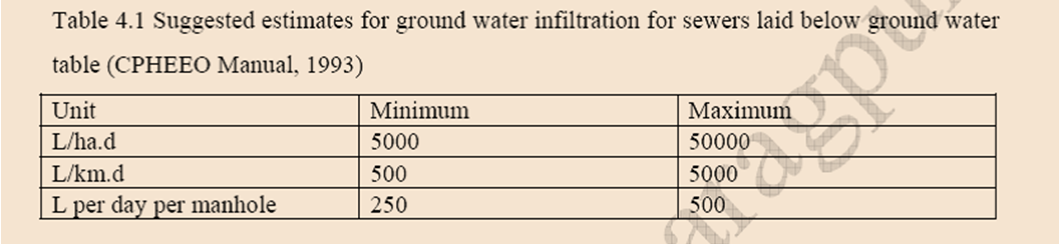
design discharge, following suggested discharge can be considered (Table 4.1).



Storm water drainage may also infiltrate into sewers. This inflow is difficult to calculate. Generally, no extra provision is made for this quantity. This extra quantity can be taken care of by extra empty space left at the top in the sewers, which are designed for running ¾ full at maximum design discharge.

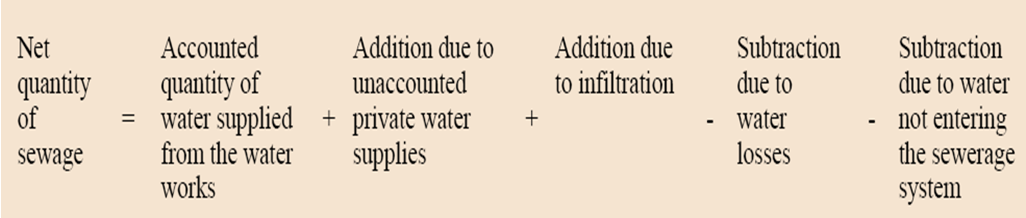
**c. Subtraction due to water losses**

The water loss, through leakage in water distribution system and house connections, does not reach consumers and hence, not appear as sewage.

**d. Subtraction due to water not entering the sewerage system**

Certain amount of water is used for such purposes, which may not generate sewage, e.g. boiler feed water, water sprinkled over the roads, streets, lawns, and gardens, water consumed in industrial product, water used in air coolers, etc.

**Net quantity of sewage:** The net quantity of sewage production can be estimated by considering the addition and subtraction as discussed above over the accounted quantity of water supplied by water authority as below:



Generally, 75 to 80% of accounted water supplied is considered as quantity of sewage produced.

**Variation in Sewage Flow**

Variation occurs in the flow of sewage over annual average daily flow. Fluctuation in flow occurs from hour to hour and from season to season. The typical hourly variation in the sewage flow is shown in the Figure 4.1. If the flow is gauged near its origin, the peak flow will be quite pronounced. The peak will defer if the sewage has to travel long distance. This is because of the time required in collecting sufficient quantity of sewage required to fill the sewers and time required in travelling. As sewage flow in sewer lines, more and more sewage is mixed in it due to continuous increase in the area being served by the sewer line. This leads to reduction in the fluctuations in the sewage flow and the lag period goes on increasing. The magnitude of variation in the sewage quantity varies from place to place and it is very difficult to predict. For smaller township this variation will be more pronounced due to lower length and travel time before sewage reach to the main sewer and for large cities this variation will be less.

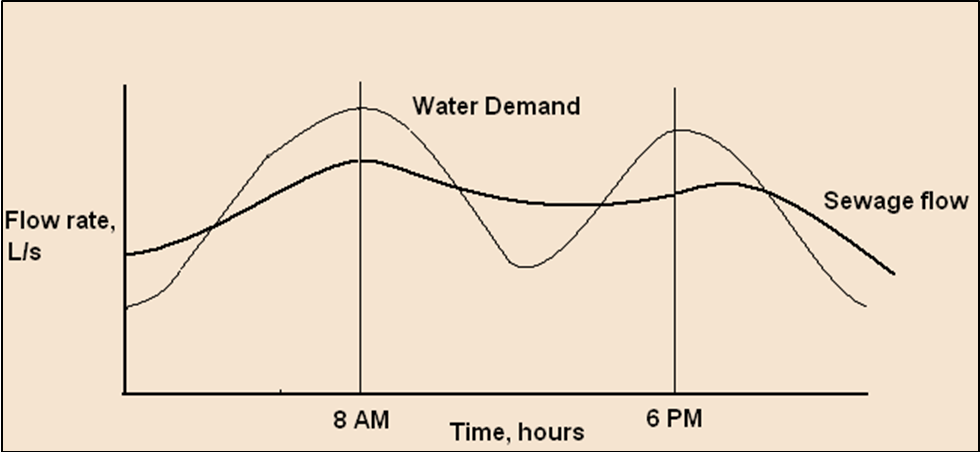


Figure 4.1 Typical hourly variations in sewage flow

For estimating design discharge following relation can be considered:

Maximum daily flow = Two times the annual average daily flow (representing

seasonal variations)

Maximum hourly flow = 1.5 times the maximum daily flow (accounting hourly

variations)

= Three times the annual average daily flow

As the tributary area increases, peak hourly flow will decrease. For smaller population served (less than 50000) the peak factor can be 2.5, and as the population served increases its value reduces. For large cities it can be considered about 1.5 to 2.0. Therefore, for outfall sewer the peak flow can be considered as 1.5 times the annual average daily flow. Even for design of the treatment facility, the peak factor is considered as 1.5 times the annual average daily flow.

The minimum flow passing through sewers is important to develop self-cleansing velocity to avoid silting in sewers. This flow will generate in the sewers during late night hours. The effect of this flow is more pronounced on lateral sewers than the main sewers. Sewers must be checked for minimum velocity as follows:

Minimum daily flow = 2/3 Annual average daily flow

Minimum hourly flow = ½ minimum daily flow

= 1/3 Annual average daily flow

The overall variation between the maximum and minimum flow is more in the laterals and less in the main or trunk sewers. This ratio may be more than 6 for laterals and about 2 to 3 in case of main sewers.

**Design Period**

The future period for which the provision is made in designing the capacities of the various

components of the sewerage scheme is known as the design period. The design period depends

upon the following:

* Ease and difficulty in expansion,
* Amount and availability of investment,
* Anticipated rate of population growth, including shifts in communities, industries andcommercial investments,
* Hydraulic constraints of the systems designed, and
* Life of the material and equipment.

Following design period can be considered for different components of sewage scheme.

1. Laterals less than 15 cm diameter : Full development

2. Trunk or main sewers : 40 to 50 years

3. Treatment Units : 15 to 20 years

4. Pumping plant : 5 to 10 years

**Design Discharge of Sanitary Sewage**

The total quantity of sewage generated per day is estimated as product of forecasted population at the end of design period considering per capita sewage generation and appropriate peak factor. The per capita sewage generation can be considered as 75 to 80% of the per capita water supplied per day. The increase in population also result in increase in per capita water demand and hence, per capita production of sewage. This increase in water demand occurs due to increase in living standards, betterment in economical condition and changes in habit of

people.

**Quantity= Per capita sewage contributed per day x   Population**

**Std. BOD5 = (Std. BOD5 of domestic sewage per person per day) x  
                  (population equivalent)**

**Questions**

1. Write about evaluation of design discharge for sanitary sewage.

2. What is dry weather flow?

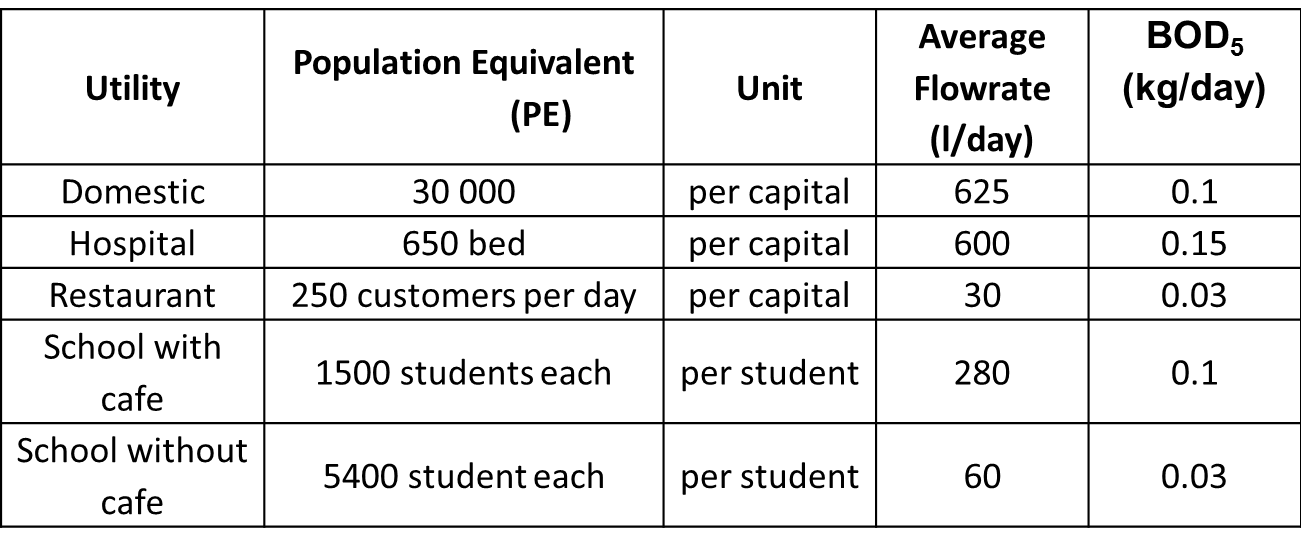
3. Describe variation in sewage flow. How design of different component of

sewerage scheme will be affected due to this variation?

4. What is design period? It depends on what parameters ? Provide design period for different components of the sewerage.

Question: Table shows the information of daily wastewater flow rate and BOD5 concentration for an urban area. Determine the average daily wastewater flow rate and BOD5 concentration.

Example of calculating average daily wastewater flow rate



Solution

i. Calculate the average wastewater flow rate

|  |  |  |
| --- | --- | --- |
| **Utility** | **PE x average daily flowrate** |  |
| Domestic | 30 000 x 625 | 18,750,000 |
| Hospital | 650 x 600 | 390,000 |
| Restaurant | 250 x 30 | 7500 |
| School with cafe | 1500 x 280 | 420,000 |
| School without cafe | 5400 x 60 | 324,000 |
| **Total wastewater flow** |  | **19,891,500 (litre/day)** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Utility**  ii. Calculate the average BOD5 concentration | **Population**  **Equivalent**  **(PE)** | **BOD5 (kg/day)** | **PE x BOD5** | |  | |
| Domestic | 30 000 | 0.1 | 30000x0.1 | | 3000 | |
| Hospital | 650 bed | 0.15 | 650x0.15 | | 97.5 | |
| Restaurant | 250 customers per day | 0.03 | 250x0.03 | | 7.5 | |
| School with cafe | 1500 students each | 0.1 | 1500x0.1 | | 150 | |
| School without cafe | 5400 student each | 0.03 | 5400x0.03 | | 162  Kg/day  Liter/day | |
| **Total BOD5**  Convert unit to mg/L | | | | **3417**  **kg/day** | |
| **Average BOD5 concentration**  **=Total BOD5 /Total wastewater flow rate** | | | | **3417**  **19,891,500**  **=0.000172** | |