefts and wastage of water.

**3. Factors affecting per capita demands:**

The annual average demand of water varies widely in Indian cities. It may be vary from 100 to 360 liters/day/person. Following are the main factors which affect the per capita demand of the city.

- Climate conditions
- Size of the city
- Living standard of the people
- Quality of water
- Industrial and commercial activities
- Cost of water
- Pressure in distribution system

- System of sanitation
- System of supply
- Metering and method of charging

**4. Fluctuations in demand of water:**

In practice it has been seen that the per capita demand does not remain uniform throughout the year but it is varies from season to season even from hour to hour. Variation in rate of demand may be termed as

- Seasonal variation: In summer people will use more water in bathing, cooling, lawn watering, street sprinkling etc. so water demand is maximum. This demand is reducing and in winter it becomes minimum because less water will be used in bathing and no lawn watering. These fluctuations may be up to 150 % of the average annual consumption.
- Daily variation: The rate of demand of water may vary from day to day also. Because of habits of the people, climate conditions, holidays etc. The maximum daily consumption may be much as 180 % of the average annual consumption.
- Hourly variation: The rate of demand for water during 24 hours does not remain uniform. It varies according to hour of the day. The maximum hourly consumption may be much as 150 % of the average annual consumption. On Sunday and other holidays the peak hours may be about 8 a.m. due to late awakening whereas it may be 6 a.m. on the other workings days. The peak flow hours and minimum flow hours is shown in figure. A typical graph showing hourly rate of consumption is shown in Fig-1.

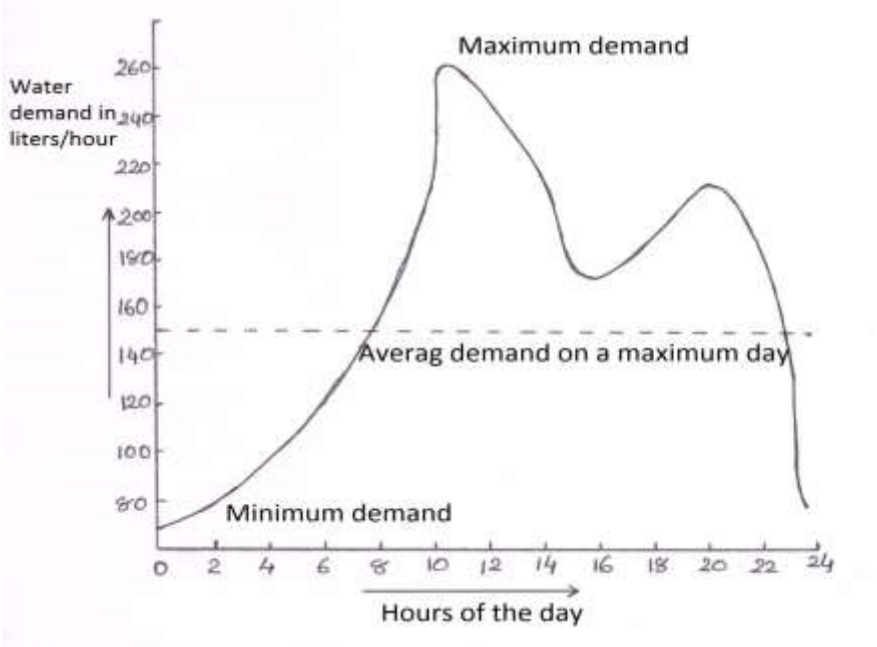


Fig-1 Hourly variation of the rate of consumption

**5. Forecasting Population:**

After deciding the quantity of water required by an individual, the next step is to determine population in various periods for design of water supply scheme. The population are increased by births, by migration, by annexation and decreased by deaths. Mostly water supply scheme are designed for 20 to 30 years. Based on present and past population, the future population can be forecast by using population forecasting methods. The water supply scheme is designed based on future population forecasting. Following are the methods used for population forecast.

**Arithmetical Increases Method:**

This is the simplest method of population forecast which generally give lower results. In this method, the increase in population is assumed to be constant and average increases of decades is calculated and added in the present population to determine population of next future decades.

$$P_n = P + n * i$$

Where, $P_n$ = Future population at the end of n decades
P= Present population
n= no. of decades
i=average increment for a decades

**Geometrical Increases Method:**

In this method it is assumed that the percentage increase in population from decade to decade remains constant. From the available census records the percentage increase in population is found and its average is found.

$$P_n = P\left[1 + \frac{i}{100}\right]n$$

Where, i = yearly percentage of increase

**Incremental Increases Method:**

This method is likely to give high results. Which is the combine the above two methods. The average increase in the population is calculated by arithmetic method and to this is added the average of the net incremental increase once for each future decade.

$$P_n = P + (I + r)n$$

Where, I = average increase in population
r= average incremental increase

**Graphical method:**

In this method the population of last decades is drawn for the city against time with scale on the graph paper. The curve is carefully extended from present to future decades and the population after each successive future decade is read from the curve.

## 6. Conclusion

Based on above study we can say that during designing any water supply scheme it is necessary to determine the total quantity of water required by the city. It is carefully examine the various types of water demand of the city and various factors which influence the rate of demand of water. After` the design period is fixed the next step is to determine population forecasting for the design period.

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