Unit-1

DOMESTIC WATER DEMAND:

The quantity of water required in houses for drinking, bathing, cooling, washing, etc., is called domestic water demand.

Social Status mainly depends on climatic conditions and the habits of the people.

As per IS: 1172 - 1993, the minimum domestic consumption for a town with a full flushing system should be taken under normal conditions in India is 135 lpcd (liters per capita per day).

Quantity of water for:

- Drinking - 5 liters
- Cooking - 5 liters
- Bathing - 55 liters
- Clothes washing - 20 liters
- Utensils washing - 10 liters
- House washing - 10 liters
- Flushing of water closets - 30 liters

Total - 135 lpcd

Factors for fully flushing systems:

- Drinking - 5 liters
- Cooking - 5 liters
- Bathing - 75 liters
- Clothes washing - 25 liters
- Utensils washing - 15 liters
- House cleaning - 15 liters
- Flushing of water closets - 15 liters
- Lawn watering & gardening - 15 liters

Total - 200 lpcd

Factors Influencing Domestic Demand:

1. Size of the city:
    - Large size of city -> more demand
    - Small size -> less demand
2. Climatic condition:

- Hot & dry places -> more demand (due to more bathing, air cooling, and drinking)

3. Class of consumer & habits of people:
    - Rich & upper class -> more demand
    - Middle class communities -> less demand
4. Quality of water:
    - More quality of water -> less demand
    - Less quality -> more demand
5. Development of sewerage facilities:
    - City provided with flush system -> more demand
6. Pressure in distribution system:
    - More pressure in conduits -> increases quantity of supply & wastage (leakage if any) -> more demand
7. Cost of water:
    - More cost -> less demand
8. System of supply:
    - Continuous water supply -> more demand
    - Intermittent water supply -> less demand
9. Method of charging:
    - On the basis of meter reading -> less demand
    - On the basis of fixed monthly flat rate -> more demand
10. Alternate source of water:
    - If any alternate source of water -> less demand

Empirical Formulae of Fire Demand

1. National Board of Fire Underwriters Formula:

$Q = 4637 \sqrt{P} (1 - 0.01 \sqrt{P})$

where:

- Q = Fire demand in L/min
- P = Population in thousands

2. Freeman Formula:

$Q = 11.36.5 (P/5 + 18)$

where:

- Q = Fire demand in L/min
- P = Population in thousands

3. Kuichling Formula:

$Q = 3182 \sqrt{P}$

where:

- Q = Fire demand in L/min
- P = Population in thousands

4. Buston's Formula:

$Q = 5663 \sqrt{P}$

where:

- Q = Fire demand in L/min
- P = Population in thousands

Note: Generally, Kuichling's formula provides satisfactory results for ordinary standard conditions.

Factors Affecting Fire Demand

- **Nature of materials of construction and materials stored:**
  - Highly inflammable materials → More demand
  - General materials → Less demand
- **Value of property:**
  - Higher value → More demand
- **Density of population:**
  - Higher density → More demand
- **Frequency of recurrence of fire accidents:**
  - Higher frequency → More demand

Insurance Services Office Formula

$F = 3.7 \times C \times \sqrt{A}$

where:

- F = Fire flow (L/s) (quantity of water available for fire protection)
- C = Coefficient based on inflammability
  - 1.5 for highly inflammable materials
  - 1.0 for ordinary materials
  - 0.6 for fire-resisting objects

- A = Area of building in square meters

Factors Affecting Industrial Water Demand:

1. **Type of Industry:** Industries like textiles, steel, paper, and chemicals have significantly higher water requirements compared to others.
2. **Production Process:** The nature of the production process, including the use of water for cooling, washing, or as a raw material, influences demand.
3. **Product Type:** The type of product manufactured affects water usage. For instance, water-intensive products like paper or textiles require more water.
4. **Production Capacity:** Larger production capacities generally lead to higher water demands.
5. **Water Recovery and Recycling:** Industries with efficient water recovery and recycling systems can reduce their overall water consumption.
6. **Climatic Conditions:** Industries located in regions with hot and dry climates may require more water for cooling purposes.
7. **Government Regulations:** Water quality standards and discharge limits imposed by governments can impact water usage and treatment practices.
8. **Cost of Water:** The price of water can influence the efficiency with which industries use water.

IRRIGATION WATER DEMAND:

Artificial application of water to raise crops from wells, canals, rivers and reservoirs is called irrigation.

IRRIGATION AND WATER:

1. **This water can be supplied to the crops in various ways:**
    - by rainfall
    - by irrigation
    - by a combination of irrigation and rainfall

Irrigation:

Irrigation is the application of controlled amounts of water to plants at needed intervals by means of artificial canals, ditches, etc. Irrigation helps to grow agricultural crops, maintain landscapes and revegetate disturbed soils in dry areas and during periods of less than average rainfall.

Water Needs:

The water need of a crop is usually expressed in mm/day, mm/month or mm/season. Suppose the water need of a certain crop in a very hot, dry climate is 10 mm/day. This means that each day the crop needs a water layer of 10 mm over the whole area on which the crop is grown.

The crop water needs mainly depend on:

- The climate
- The crop type
- The growth stage

The climate:

In a sunny and hot climate crops need more water per day than in a cloudy and cool climate.

The crop type:

crops like maize or sugarcane need more water than crops like millet or sorghum.

The growth stage of the crop:

fully-grown crops need more water than crops that have just been planted.

The Climate:

In a sunny and hot climate, crops need more water per day than in a cloudy and cool climate. One has to consider the amount of rainfall and water loss trough percolation and evapotranspiration in order to calculate the right amount of irrigation water needed.

Mean daily temperature

Climatic zone	**Low**	**Medium**	**High**
Desert/arid	less than 15°C	(15 - 25°C)	more than 25°C
Semi-arid	4-6 mm	7-8 mm	9-10 mm
Sub-humid	4-5 mm	6-7 mm	8-9 mm
Humid	3-4 mm	5-6 mm	7-8 mm
	1-2 mm	3-4 mm	5-6 mm

Average daily water need of standard grass during irrigation season. Source: FAO (1986)

The Crop Type:

There exist crops like rice or sugarcane, which need more water than crops like beans and wheat. The table below gives some idea about the different seasonal water needs of the most important field crops.

Crop	**Crop water need(mm/total growing period)**

Banana	1200-2200
Barley/Oats/Wheat	450-650
Bean	300-500
Cabbage	350-500
Citrus	900-1200

RECREATION

- Recreation means any activity done for enjoyment. When one is not working.
- Recreational waters refer to rivers, lakes and coastal waters. People use sea recreational water for activities like:
- Swimming
- Surfing (The sport of riding a wave towards shore)
- Water Skiing
- White water sports
- Tender water driving
- Boating
- Recreational waters used for water falls, cascades and fountains, not only for aesthetic beauty of a place, they purify water and create hilarious environment.
- Swimming is the best exercise for all the organ of the body.
  A swimming pool in a colony may be a luxury, but, definitely pays in the long run in improving the public health status.
- Boating through a water body adds to the pleasure - causing great free recreation.

Recreational water quality:

Recreational water quality is important for health, because it can become contaminated with faecal pathogens from human sewage and animal manure.

This contaminated recreational water can cause:

-
    1. Gastrointestinal illness (causing diarrhea and vomiting)
-
    1. Respiratory disorder
-

1. Eye, ear, nose and throat symptoms.

- 1. Hepatitis A (causing fever and jaundice)
- Algal blooms from excess nutrients may also cause health effects through shellfish (con) toxin produced by cyanobacteria.
- Any one can be affected, but, young children, older adults and people with weakened immune system are more vulnerable.
- General contamination of rivers and lakes can occur through:
- a) Point source discharges (Eg. - Discharge of treated waste water)
- b) Diffuse source pollution (Eg - run off. from agricultural land)
- IS 3328: 1993 prescribes the quality tolerance for water used in swimming pools of continuous circulation hygiene.
- Physical Tolerance:
    - Color: less than 8 odouters
    - pH: 7-8
    - PD: 0.1 mg/l
    - Chlorides: 500 mg/l
    - Iron: 0.1 mg/l
    - Turbidity: 10 NTU
    - TDS: 1500 mg/l
    - Alkalinity: 50 to 500 mg/l
    - Al: 0.1 mg/l
- Biological Tolerance
    - MPN (Most Probable Number): $ 10 per 100 ml coliform organisms $ 0.7 of 10 ml bacteria of samples

Types of Dust Palliatives

1. Water

- **Simple and cost-effective.**
- **Requires frequent application.**
- **Less effective in dry climates.**

2. Water Absorbing Products

- **Hygroscopic substances** like calcium chloride and magnesium chloride.

- **Absorb moisture from the air.**
- **Maintain road dampness.**
- **Can be corrosive to vehicles.**

3. Organic Petroleum Products

- **Asphalt emulsions, cutback asphalt, and dust oils.**
- **Bind dust particles together.**
- **Provide longer-lasting effects.**
- **Environmental concerns due to potential pollutants.**

4. Organic Non-Petroleum Products

- **Plant-based options like lignosulfonate and vegetable oils.**
- **More environmentally friendly.**
- **Might have limitations in performance.**

5. Electrochemical Products

- **Enzymes and ionic products.**
- **Relatively new technology.**
- **Potential for effective dust control.**
- **Limited availability and higher cost.**

6. Synthetic Polymer Products

- **Synthetic compounds like polyvinyl acetate.**
- **Strong binding properties.**
- **Durable and long-lasting.**
- **Environmental impact might be a concern.**

7. Clay Additives

- **Bentonite and montmorillonite.**
- **Increase soil cohesion.**
- **Can be effective in specific conditions.**

Selecting the Right Dust Palliative

Choosing the best dust palliative depends on factors like:

- **Climate:** Dry vs. humid conditions.
- **Traffic volume:** High or low traffic.
- **Environmental concerns:** Impact on water bodies and vegetation.

- **Cost-effectiveness:** Initial and long-term costs.
- **Durability:** Desired lifespan of the treatment.

Water as a Dust Palliative: A Closer Look

water is a simple and readily available dust palliative. It works by increasing the moisture content of the road surface, causing the soil particles to adhere to each other and reducing dust generation.

Key Points:

- **Effectiveness:** Water's effectiveness is dependent on climatic conditions, with higher humidity and lower temperatures increasing its duration.
- **Application:** Regular, light watering is more effective than less frequent, heavy applications.
- **Equipment:** While water is widely available, its application can be challenging, especially in smaller communities. Equipment like water trucks and specialized spreading systems can be beneficial.
- **Environmental Impact:** Water is generally considered environmentally friendly as a dust palliative, with minimal negative impacts.

Advantages of Water as a Dust Palliative:

- **Low cost:** Water is often a readily available and inexpensive resource.
- **No harmful chemicals:** Water is non-toxic and poses no direct environmental risks.

Disadvantages of Water as a Dust Palliative:

- **Short-term effectiveness:** Water evaporates quickly, requiring frequent reapplication.
- **Ineffective in dry climates:** Water's effectiveness is reduced in hot and dry conditions.
- **Potential for mud:** Excessive water application can lead to muddy conditions.

In conclusion, while water is a simple and environmentally friendly dust palliative, its effectiveness is limited by climatic conditions and requires frequent application. For long-term dust control, other methods may be more suitable.

Transportation

There are mainly 3 modes of transportation:

1. Airways
2. Waterways
3. Land Roads

Waterways

Water transportation is described as the movement of people and freight by boat, ship, barge, or sailboat across oceans, seas, lakes, canals, rivers, or other water bodies.

Types of Water Transport:

1. **Rivers:**
    - This is a local form of water transport responsible for transport in a river within a country.
    - Shallow fresh water bodies in landlocked areas.
2. **Lakes:**
    - In a technical sense, lakes are enclosed bodies of water with varying surface areas and depths.
    - They can range from the size of Bhopal Lake in India to the size of Lake Superior in the United States.
    - Inland waterways.
3. **Coastal:**
    - These are deep-water transportation areas.
    - Both commercial and passenger vessels.
    - International waterways.

Types based on ownership and utility:

1. **Commercial:**
    - All forms of inland or deep-sea vessels dedicated to trade, commerce, and industrial purposes.
    - Oil barges, rice carriers, bulk carriers, etc.
    - An LPG carrier.
2. **Passenger and public transport:**
    - Vessels dedicated to passenger travel as a mode of waterborne public transportation.
    - For pleasure, luxury, recreation purposes.
    - Holiday seekers and travelers.
3. **Private vessels:**
    - Small to medium-sized vessels.
    - Limited to private ownership only.
    - May be limited to organizations.
4. **Defense:**

- Single person or a body of vessels.
- Naval fleet as part of the military.
- Warships, carriers.

Disadvantages of Water Transportation

1. Sluggish and Time-Consuming:

- Water transport is slower than air or land transport, especially over long distances.
- Rivers often have twists and turns, further increasing travel time.
- This can lead to delays in deliveries and missed deadlines.

2. Reliability:

- While air and land transport can be affected by weather, water transport is more susceptible to delays.
- Even short delays can impact businesses that rely on timely deliveries.

3. Port Accessibility:

- Not all ports can accommodate large ships, leading to logistical challenges.
- The absence of suitable port infrastructure in some countries can cause further delays.

4. Journey Frequency:

- Regular routes are common, but less frequent routes can result in longer delivery times.
- Ships require more preparation time compared to other modes of transport.

5. Not Appropriate for Perishable Goods:

- The long travel time makes water transport unsuitable for perishable products.

Necessity of Water

Key Points:

- **Water is required for:**
  - Domestic use
  - Community use
  - Public use
  - Commercial use
  - Industrial use
  - Construction
  - Cultivation

    - Navigation
    - Aquaculture and irrigation

- **Water is also required for:**
    - Recreation
    - Firefighting
    - Rearing up domestic animals
    - Dilution of solutions
    - Public health
- **Water is also used as:**
    - A universal solvent
    - A leveler (effect of solvent on acid and base)
    - An adsorbent and absorbent of impurities

Public Demand:

- **Street Cleaning:** Water used for cleaning streets, roads, and sewers.
- **Public Gardens:** Water for maintaining and irrigating public parks and gardens.
- **Parks, Market, Bus Stations, Railway Stations, and Fountains:** Water required for the upkeep and operation of these public spaces.
- **Fire Protection:** Water dedicated to firefighting purposes, often referred to as fire demand.

Provision for Public Use:

- The text suggests that 5% of the total water consumption in a city should be allocated for public use.
- A general estimate of 10 liters per head per day (lphd) is mentioned for public water demand.

Fire Demand:

- The quantity of water needed for firefighting purposes is termed fire demand.
- It is estimated to be between 5% and 10% of the total water consumption, or 10-20 lphd.
- Fire demand is typically calculated using empirical formulas.

Fire Demand and Flow:

- **Fire flow (F):** 500 liters/minute for inflammable materials, 400 liters/minute for ordinary materials.
- **Minimum streams required:** At least 3 streams for firefighting.
- **Qmin:** Minimum fire demand of 260 liters/minute.
- **Frequency of fire demand (Q):** A formula is provided to calculate this based on duration (e) and period of recurrence (T).

Water as a Fire Extinguisher:

- **Advantages:** Water is generally the cheapest extinguishing agent.
- **Limitations:**
    - Not suitable for all fires, especially those involving certain hazardous materials.
    - Can react violently with some substances, creating flammable or toxic products.
    - Examples given: Reactions of sodium, potassium, and lithium with water.

Crop Water Requirements (mm)

Crop	Water Requirements
Cotton	700-1300
Maize	500-800
Melon	400-600
Onion	350-550
Peanut	500-700
Pea	500-700
Pepper	600-900
Potato	500-700
Rice (paddy)	450-700

Sorghum/Millet	450-650
Soybean	450-700
Sugar beet	550-750
Sugarcane	1500-2500
Sunflower	600-1000
Tomato	400-800

The Growing Stage:

A fully-grown crop needs more water than a newly planted crop. About 50% of the total water required by a crop is needed during the mid-season stage when the crop is fully developed. As the crop grows, the amount of water it needs gradually increases until it reaches its maximum need.

4. Nutrient Requirements:

Plants get nutrients from both the air and water. These include:

- **Carbon (C)**
- **Hydrogen (H)**
- **Oxygen**

Macronutrients: (nutrients needed in large amounts)

- **Nitrogen**
- **Phosphorus**
- **Potassium (K)**
- **Calcium (Ca)**
- **Sulphur**
- **Magnesium (Mg)**

Micronutrients: (nutrients needed in small amounts)

- **Zinc (Zn)**
- **Iron (Fe)**
- **Boron (B)**
- **Copper (Cu)**
- **Chlorine** etc.

5. The three methods of irrigation are:

- **Basin irrigation**
- **Border irrigation**
- **Furrow irrigation**

Basin irrigation: This involves surrounding a piece of land with embankments to form a basin. The basin is then flooded with water. This method offers good control over irrigation water and has high water application efficiency. While the initial set-up cost is high, it requires less labor and has low maintenance costs. Additionally, water wastage and soil erosion are reduced.

Border irrigation: This is a type of surface irrigation where the field is divided into strips separated by border ridges. These ridges run down the slope of the field, and the area between them is flooded during irrigation.

Furrow irrigation: This type of surface irrigation involves digging small trenches or "furrows" between crop rows. Water flows down these furrows, allowing it to seep vertically and horizontally into the soil.

In practice: For small-scale irrigation projects, 40-70 mm of water is typically applied using basin irrigation. For border irrigation and furrow irrigation, 20-50 mm is common. However, in large-scale irrigation projects, these amounts may be much higher.

Advantages of Water Transportation

Economical

Rivers are a naturally occurring transportation route that doesn't require any building or maintenance. Creating and maintaining canals is much cheaper than building and maintaining roadways. Using waterways for transportation, such as irrigation, is very cost-effective. Additionally, the cost of operating water transport is very low.

It is the least expensive method for transporting products between locations. Water transportation has a minimal operating cost, making it the cheapest mode of travel, especially across large distances.

Large boats are more economical to operate since fuel costs are distributed across a larger volume. Distance also has a negligible effect on overall transit costs.

While road and rail transport have very high maintenance costs, water transport has relatively low maintenance costs.

Large Storage Capacity

Ships have a higher capacity for transporting large amounts of goods compared to other modes of transport like rail, truck, or air. This makes water transport particularly well-suited for moving large and heavy items at a low cost.

Safe Mode Of Transport

Weather more readily impacts the departure and arrival times of airplanes. Ships, however, can operate in more complex and unpredictable weather situations due to their durability, resilience, and dependability.

Increased Product Diversity and Transportable Materials

One notable advantage of water transport, especially compared to air transport, is its ability to carry a wider variety of goods. Air transport has strict regulations regarding dangerous materials, often prohibiting liquid or dangerous cargo. Water transport, on the other hand, is often the only option for transporting items like oil, liquids, and other potentially dangerous goods. This makes it crucial for intercontinental transport of such materials.

Environmentally Friendly

Although oil leakage from tanks is a concern, water transport causes very little environmental damage overall. When aiming to reduce CO2 emissions for a greener world, water transport often has a lower carbon footprint compared to other methods. However, this advantage lessens if an oil spill is factored into the comparison.

DILUTION OF WASTE WATERS:

Any concentrated liquid can be diluted by adding water. The diluted water, now less concentrated and transparent, is the best medium to dilute a solution.

Concentrated wastewater (raw sewage) or treated sewage (effluents from a treatment plant) is discharged into a water body; this is called **dilution**.

When concentrated sewage is released into a body of water, the receiving water must be able to carry the additional pollutants safely without causing pollution or nuisance.

Sewage or wastewater disposal can rely on treatment or dilution. Dilution depends on the natural purification processes in the water.

Conditions favoring dilution of wastewater:

i) When sewage is comparatively **fresh**.
ii) When sewage has been mostly **screened** (removing large debris) and most **settleable solids** have been removed.
iii) When it is possible to **thoroughly mix** (diffuse) sewage throughout the diluting water.
iv) When the diluting water has a **high dissolved oxygen (D.O.) content**.
v) When currents are favorable, causing **no depositional nuisance** or destruction of aquatic life.

Standards of Dilution:

1. When available dilution is **500 times** (or more) **crude** sewage (without treatment) may be released into the water body.
2. When available dilution is between **300 to 500 times**, the sewage effluent should not contain suspended solids more than **150 p.p.m. (mg/L)**.
    - Preliminary treatment involving **plain sedimentation** is suggested.
3. When available dilution is between **150 to 300 times**, sewage effluent should not contain suspended solids more than **60 p.p.m. (mg/L)**.
    - **Chemical precipitation** would be an essential treatment.
4. When available dilution is **less than 150 times** the effluent should not contain more than **30 p.p.m.** of suspended solids.

- And 5-day **BOD at 18.3°C** (Biological Oxygen Demand, a measure of organic pollution) should not exceed **20 p.p.m.**
- **Complete treatment** is necessary.