Water Demand Supply & Distribution (CE-562)
Lecture - 5

Engr. Nadeem Ullah
Department of Civil Engineering,
Iqra National University Peshawar

Water Supply Systems (Part – 1)

Introduction

- **Water Supply System is concerned with extraction / provision, treatment and supply of water for municipal, industrial and / or irrigation purposes.**

- **Water supply system includes:**
  - ✓ Water pumping, storage and treatment
  - ✓ Water transmission and distribution

- **Water pumping is concerned with:**
  - ✓ Lifting of water from source to storage
  - ✓ Forcing water through water treatment facilities
  - ✓ Forcing water through transmission and distribution systems

Introduction

- **Water storage could be:**
  - ✓ at source prior to transmission
  - ✓ at the treatment plant (before and/or after)
  - ✓ in between the transmission and distribution systems
  - ✓ within the water distribution system

- **Water treatment could be:**
  - ✓ limited just to disinfection
  - ✓ conventional (suspended & colloidal solids removal, and disinfect)
  - ✓ advanced (softening/demineralization, and removal of heavy metals, fluorides, organics, etc.)

Transmission System

- Conveys water from source(s) to a Distribution system and / or Storage Reservoir(s)
- Untreated and/or treated water is transmitted from source.
- Gravity flow transmission lines, through shortest route bypassing rough/difficult and inaccessible terrain are preferred for surface water source.
- Pumped flow pipelines are used for transmitting water from underground water source.

Transmission System

- Gravity systems are low cost with no energy consumption.
- Pumped systems have high operation and maintenance costs
- Systems pumping to distribution systems often have provisions to send excess water to storage reservoir(s)

Design of Transmission System

- Transmission system is designed to accommodate flow for the Maximum Day Demand (MDD) of the design peroid.

- ✓ Transmission systems directly connected to distribution systems without storage reservoirs are designed for the Maximum Hourly Demand (MHD)

- The smallest diameter transmission line that can be provided should has the average water demand capacity.

- ✓ Variable demand (including seasonal fluctuations) can be accommodated in storage tanks, which are usually designed to handle the daily fluctuations

Design of Transmission System

- ✓ Transmission systems are usually designed for MDD + industrial demand + fire flow capacity.
- ✓ For systems, with storage reservoirs of 20-25% of average day demand (ADD), the capacity is 1.25 times ADD.

- ➢ While sizing the transmission lines, allowance is provided to the loss of carrying capacity due aging and line losses.

- ➢ Flow velocity in the transmission lines should be <1.5 m/sec.
- ✓ Provide multiple conduits if possible (for reliability).

- ➢ Minimum cover (>0.75 m) is provided over the pipeline
- ✓ The cover must be > the frost penetration depth
- ✓ It must be sufficient to support the imposed dead and live loads

Appurtenances

Valves:

- Devices used to control movement of water and/or air through pipelines by opening or closing to different extents: Commonly used types of valves are:

- ✓ Block/isolation valves (allow full flow or no flow)
- ✓ Shutoff valves (at all reasonable locations to isolate pipeline sections for repair and maintenance)
- ✓ Control valves
- ✓ Directional (or check or non-return) valves
- ✓ Pressure reducing valves
- ✓ Air valves (air release valves and vacuum breaking valves)

Appurtenances

- Gauges and meters for measuring flows
- Devices like surge tanks to eliminate water hammer effects
- Joints to attach pipes together or to attach pipes to other devices
- Unions and couplings: provided in pipelines (to join two same dia. pipes) to facilitate repair
- ✓ couplings are cheaper than unions

- Reducers, elbows and reducing elbows, tees (for pipe size reduction, for change of flow direction)
- Tees and crosses (for dividing flows)

Materials and Coating

- Commonly used materials:
  - ✓ Cast iron, ductile iron and mild steel
  - ✓ Pre-stressed concrete, reinforced cement concrete, asbestos cement
  - ✓ Polyvinyl chloride (PVC)
  - ✓ Plastic pipe

- Selected pipe material should withstand the highest possible pressure in the pipeline:
  - ✓ Non-metallic pipes may be used only in non-freezing climates
  - ✓ Iron and steel pipes subjected to freezing must be insulated or protected
- Pipe material degradation by ultraviolet must be protected.

Factors in Selecting Pipeline Materials

- **Flow Characteristics**: friction head loss and flow capacity
- **Pipe Strength:** working pressure and bursting pressure rating should be adequate to meet the operating conditions of the system
- **Durability:** sufficient life expectancy considering the operating conditions and the soil conditions of the system

Factors in Selecting Pipeline Materials

- **Type of Soil:** Select the type of pipe that suits the type of soil
- ✓ acidic soil can easily corrode G.I. pipes
- ✓ very rocky soil can damage plastic pipes unless properly bedded in sand

- **Availability:** Select locally manufactured/fabricated pipes whenever available.

- **Cost of Pipes**:
- ✓ Initial cost
- ✓ Installation cost

Water Distribution Systems

- Objective is to distribute adequate quantity of water at adequate pressure to individual consumers
- ✓ The treated water transmitted and/or stored is distributed

- Main elements of a water distribution systems:
- ✓ Pipe network with necessary valves and other appurtenances
- ✓ Pumping stations and Storage facilities
- ✓ Service connections with valves and fittings
- ✓ Fire hydrants (provided only on ≥150 mm size distribution lines)

Water Distribution Systems

- Layout of a distribution system is determined by:
- ✓ Size and location of water demands
- ✓ Street patterns and topography
- ✓ Location of water treatment and storage facilities

- A service area can have more than one distribution systems

Requirements of Good Distribution System

- Water quality should not get deteriorated in the distribution pipes.
- It should be capable of supplying water at all the intended places with sufficient pressure head.
- It should be capable of supplying the requisite amount of water during fire fighting.
- All the distribution pipes should be preferably laid one meter away or above the sewer lines.
- It should be fairly water-tight as to keep losses due to leakage to the minimum.

Layouts of Distribution System

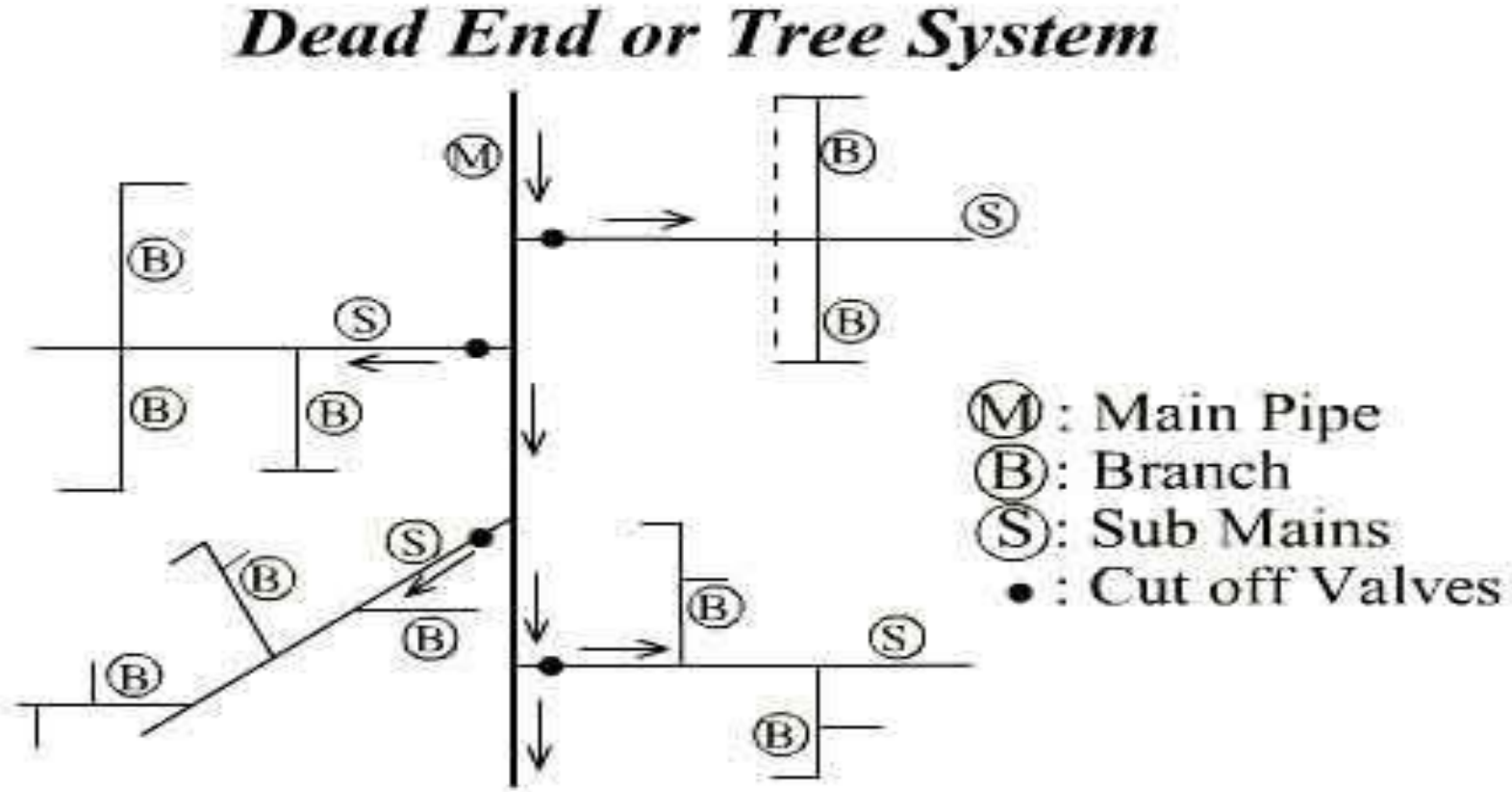
- The distribution pipes are generally laid below the road pavements, and as such their layouts generally follow the layouts of roads.
- There are in general four different types of pipe networks; any one of which either single or in combination, can be used for a particular place.

They are:

- ✓ Dead End System
- ✓ Radial System
- ✓ Grid Iron System
- ✓ Ring System

(1) Dead End System

- It is suitable for old towns and cities having no definite pattern of roads.



(1) Dead End System

Advantages:

- ✓ Relatively cheap.
- ✓ Determination of discharges and pressure easier due to less number of valves.

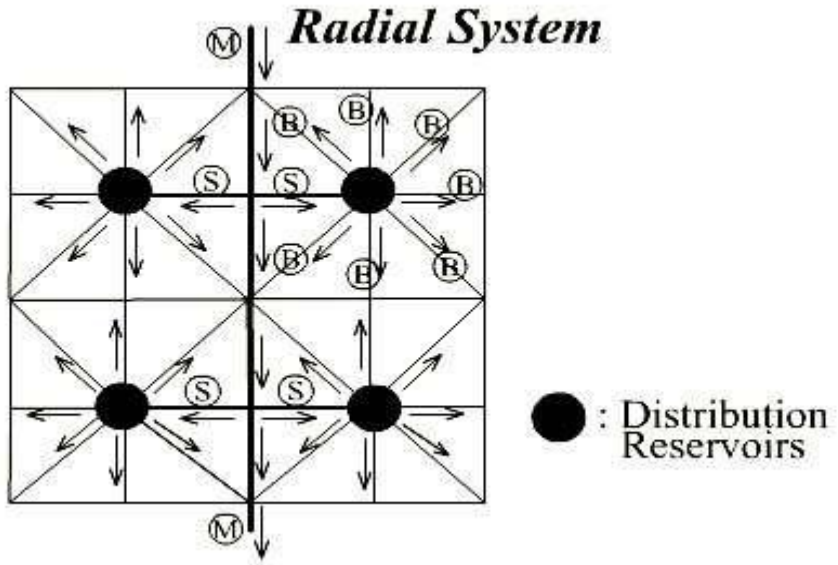
Disadvantage:

- ✓ Due to many dead ends, stagnation of water occurs in pipes.

(2) Radial System

The area is divided into different zones.

- ✓ The water is pumped into the distribution reservoir kept in the middle of each zone.
- ✓ The supply pipes are laid radially ending towards the periphery.

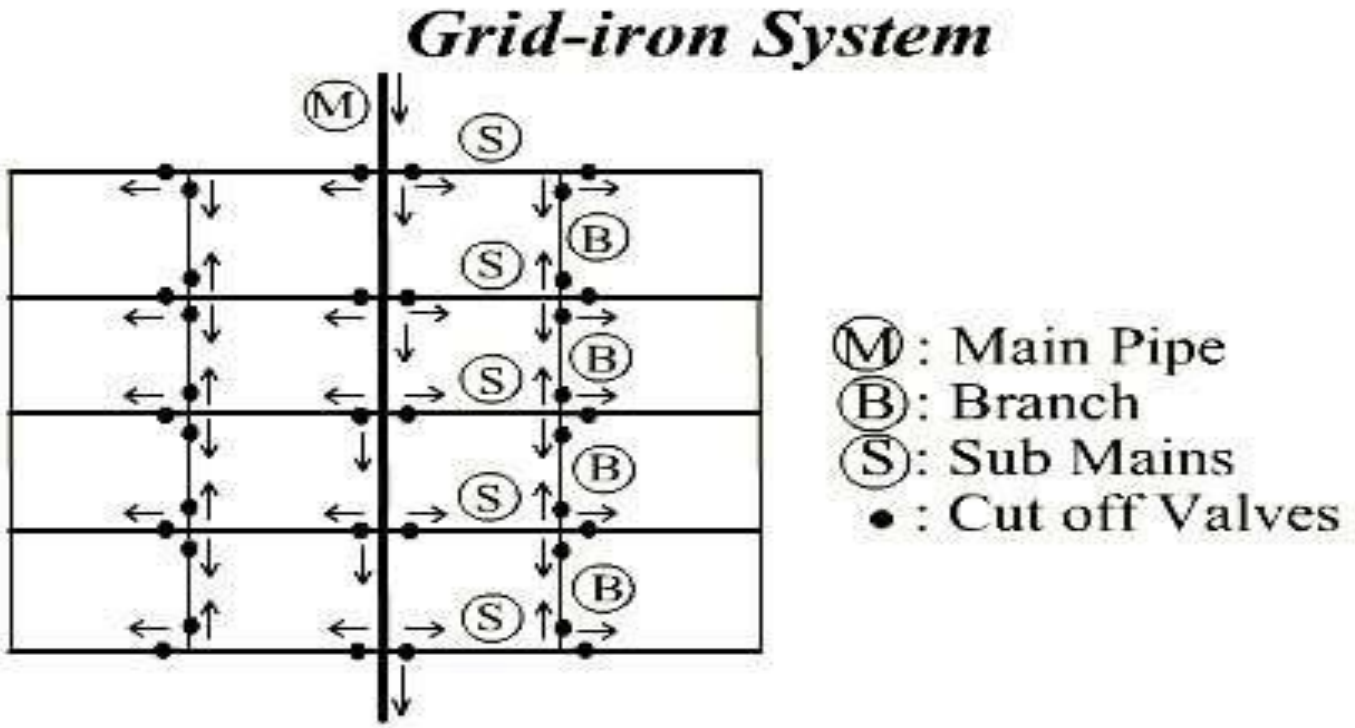


Advantages:

- ✓ It gives quick service.
- ✓ Stagnation does not occur.

(3) Grid-iron System

- It is suitable for cities with rectangular layout, where the water mains and branches are laid in rectangles



(3) Grid-iron System

Advantages:

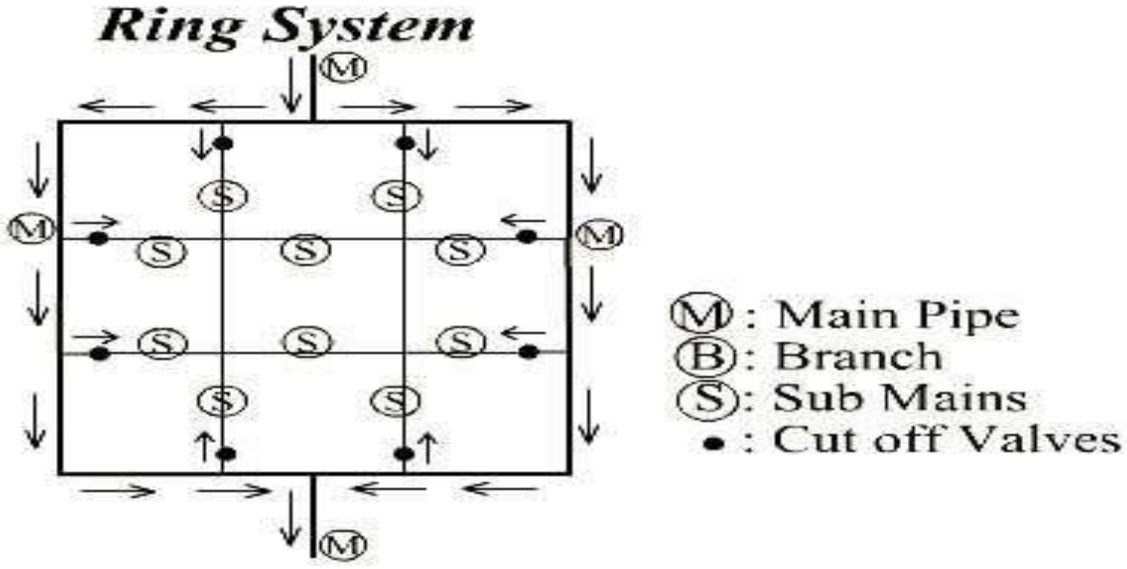
- ✓ Water is kept in good circulation due to the absence of dead ends.
- ✓ In the cases of a breakdown in some section, water is available from some other direction.

Disadvantage:

- ✓ Proper designing is relatively difficult.

(4) Ring System

- The supply main is laid all along the peripheral roads and sub mains branch out from the mains.
- This system also follows the grid iron system with the flow pattern similar in character to that of dead end system.
- So, determination of the size of pipes is easy.



Advantage:

- ✓ Water can be supplied to any point from at least two directions.

Thank You