IQRA NATIONAL UNIVERSITY

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Course Title: Water Supply Demand And Distribution

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Q 01: Define desalination and briefly describe its various types which method is most effectively, Describe?

ANSWER : As populations increase and sources of high quality fresh drinking water decrease, many communities have considered using desalination processes to provide fresh water when other sources and treatment procedures are uneconomical or not environmentally responsible. Desalination is any process that removes excess salts and other minerals from water. In most desalination processes, feed water is treated and two streams of water are produced:

- Treated fresh water that has low concentrations of salts and minerals
- Concentrate or brine, which has salt and mineral concentrations higher than that of the feed water

The feed water for desalination processes can be seawater or brackish water. Brackish water contains more salt than does fresh water and less than salt water. It is commonly found in estuaries, which are the lower courses of rivers where they meet the sea, and aquifers, which are stores of water underground.
An early U.S. desalination plant was built in 1961 in Freeport, Texas. It produced 1 million gallons per day (mgd) using a long vertical tube distillation (LVT) process to produce water for the City of Freeport, Texas. As technology rapidly improves, two other processes—thermal and membrane—are becoming viable options to convert saline water to drinkable fresh water.

Source waters:

Several factors influence the selection of source waters to feed desalination plants: the location of the plant in relation to water sources available, the delivery destination of the treated water, the quality of the source water, the pretreatment options available, and the ecological impacts of the concentrate discharge.

Seawater:

Seawater is taken into a desalination plant either from the water's surface or from below the sea floor. In the past, large-capacity seawater desalination plants have used surface intakes on the open sea.
Although surface water intake can affect and be affected by organisms in the ocean, the issues related to this method can be minimized or resolved by proper intake design, operation, and maintenance of technologies. The technologies include passive screens, fine mesh screens, filter net barriers, and behavioral systems. They are designed to prevent or minimize the environmental impact to the surrounding intake area and to minimize the amount of pretreatment needed before the feed water reaches the primary treatment systems.
Subsurface intakes are sometimes feasible if the geology of the intake site permits. When the water is taken in from below the surface, the process causes less damage to marine life. However, if the geology of the site is unfavorable, a subsurface intake can harm nearby freshwater aquifers. Methods of subsurface intake include vertical beach wells, radial wells, and infiltration galleries.
A major advantage to using a subsurface intake is that the water is filtered naturally as it passes through the soil profile to the intake. This filtration improves the quality of feed water, decreasing the need for pretreatment.

Brackish water:

Brackish water is commonly used as a source for desalination facilities. It is usually pulled from local estuaries or brackish inland water wells. Because it typically has less salt and a lower concentration of suspended solids than does seawater, brackish water needs less pretreatment, which decreases overall production costs. However, a disadvantage is that disposing of the brine from an inland desalination location increases the cost and can raise environmental concerns.

Desalination Technologies:

Two distillation technologies are used primarily around the world for desalination: thermal distillation and membrane distillation.
Thermal distillation technologies are widely used in the Middle East, primarily because the region's petroleum reserves keep energy costs low. The three major, large-scale thermal processes are multistage flash distillation (MSF), multi-effect

distillation (MED), and vapor compression distillation (VCD). Another thermal method, solar distillation, is typically used for very small production rates. Membrane distillation technologies are primarily used in the United States. These systems treat the feed water by using a pressure gradient to forcefeed the water through membranes. The three major membrane processes are electrodialysis (ED), electrodialysis reversal (EDR), and reverse osmosis (RO).

Most effectively used method for desalination is thermal technologies that is describe briefly as fellow;

Thermal Technologies

Multi-stage flash distillation

Multi-stage flash distillation is a process that sends the saline feed water through multiple chambers . In these chambers, the water is heated and compressed to a high temperature and high pressure. As the water progressively passes through the chambers, the pressure is reduced, causing the water to rapidly boil. The vapor, which is fresh water, is produced in each chamber from boiling and then is condensed and collected.

Multi-effect distillation

Multi-effect distillation employs the same principalsas the multi-stage flash distillation process except that instead of using multiple chambers of a single vessel, MED uses successive vessels. The water vapor that is formed when the water boils is condensed and collected. The multiple vessels make the MED process more efficient.

Vapor compression distillation

Vapor compression distillation can function independently or be used in combination with another thermal distillation process. VCD uses heat from the compression of vapor to evaporate the feed water . VCD units are commonly used to produce fresh water for Zsmall- to medium-scale purposes such as resorts, industries, and petroleum drilling sites.

Solar distillation

Solar desalination is generally used for small scale operations. Although the designs of solar distillation units vary greatly, the basic principals are the same. The sun provides the energy to evaporate the saline water. The water vapor formed from the evaporation process then condenses on the clear glass or plastic covering and is collected as fresh water in the condensate trough. The covering is used to both transmit radiant energy and allow water vapor to condense on its interior surface. The salt and un-evaporated water left behind in the still basin forms the brine solution that must be discarded appropriately.

This practice is often used in arid regions where safe fresh water is not available. Solar distillation units produce differing amounts of fresh water, according to their design and geographic location. Recent tests on four solar still designs by the Texas AgriLife Extension Service in College Station, Texas, have shown that a solar still with as little as 7.5 square feet of surface area can produce enough water for a person to survive.

Membrane technologies

A membrane desalination process uses a physical barrier—the membrane—and a driving force. The driving force can be an electrical potential, which is used in electrodialysis or electrodialysis reversal, or a pressure gradient, which is used in reverse osmosis.
Membrane technologies often require that the water undergo chemical and physical pretreatment to limit blockage by debris and scale formation on the membrane surfaces.

Electrodialysis and electrodialysis reversal

The membranes used in electrodialysis and electrodialysis reversal are built to allow passage of either positively or negatively charged ions, but not both. Ions are atoms or molecules have a net positive or net negative charge. Four

common ionic molecules in saline water are sodium, chloride, calcium, and carbonate.
Electrodialysis and electrodialysis reversal use the driving force of an electrical potential to attract and move different cations (positively charged ions) or anions (negatively charged ions) through a permeable membrane, producing fresh water on the other side.

The cations are attracted to the negative electrode, and the anions are attracted to the positive electrode. When the membranes are placed so that some allow only cations to pass and others allow only anions to pass, the process can effectively remove the constituents from the feed water that make it a saline solution.
The electrodialysis reversal process functions as does the electrodialysis process; the only difference is that in the reverse process, the polarity, or charge, of the electrodes is switched periodically. This reversal in flow of ions helps remove scaling and other debris from the membranes, which extends the system's operating life.

Reverse osmosis

Reverse osmosis uses a pressure gradient as the driving force to move high-pressure saline feed water through a membrane that prevents the salt ions from passing.

There are several membrane treatment processes, including reverse osmosis, nanofiltration, ultrafiltration, and microfiltration. The pore sizes of the membranes differ according to the type of process .

Because the RO membrane has such small pores, the feed water must be pretreated adequately before being passed through it. The water can be pretreated chemically, to prevent biological growth and scaling, and physically, to remove any suspended solids.
The high-pressure feed water flows through the individual membrane elements. The spiral RO membrane element is constructed in a concentric spiral pattern that allows alternating layers of feed water and brine spacing, RO membrane, and a porous product water carrier . The porous product water carrier allows the fresh water to flow into the center of the membrane element to be collected in the product water tube.

To enable each pressure vessel to treat more water, the individual membrane elements are connected in series. After the water passes through the membrane elements within the pressure vessels, it goes through post treatment. Post treatment prepares the water for distribution to the public.

Concentrate management options

Both thermal and membrane desalination processes produce a stream of brine water that has a high concentration of salt and other minerals or chemicals that were either removed during the desalination process or added to help pretreat the feed water. For all of the processes, the brine must be disposed of in an economical and environmentally friendly way.
Options for discharging the brine include discharge into the ocean, injection through a well into a saline aquifer, and evaporation. Each option has advantages and disadvantages. In all cases, the brine water should have a minimal impact on the surrounding water bodies or aquifers. Specific considerations for the water quality include saline concentration, water temperature, dissolved oxygen concentrations, and any constituents added as pretreatment.

- **END OF ANSWAR 01**

Q2: Briefly Describe merits and demerits of 4 types of water distribution layout? Which layout will recommended for newly proposed township in hilly area.

ANSWER: The aim of a distribution network is to supply a community with the appropriate quantity and quality of water. There are four network types: dead end, gridiron, circular and radial systems. Investment costs for network construction (material, labour, planning for pipes and trenches) as well as maintenance costs (repair, pumping station, leakage control, preventing recontamination) are high.

Advantages:

Access to clean water if the system is properly designed and managed

No more walking to water source or collecting water from open sources

Disadvantages:

High investment and maintenance costs

Recontamination of drinking water if the system is maintained poorly

In	Out
Freshwater, Drinking Water, Treated Water	Freshwater, Drinking Water, Treated Water

Factsheet Block Body

Networks are a system of pipes and trenches providing the appropriate quality and quantity of water to a community. The network construction and layout have to be carefully prepared in order to guarantee enough pressure and ensure hygienically safe water. Once constructed, maintenance – including repair, leakage control, preventing recontamination, etc. and the operation of pumping stations were gravity pressure is not enough– has to be ensured.

Requirements of an adequate distribution system

Factsheet Block Body

- Water quality should not deteriorate while in the distribution pipes.
- The system should be capable of supplying water to all the intended places with sufficient pressure head.
- It should be capable of supplying the requisite amount of water during firefighting.
- The layout should be such that no consumer is without water supply, during the repair of any section of the system.
- All the distribution pipes should preferably be laid one metre from or above sewer lines.
- It should be fairly watertight to keep losses (e.g. due to leakage) to a minimum.

Network types

Factsheet Block Body

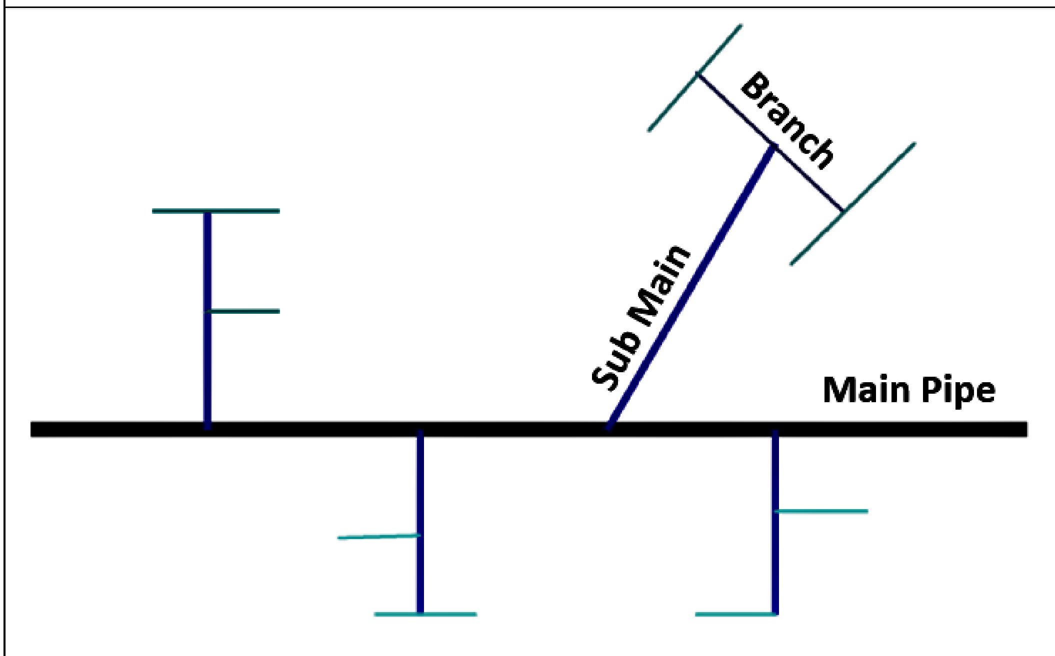
There are four principal methods to design a distribution system:

- Dead end or tree system
- Gridiron system
- Circular or ring system
- Radial system

1. Dead-end or tree distribution system

Description

In the dead end system (also called tree system), one main pipeline runs through the centre of the populated area and sub-mains branch off from both sides. The sub-mains divide into several branch lines from which service connections are provided.



Schematic design of a dead-end distribution system. Source: GONU (2009)

Advantages dead-end System:

- The design calculation is simple and easy.
- A smaller number of cut-off valves are required and the operation and maintenance cost is low.
- Pipe laying is simple

Disadvantages dead-end system:

- The system is less successful in maintaining satisfactory pressure in remote areas and is therefore not favored in modern waterworks practice

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- One main pipeline provides the entire city, which is quite risky
- The head loss is relatively high, requiring larger pipe diameter, and/or larger capacities for pumping units. Dead ends at line terminals might affect the quality of water by allowing sedimentation and encouraging bacterial growth due to stagnation. Water hammer could also cause burst of lines. A large number of scour valves are required at the dead ends, which need to be opened periodically for the removal of stale water and sediment
- The discharge available for fire fighting in the streets is limited due to high head loss in areas with weak pressure
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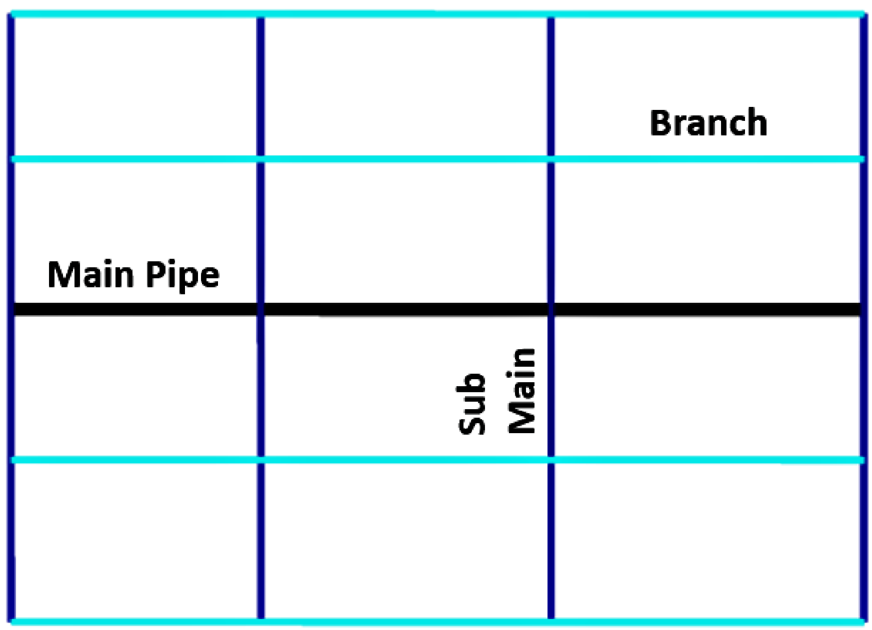
2. Gridiron distribution system

Description:

In this system the main supply line runs through the Centre of the area and sub mains branch off in perpendicular directions. The branch lines interconnect the sub-mains. This system is ideal for cities laid out on a rectangular plan resembling a gridiron. The distinguishing feature of this system is that all of the pipes are interconnected and there are no dead ends. Water can reach a given point of withdrawal from several directions, which permits more flexible operation, particularly when repairs are required.



Design of the Gridiron distribution system. Source: GONU (2009)

Advantages of the Gridiron distribution system:

- The free circulation of water, without any stagnation or sediment deposit, minimizes the chances of pollution due to stagnation.
- Because of the interconnections water is available at every point with minimum loss of head.
- Enough water is available at street fire hydrants, as the hydrant draws water

from the various branch lines.

- During repairs, only a small area of distribution is affected.

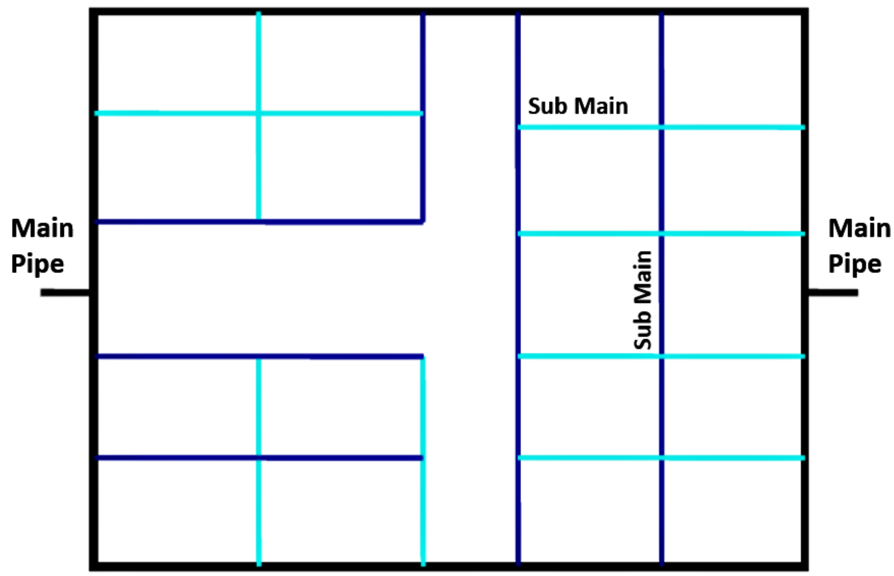
Disadvantages of the Gridiron distribution system:

- A large number of cut-off valves are required.
- The system requires longer pipe lengths with larger diameters.
- The analysis of discharge, pressure and velocities in the pipes is difficult and cumbersome.
- The cost of pipe laying is higher.

3. Circular or ring distribution system

Description:

In a circular or ring system, the supply main forms a ring around the distribution area. The branches are connected cross-wise to the mains and also to each other. This system is most reliable for a town with well-planned streets and roads. The **advantages** and **disadvantages** of this system are the same as those of the gridiron system. However, in case of fire, a larger quantity of water is available, and the length of the distribution main is much higher.



Design of a ring distribution system. Source: GONU (2009)

4. Radial distribution system

Description:

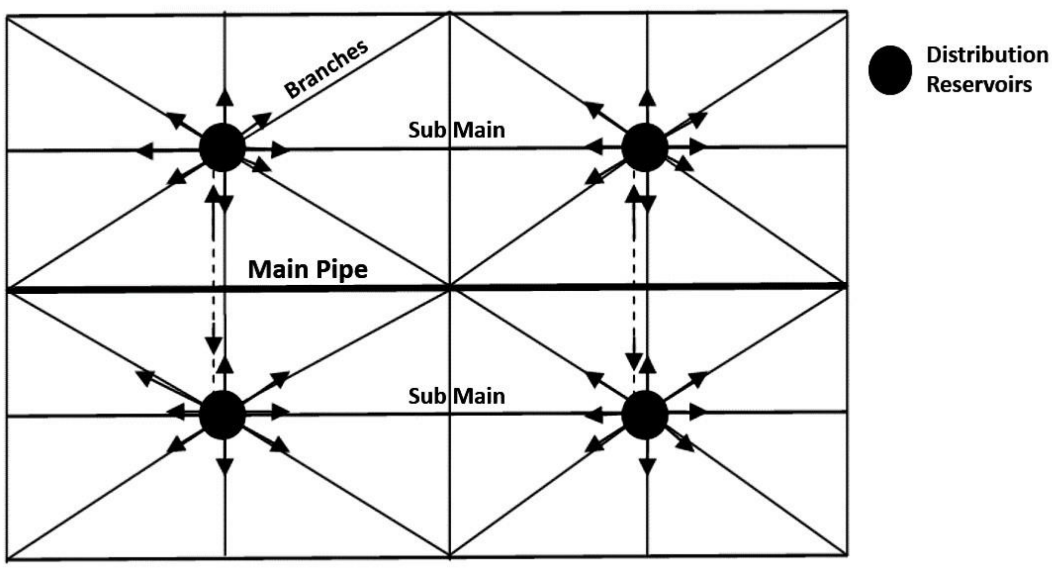
In this system, the whole area is divided into a number of distribution districts. Each district has a centrally located distribution reservoir (elevated) from where distribution pipes run radially towards the periphery of the distribution district. This system provides swift service, without much loss of head. The design calculations are much simpler

. **Advantages of the radial distribution system**

- Simplest as fed at only end.
- The initial cost is low.
- It is useful when the generating is at low voltage.
- Preferred when the station is located at the center of the load.
- More economical for some areas which have a low load requirement
- Require less amount of cables
- It has a low maintenance

Disadvantages of the radial distribution system

• The end of distributor near to the substation gets heavily loaded.
• When load on the distributor changes, the clients at the distant end of the distributor face serious voltage fluctuations.
• As users are dependent on single feeder and distributor, a fault on any of these two causes interruption in supply to all the users connected to that distributor



The radial system. Source: GONU (2009)

Newly proposed township in hilly area: For newly proposed township in hilly area I will recommend Grid iron System because in that system 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.

- **END OF ANSWER 02**

Q3: What are different types of reservoirs used in water supply system? Briefly describe its importance and how its storage capacity be calculated?

Answer: " A water supply scheme drawing water directly from a river or a stream may fail to satisfy the consumers demands during extremely low flows , while during high flows it may become difficult to carry out its operation due to devastating floods , a barrier in the form of dam is , therefore , constructed across the river, so as to form a pool of water on the upstream side of the dam is known as a reservoirs."

Types Of Reservoirs:

1. Storage / conservation reservoir
2. Flood control reservoir
3. Multipurpose reservoir
4. Distribution reservoir

"A storage or a conservation reservoir can retain such excess supplies during periods of peak flows, and can release them gradually during low flows as and when the need arises."

} City water supply} Irrigation water supply} Hydroelectric project It may fail to satisfy the consumers demands during: 1). Extremely low flows 2). High flow It may become difficult to carry out their operations due to devastating floods.

} CONTROLLING FLOOD} REDUCE FLOOD DAMAGE BELOW THE RESERVOIR

"A flood control reservoir , generally calleda flood-mitigation reservoir stores aportions of the flood flows in such a way asto minimise the flood peaks at the areas tobe protected downstream."

} The entire inflow entering the reservoir is discharged till the out flow reaches the safe capacity of the channel downstream.} The inflow in excess of this rate is stored in the reservoir , which is then gradually released , so as to recover the storage capacity for the next flood.} A flood control reservoir differs from a conservation reservoir only in its need for a large sluiceway capacity to permit rapid drawdown before or after a flood.

There are two basic types of flood mitigation reservoirs; (1). Storage reservoir;} (2). Retarding reservoir.

Storage reservoir: „A reservoir having gates and valves installation at its spillway and at its sluice outlets is known as storage reservoir.‟} Retarding reservoir: „A reservoir with uncontrolled and ungated outlets is known as a retarding basin or retarding reservoirs.‟

"A reservoir planned and constructed to serve not only one purpose but various purpose together is called a multipurpose reservoir."

A multipurpose reservoir is a man-made lake which is managed for multiple purposes.} Multipurpose reservoirs may be managed to balance some or all of the following activities: } Water supply} Flood control} Soil erosion} Environmental management} Hydroelectric power generation} Navigation} Recreation} Irrigation

. Bhakra Dam is aconcrete gravity dam across the Sutlej River, and isnear the borderbetween Punjab andHimachal Pradesh innorthern India

} "A distribution reservoir connected with the conduits of a primary water supply; used to supply water to consumers according to fluctuations in demand over short time periods and serves for local storage in case of emergency."

} Such a reservoir can be filled by pumping water at a certain rate and can be used to supply water even at rate higher than inflow rate during period of maximum demands called critical periods of demand.} Such reservoirs are,therefore, helpful in permitting the pumps or the water treatment plants to work at a uniform rate, and they store water during the hours of no demand or less demand, and supply water from their storage during the critical periods of maximum demand.

- **END OF ANSWER 03**

Q 04: Why pumps are used in water supply scheme How to calculate pumps curve to meet waster demand?

Answer: Because it delivers a constant flow of water at a constant pressure for any given set of conditions, the centrifugal pump is ideal for delivering water to customers. Most well pumps are centrifugal pumps. They are ideal for use in the distribution system since they do not produce pulsating surges of flow and pressure.

DEMAND.

GENERAL. Population and water consumption estimates are the basis for determining the flow demand of a water supply and distribution system. Several analyses should be made to investigate alternative piping arrangements within the distribution system. Flow and pressure demands at any point of the system are determined by hydraulic network analysis of the supply, storage, pumping, and distribution system as a whole. Supply point locations such as wells and storage reservoirs are normally known based on a given source of supply or available space for a storage facility.

FACTORS FOR DETERMINING DEMANDS. The hydraulic network analysis should assume the following demand rates:

Annual Average Daily Consumption (ADC)

• Annual Maximum Daily Consumption (MDC)

• Peak Hour Consumption on Annual Maximum Day (MDC/Peak-Hour)

• MDC plus Simulated Fire flow Several analyses should be made to investigate alternative piping arrangements within the distribution system as well as for connecting proposed pumping stations to the distribution system. If future improvements are contemplated, the analysis should be performed based on future conditions, thus assuring the correct selection of the final alternative to be implemented initially.

SYSTEM PRESSURES. The pressure distribution in the system will assume the following criteria: •

Maximum curb pressures (70 psi)

• Minimum curb pressures at any point on the distribution network (usually 30 psi)

• Residual curb pressure to be maintained at a point of simulated fire flow (20 psi minimum) For large distribution system design a pressure contour map will be developed using known topography and the hydraulic network analysis and showing pressure in pounds per square inch. Pressure contours must be adjusted for elevations of surrounding terrain. The pump discharge head will be derived from the system pressures at the pump station location plus the pump station piping head loss. The location of the pump station and intake structure, and the anticipated heads and capacities are the major factors in the selection of pumps. The function of a pump station in the overall distribution system operation can also affect the determination of capacities. Basic pump hydraulic terms and formulas, pump fundamentals and applications, and instructions for installation, operation and maintenance are given in the Hydraulic Institute Engineering Data Book and Hydraulic Institute Standards. It is recommended that these books be part of the permanent library of the fluid system designer.

PUMP TYPES.

01. BOOSTER PUMPS.

02. HIGH LIFT PUMPS.

There are generally two types of pumps used for potable water pumping applications: the vertical turbine pump, line shaft and submersible types, and the centrifugal horizontal or vertical split case pump designed for waterworks service. If the pump station and intake structure are to be located within a surface or underground reservoir, vertical turbine pumps with the column extending down into the reservoir or its suction well will be a logical choice. If the pump station is located at an above ground storage facility, split case centrifugal pumps will be the preferred selection. These pumps are normally horizontal but vertical split case pumps are common where there is limited space. Flexible couplings will connect pump and driver shafts. Split case pump design is used for ease of maintenance of the rotating elements, which can be removed without disconnecting the suction or discharge piping. For standard waterworks design for potable systems, pump casing will be cast iron and impellers will be bronze. Base for pump and driver will be cast iron or fabricated steel. Pump impeller and casing may have wearing rings depending upon manufacturers' recommendations and consideration of the cost of replacing the rings. Pumps will have mechanical seals or packing seals, ball or roller bearings, and lubrication system. Pumps which may operate © J. Paul Guyer – 2012 8 under extreme conditions such as at the ends of pump curves or under frequent on-off operation will have packing seals in lieu of mechanical seals. Mechanical seals will be considered for pumps likely to stand idle for long periods of time. Where scale or abrasive water conditions exist, pump linings and other material options for impeller, shaft, wear rings, and seals are available. A water analysis at the point of service must be secured and analyzed before non-standard materials are selected. Lubrication for horizontal pumps will be oil bath or grease. Vertical dry pit pumps will be grease lubricated. Vertical wet pit pumps will have oil or water lubrication.

- **END OF ANSWER 04**