PUBLIC HEALTH ENGINEERING

INTERNALS ASSESTMENT 1

ANSWER ALL QUESTIONS

1) Explain different types of water demand.

Ans

- Domestic water demand: This includes the water required in private buildings for drinking, cooking, bathing, lawn sprinkling, gardening, sanitary purposes etc.
- Industrial water demand: The ‘industrial water demand’ represents the water demand for industries, which are either existing or likely to be started in future, in the city for which water supply is being planned
- Institution and commercial water demand: The water requirements of institutions such as hospitals, hotels, restaurants, schools and colleges, railway stations, offices, factories etc. should also be assessed and provided for in addition to domestic and industrial water demands as discussed above.
- Fire Demand: During the fire breakdown large quantity of water is required for throwing it over the fire to extinguish it. Therefore provision is made in the water work to supply sufficient quantity of water to keep as reserve in the water mains for this purpose In thickly populated and industrial areas, fires generally break out and may lead to serious damages, if no controlled effectively.
- Water required to compensate losses in wastes and thefts:
  Losses due to defective pipe joints, cracked and broken pipes, faulty valves and fittings. Losses due to, continuous wastage of water. Losses due to unauthorized and illegal connections. While estimating the total quantity of water of a town; allowance of 15% of total quantity of water is made to compensate for losses, thefts and wastage of water

2) What is meant by per capita income? List and discuss the factors that affect per capita demant.

Ans. The annual average daily draft in l/day required by a town can be worked out by multiplying the probable number of the persons who are going to use the facilities provided by the scheme, and the annual average daily consumption of each person (for all uses) called per capita demand (q).

If ‘Q’ is the total yearly water requirement of the city by various purposes and ‘P’ is design population of town, then per capita demand will be

Per capita demand = Q / p x 365 liters/day/head

The factors affecting per capita demand are:

- Size of city: If the city is small, the water consumption is less and if the city is big the water consumption will be more.
- Climatic conditions: At hotter and dry places, the consumption of water is generally more, because more of bathing, clearing, air-coolers, air-conditioning etc. are involved. Similarly, in extremely cold countries, more water may be consumed, because the people may keep their taps open to avoid freezing of pipes and there may be more leakage from pipe joints since metals contract with cold.
- Types of Gentry and Habits of people: The rate of consumption will be more due to the better standard of living of persons. The higher status will have more consumption when compared to the middle and lower class people.
- Industrial and Commercial activities: The pressure of industrial and commercial activities at a particular place increases the water consumption by large amount. The water consumption will be more when more industries are located and more commercial activities are taking place in the city. Also there is no direct connection with the population or the size of the city.
- Quality of water Supplies: Improved water quality will lead to more water consumption. Unpleasant taste and odour will lead to reduced water consumption. If the quality and taste of the supplied water is good, it will be consumed more, because in that case, people will not use other sources such as private wells, hand pumps, etc. Similarly, certain industries such as boiler feeds, etc., which require standard quality waters will not develop their own supplies and will use public supplies, provided the supplied water is up to their required standards.
- Pressure in Distribution System: Increase in distribution pressure will increase the water consumption. Increase of 2-3 kg/cm2 lead to increase in water consumption to an extent of about 25 to 30 %. If the pressure in the distribution pipes is high and sufficient to make the water reach at 3rd or even 4th storage, water consumption shall be definitely more.

- Development of Sewerage Facilities: The water consumption will be more, if the city is provided with ‘flush system' and shall be less if the old ’conservation system’ of latrines is adopted.
- System of supply: Water may be supplied either continuously for all 24 hours of the day, or may be supplied only for peak period during morning and evening. The second system, i.e. intermittent supplies, may lead to some saving in water consumption due to losses occurring for lesser time and a more vigilant use of water by the consumers.
- Cost of water: If the water rates are high, lesser quantity may be consumed by the people. This may not lead to large savings as the affluent and rich people are little affected by such policies.
- Policy of metering and method of Charging: Water charges (water tax) may be assigned by two ways
  i) On the basis of meter reading - Installation of meters reduces the rate of consumption
  ii) On the basis of certain fixed monthly flat rate.

  When the supplies are metered, people use only that much of water as much is required by them. Although metered supplies are preferred because of lesser wastage, they generally lead to lesser water consumption by poor and low income group, leading to unhygienic conditions.

3) The following population data are available for a town. Estimate the probable population in the after one, two and three decades by geometrical and incremental increase methods

Year	1930	1940	1950	1960	1970
Population	25000	28000	34000	42000	47000

Ans

3) The population of 5 decades from 1930 to 1970 are given, Find the population after 1, 2, 3 decades beyond the last known decade, by using Geometic Mean Method.

Year	1930	1940	1950	1960	1970
Population	25,000	28,000	34,000	42,000	47000

A.

Year (1)	Population (2)	(3) Increase in Population in each decade	Percentage increase in population ie growth rate (r) $= \frac{Col.(3)}{Col.(1)} \times 100$
1930	25,000		
		3000	$\frac{3000}{25000} \times 100 = 12\%$
1940	28,000		
		6000	$\frac{6000}{28,000} \times 100 = 21.4\%$
1950	34,000		
		8000	$\frac{8000}{34000} \times 100 = 23.5\%$
1960	42,000		
		5000	$\frac{5000}{42000} \times 100 = 11.9\%$
1970	47,000		

The geometic mean of the growth rates (r)

$$r = \sqrt[t]{r_1 r_2 r_3 \dots r_n}$$

$$r = \sqrt[4]{12 \times 21.4 \times 23.5 \times 11.9}$$

$$r = 16.37\% \text{ per decade}$$

Assuming (16.37%) is the constant rate in increase of population, we have

$$P_n = P_o\left(1 + \frac{r}{100}\right)^n$$

$$P_n = P_o(1 + 0.1637)^n$$

$$P_n = P_o(1.1637)^n$$

using n = 1, 2, 3 decades we have,

(a) population after 1 decade beyond 1970

$$P_1 = P_{1980} = 47000(1.1637)^1$$

$$P_1 = \underline{54,694}$$

(b) Population after 2 decade beyond 1970

$$P_2 = P_{1990} = 47000(1.1637)^2$$

$$P_2 = \underline{63,647}$$

(c) Population after 3 decades beyond 1970

$$P_3 = P_{2000} = 47000(1.1637)^3$$

$$P_3 = \underline{74066}$$

Q 5> The population of 5 decades from 1930 to 1970 are given, Find the population after 1, 2 & 3 decades beyon the last known decade, by using Incremental increase method.

Sol.

Year (1)	Population (2)	Increase in Population (3)	Incremental increase i.e increment of the increase (4)
1930	25,000		
		3000	
1940	28,000		(+) 3000
		6000	
1950	34,000		(+) 2000
		8000	
1960	42,000		(-) 3000
		5000	
1970	47,000		
Total		22,000	(+) 2000
Avg. per decade		$\bar{x} = \frac{22,000}{4} = 5500$	$\bar{y} = \frac{2000}{3} = (+) 667$

The future P_n is given by

$$P_n = P_0 + n\bar{x} + n.\frac{(n+1)}{2}.\bar{y}$$

(a) population after 1decade beyond 1970

$$P_{1980} = P_1 = P_{1970} + 1.\bar{x} + \frac{1(1+1)}{2}.\bar{y}$$

$$P_1 = 47000 + 1 \times 5500 + \frac{(1 \times 2)}{2} \times 667$$

$$P_1 = 53,167$$

(b) Population after 2decade beyond 1970

$$P_{1990} = P_2 = P_{19870} + 2.\bar{x} + \frac{2(2+1)}{2}.\bar{y}$$

$$P_2 = 47000 + 2 \times 5000 + 3 \times 667 = 60,001$$

(c) Population after 3decade beyond 1970

$$P_{2000} = P_3 = P_{1970} + 3.\bar{x} + \frac{3(3+1)}{2}.\bar{y}$$

$$P_3 = 47,000 + 3 \times 5500 + 6 \times 667$$

$$P_3 = 67,502$$

4) Explain different types of filtration methods.

Ans. The filters are classified based on their rate of filtration;

- Slow sand gravity filter
- Rapid sand gravity filter
- Pressure filter

Slow sand gravity filter: In the older days slow sand filters were used to treat the raw water and the rapid sand filter replaced it in the modern days. However, they may be still preferred on smaller plants at warm places, where covers on filters are not required to protect the filter from freezing

Rapid sand gravity filter: The slow sand filters can yield at a very slow rate and requires huge quantities of filtering materials and such filters requires larger space which may prove to be very costly. Therefore, to increase the rate of filtration we are using rapid sand filters or mechanical sand filters.

Pressure filter : Pressure filters are just like rapid sand gravity filters placed in closed vessels and trough which water to be treated is passed under pressure. Since water is passed through such filters at a pressure greater than the atmospheric pressure, it is necessary that these filters are located in air tight vessels. The raw water is pumped into the vessels by means of pumps. The pressure so developed may normally vary between 30 to 70 meter head of water.

5.

Design five slow sand filter beds from the following data for the water works of a town of population 75,000; Per capita demand =135 litres/day/capita

Rate of filtration = 210 litres/hour/m^2

Assume maximum demand as 1.5 times the average demand. Out of five units, one is to be kept as stand by and used while repairing other units.

Average demand of the town = 75000 * 135

= 10.125 * 10^6 lites/ day

Maximum demand= 1.5 * 10.125 * 10^6

= 15 .18 * 10^6 liters/day

Rate of filtration = 210 litres/hour/ m^2

= 210 * 24

= 5040 l/m2/d

Total surface are of the filters required

$$= \frac{\text{maximum daily demand}}{\text{rate of filtration/day}} = \frac{15.18 * 10^6}{5040}$$

=3012 m^2

Out of 5 only 4 units will be used

= 3012 / 4 = 753.5 m^2

A=l*b

The length of the slow sand filter as 2.5 times its width

2.5 b* b = 753.5

B= 17.36m

L= 2.5 * 17.36 = 43.5 m

Size of the slow sand filter unit= 43.5 * 17.4 m