Environmental Engineering – Module 2: Sewage and Wastewater Management

1. Sewage: Domestic and Storm Water

Domestic Sewage

- Wastewater generated from residential and commercial sources including toilets, kitchens, bathrooms, and laundries.
- Contains organic matter, pathogens, nutrients, and suspended solids.
- Also referred to as domestic wastewater or sanitary sewage.

Storm Water

- Rainwater runoff collected from rooftops, roads, pavements, and other surfaces.
- Can carry sediments, oils, and other pollutants.
- Requires proper quantification and management to prevent flooding and pollution.

2. Quantity and Variations in Sewage Flow

- **Quantity estimation:** Based on per capita water use and infiltration/inflow.
- Typical sewage quantity is 70-90% of the water supply quantity.
- **Flow variations:**
  - Diurnal variation due to daily activities.
  - Seasonal variation influenced by rainfall and water use patterns.
  - Stormwater inflow during rainy seasons increases sewage volume.

3. Conveyance of Sewage

Sewers

- **Definition:** Underground pipelines designed to carry sewage from sources to treatment plants.
- **Types of Sewers:**
  - **Sanitary Sewers:** Carry domestic sewage only.
  - **Storm Sewers:** Carry only stormwater runoff.

- **Combined Sewers:** Carry both sewage and stormwater (less common due to pollution concerns).

Shapes of Sewers

- Common cross-sectional shapes:
  - Circular
  - Egg-shaped (common for varying flow rates)
  - Rectangular or trapezoidal (less common)

Design Parameters of Sewers

- Hydraulic gradient, pipe diameter, flow velocity (typically 0.6 to 3 m/s)
- Self-cleansing velocity to avoid sediment deposition (minimum ~0.6 m/s)
- Slope of sewer line to maintain flow by gravity.

Operation and Maintenance

- Regular cleaning to prevent blockages.
- Inspection for leaks, corrosion or infiltration.
- Maintenance of access points such as manholes.

4. Sewage Pumping

- Required when gravity flow is not possible due to terrain or layout constraints.
- Pumps lift sewage to higher elevations or into sewer mains.
- Pump types include centrifugal pumps commonly used in sewage pumping stations.

5. Sewerage and Sewer Appurtenances

- **Sewerage System:** Network of pipes, pumping stations, manholes, and treatment units for sewage management.
- **Appurtenances include:**
  - Manholes: Access points for inspection and cleaning.
  - Ventilation shafts: Prevent accumulation of gases.
  - Inverted siphons: For crossing obstacles.
  - Junction chambers: Combine flows from branches.

6. Design of Sewerage Systems

- Layout to maintain gravity flow as much as possible.
- Adequate pipe sizing to handle peak flow rates.
- Provision for future expansion.
- Manhole spacing per local codes (usually 30–90 meters).
- Consideration of infiltration and exfiltration control.

7. Small Bore Systems

- Sewage collection systems that separate black water (toilet waste) from grey water (kitchen, bath).
- Black water is conveyed separately to treatment; grey water may be disposed or recycled differently.
- Useful for water-saving and reducing treatment load.

8. Storm Water: Quantification and Design

- **Quantification:** Based on rainfall intensity, catchment area, runoff coefficients.
- Methods like Rational Method ($Q = CiA$) are used for peak discharge estimation.
- **Design:** Stormwater drains sized to convey peak flows without flooding.
- Separation of stormwater from sewage to reduce treatment load and environmental impact.

9. Sewage and Sullage

- **Sewage:** Black water including toilet and other organic wastes.
- **Sullage:** Grey water from domestic washing and kitchens.
- Proper segregation reduces treatment complexity.

10. Pollution Due to Improper Sewage Disposal

- Contamination of water bodies with pathogens, organic matter causing oxygen depletion.
- Spread of waterborne diseases.
- Eutrophication due to nutrient loading.
- Groundwater contamination.

11. National River Cleaning Plans

- Government initiatives aimed at reducing pollution loads.
- Programs like the National River Conservation Plan (NRCP), National Ganga River Basin Authority (NGRBA).
- Emphasis on sewage treatment, industrial effluent control, and community participation.

12. Wastewater Treatment

12.1 Aerobic Treatment Systems

- Treatment in presence of oxygen.
- Biological oxidation of organic matter.
- Examples: Activated sludge process, trickling filters, oxidation ponds.

12.2 Anaerobic Treatment Systems

- Treatment without oxygen.
- Decomposition of organics producing biogas (methane).
- Examples: Anaerobic digesters, septic tanks.

12.3 Suspended Growth Systems

- Microorganisms suspended in wastewater.
- Activated sludge, aerated lagoons.

12.4 Attached Growth Systems

- Microorganisms attached on media surfaces.
- Trickling filters, rotating biological contactors.

13. Recycling of Sewage

- Treated wastewater reused for irrigation, industrial uses, groundwater recharge.
- Quality requirements vary by application (e.g., pathogen limits for irrigation).
- Ensures water conservation and reduces environmental discharge.

If you want, I can prepare notes for any specific subtopics, design calculations, or example problems related to this module. Just let me know!