Water Supply System

RESERVOIRS

METHODS OF DISTRIBUTION

- The method of distribution depends upon the topography of the area. The following methods or systems may be adopted for distribution:

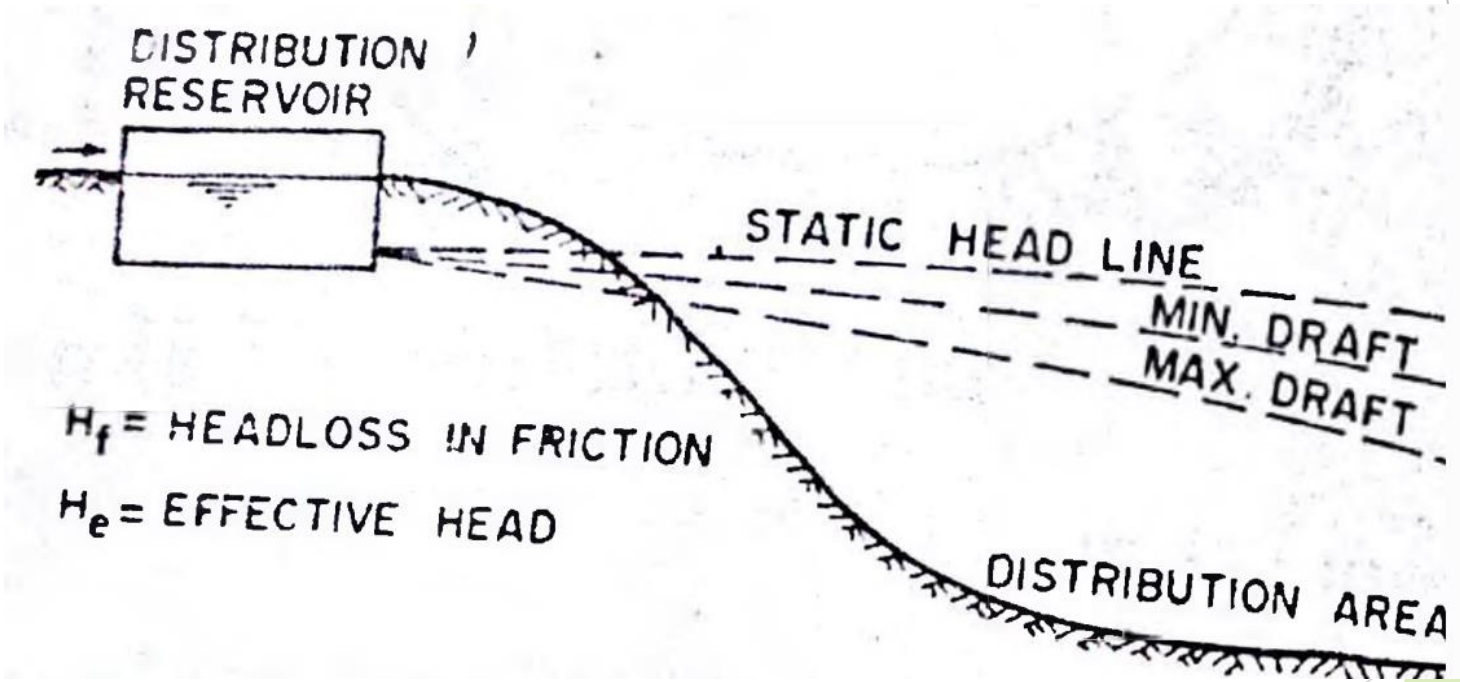
1- Gravity system

2- Pumping system

3- Combined gravity and pumping system

Gravity System

- In the gravity system, the source of the water supply is so located with respect to the area of distribution that water is available with sufficient pressure at various points of the area. No pumping is normally required. However if the purification units are located on a hill, and the source of water supply (i.e a lake or reservoir) is also located behind the hill, pumping may be required to convey water from the raw water source to the purification works. The purified water then flows entirely under gravity. This is the most reliable and economical distribution system.



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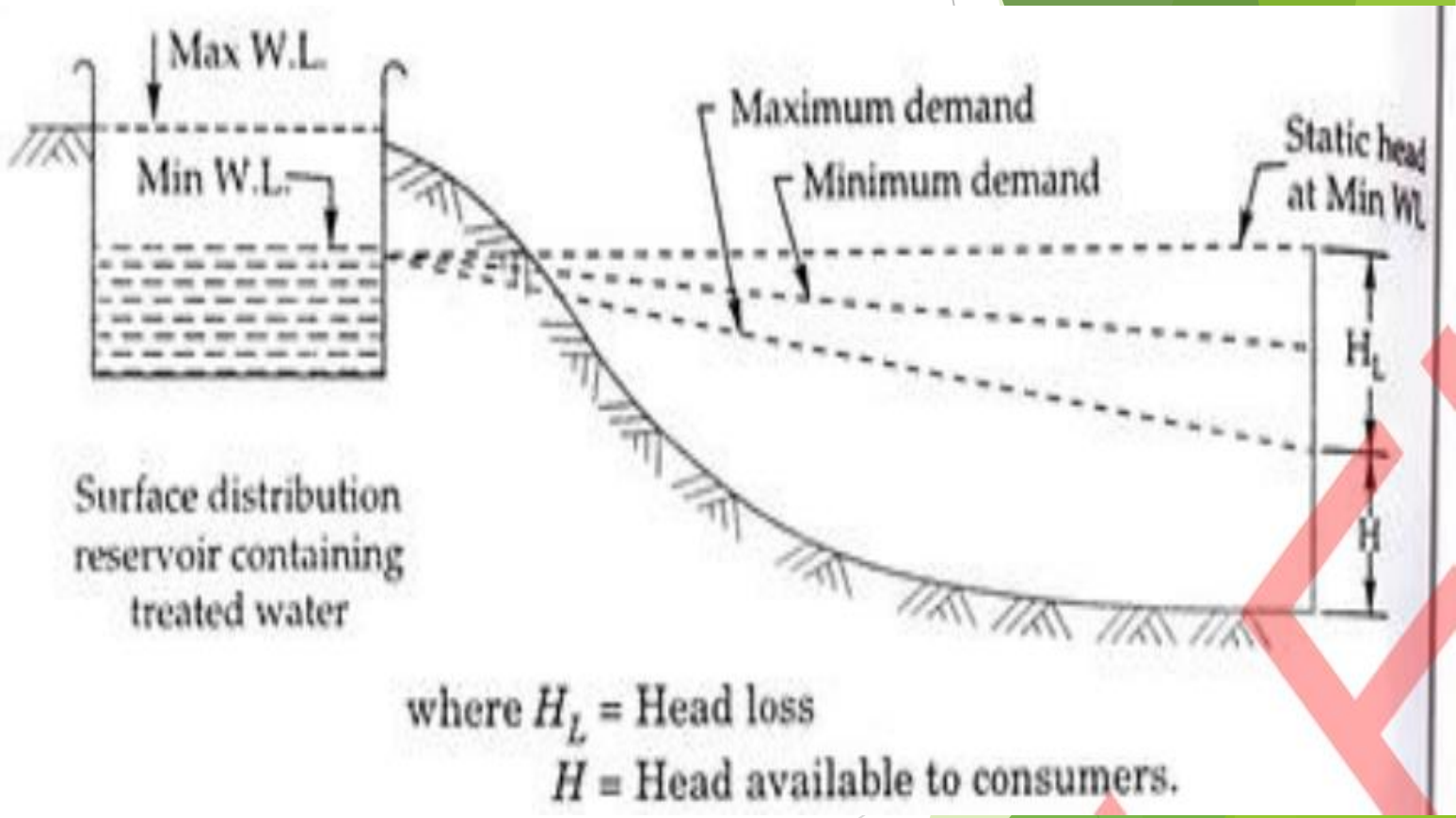
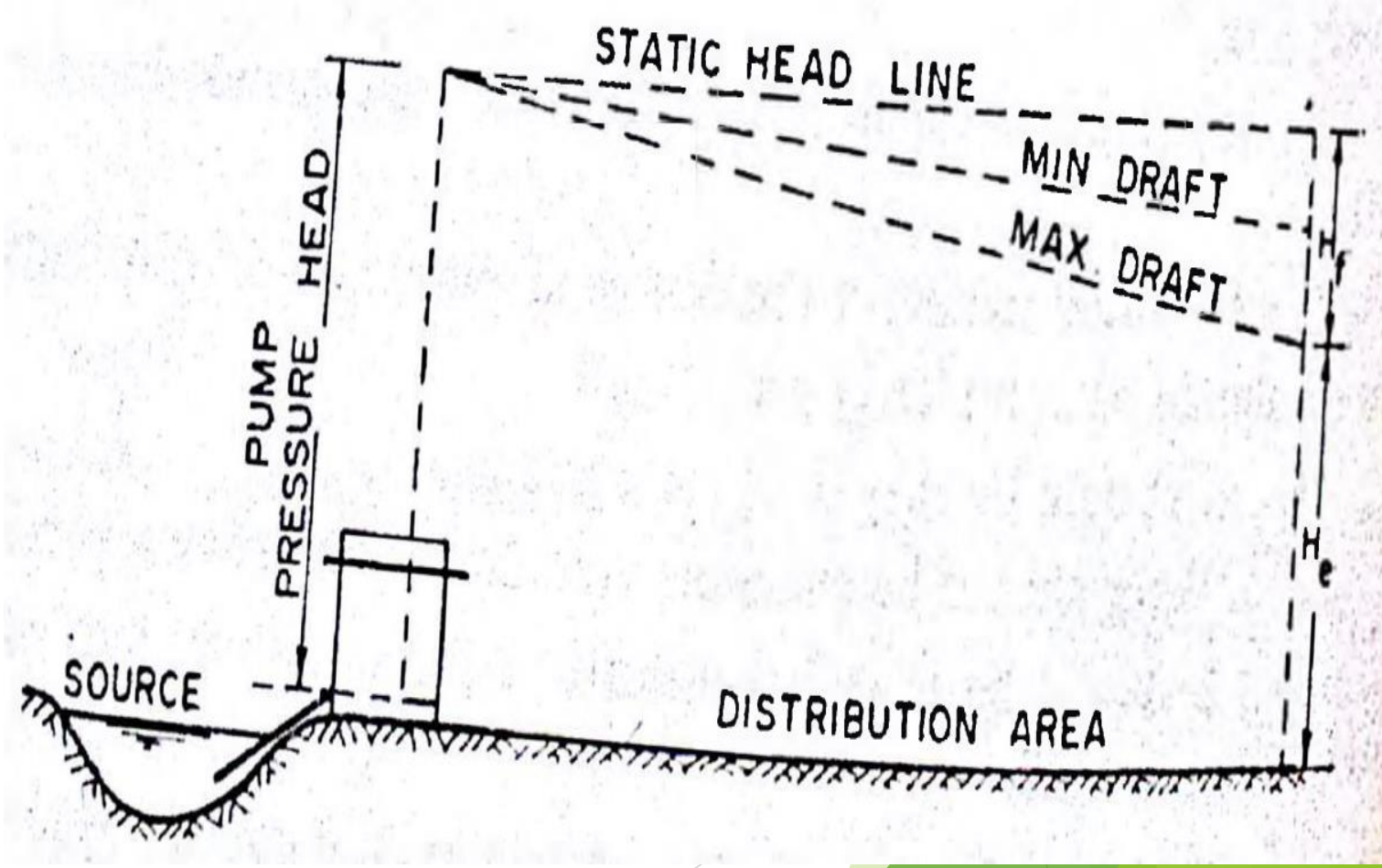


Pumping system

- In this system, water is pumped directly into the distribution system to achieve the required pressure,. Such a system is not desirable. Tenerally double pumping is required, first to pump raw water from the source to the treatment works and then to pump purified water direct into the distribution mains. The pmumps have to be run at varying speeds accoding tho the variations in the consumption. In case of the power failure, the entire water distribution system of the locality is distrurbed. The system also requires constant attendance.



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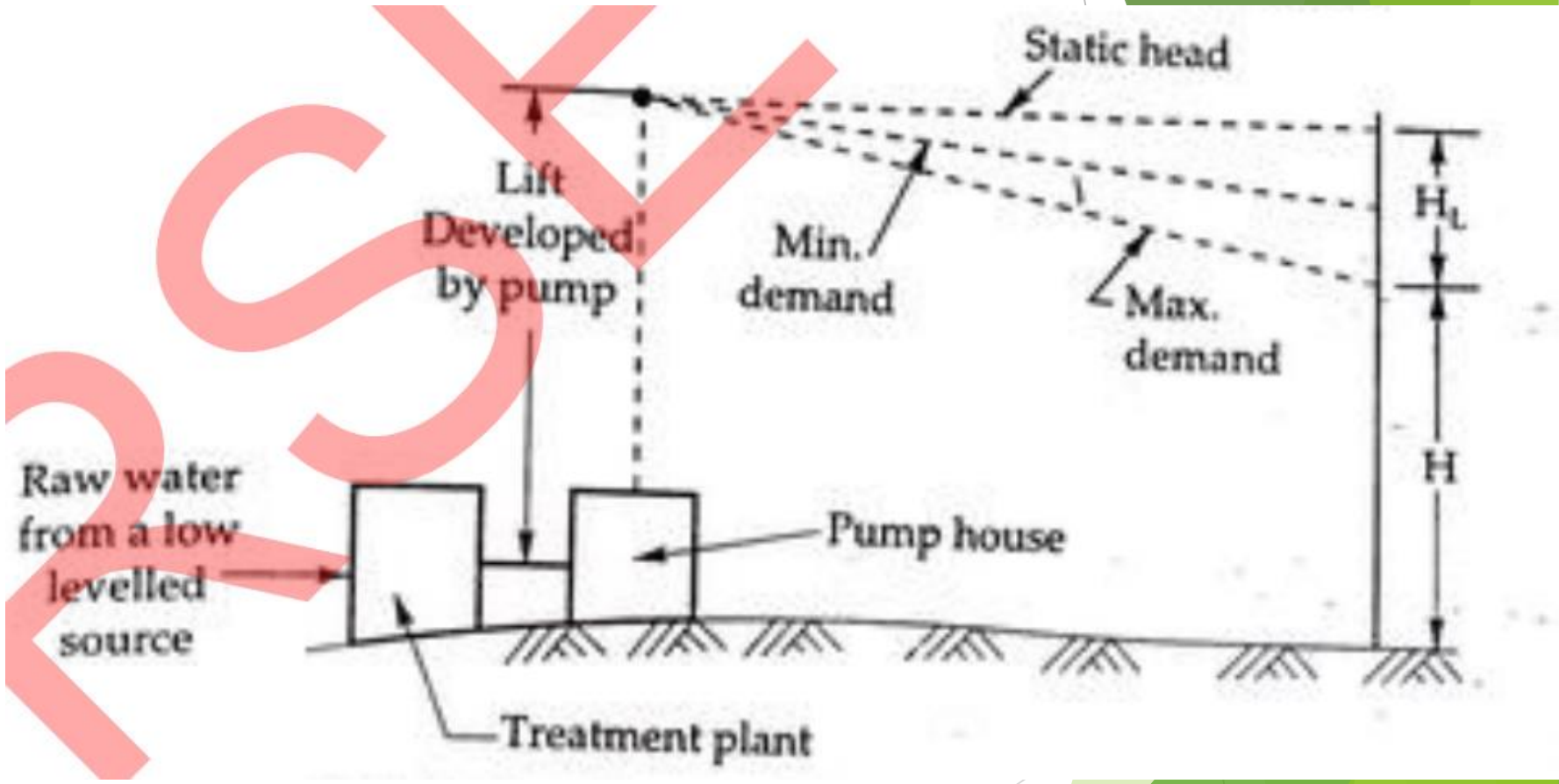
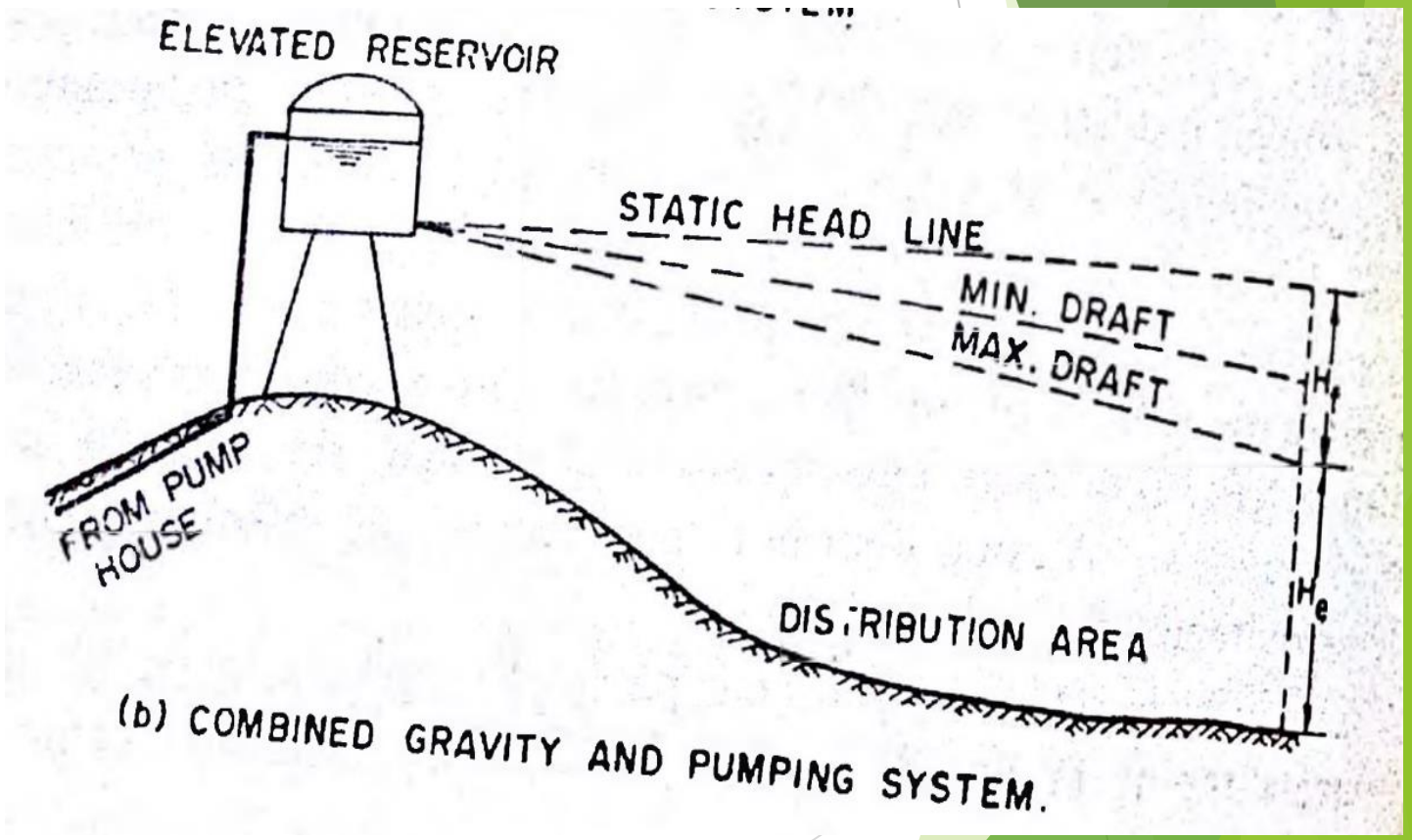


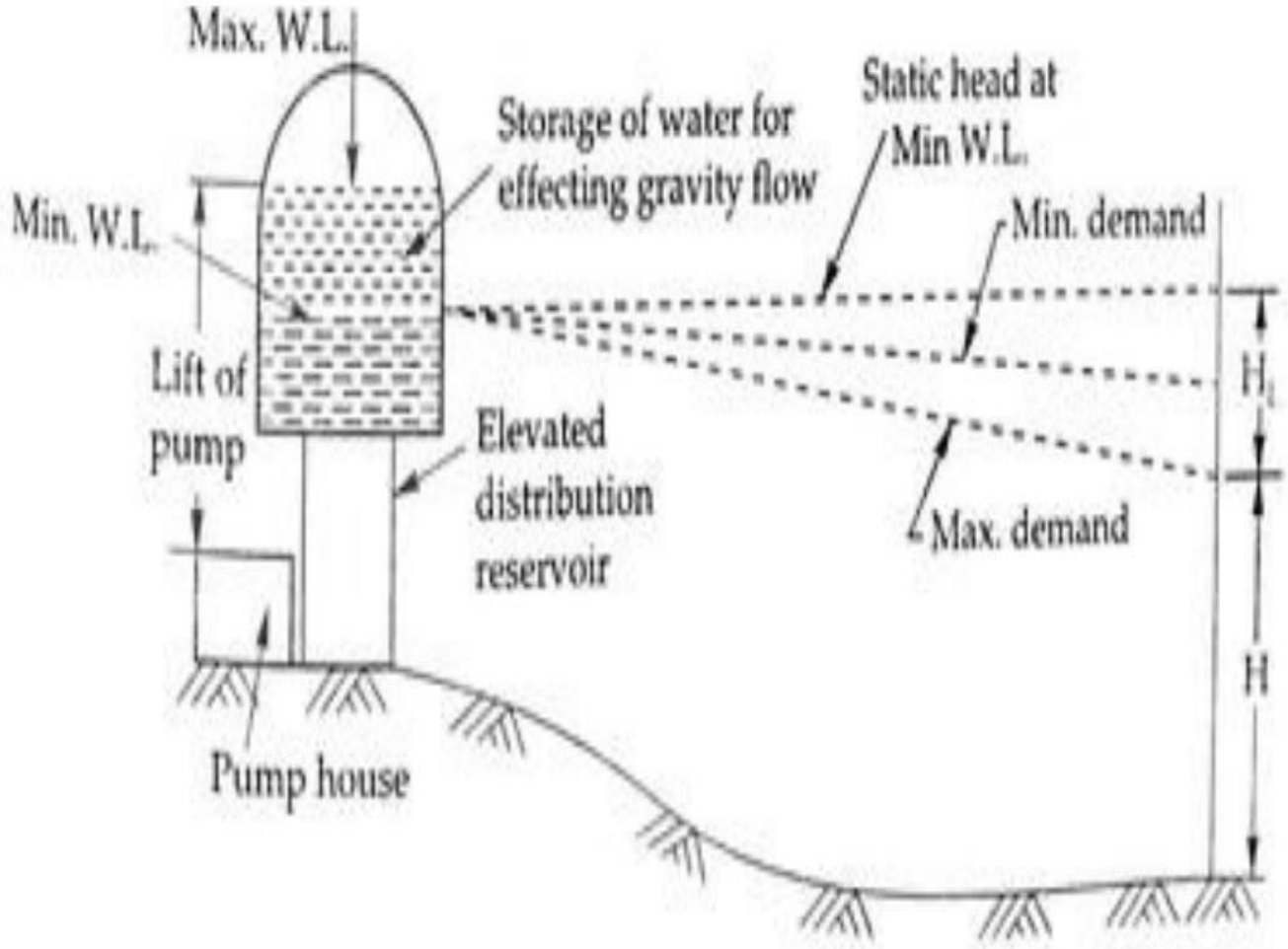
Combined gravity and pumping system

- This is the most common system adopted in most of the cases. Generally, the water purification works are located almost at the same level as the area of distribution – specially when source of raw water supply is a river or a reservoir formed behind a dam. In order to obtain sufficient distribution pressure, filtered water is pumped into clear water reservoirs located either on a higher ground or elevated on a tower. The water from the elevated reservoir then flows under gravity.



Combined gravity and pumping system

- In this system, the treated water is pumped at a constant rate and stored into an elevated distribution reservoir, from where it is distributed to the consumers by the mere action of gravity. Sometimes, the entire water is first of all pumped into the distribution reservoir, and many a times, it is pumed into the distribution mains and reservoirs simultaneously
- The excess water during low demand periods gets stored in the reservoir during low consumption nearly equals the extra demand during high consumption.



Advantages of the Combined gravity and pumping system

- This type of system is invariably and almost universally adopted because of its following advantages:
- 1- the balancing reserve of the distribution reservoir can be supplied to the places of fire. However, the necessary pressure required to be developed for fire fighting can be achieved by closing down the supply of some localities of by using motor pumpers.
- 2- The pumps are to be worked at uniform rate and thereby operating them to their rated capacities. This increases their efficiency and also reduces the wear and tear of the pumps. The attendance and supervision required for operating these pumps is much less compared to the case when they are operated at variable speeds.
- This method is quite reliable because even during the power failure or pumps failure, certain amount of water can be supplied from the storage or service reservoir.
- This system proves to be overall cheap, efficient and reliable.

PRESSURE IN DISTRIBUTION MAINS

- From the time the water enters the distribution mains, and up to the time it comes out at a comsumer's tap, water-head is constantly lost in overcoming friction of the pites (HL) and also in the fittings, meters, valves, etc..
- The net available head at a consumer's doorstep is thus reduced by these losses. This net available head or effective head (H) is the most important pressure, because it will make the water rise up to the different storey heights.
- The greater this pressure, the greater will be the height up to which water will be able to rise. For example, if this pressure is 0.6kg.cm2 (60kN/m2), then naturally, water can, at the most, rise by 6m, and not above that.
- For this reason, it is necessary that sufficient pressures are maintained in the distribution system, so as to supply water to the consumers up to the desired heights. It is also necessary to keep the losses in the distribution pipes and fittings to a minimum.

PRESSURE IN DISTRIBUTION MAINS

- The municipal water supplies in India are mostly under-developed because they ensure the water supply only to the ground floors or at the most to the first floor consumers.
- The distribution system in Indian cities is required to take a maximum pressure head of hardly 8 to 15 meters; wheeas in America, the normal minimum pressure maintained is of the order of 20m to 30meters.
- Pressures in excess of 70m in the distribution system are generally undesirable and maximum allowable pressure is of the order of 100m.

SYSTEMS OF WATER SUPPLY: CONTINOUS SYSTEM

- In the continuous system, water is available to the consumers for all the 24 hours of a day. No doubt, this is the best system since water is available as and when it is needed, but this leads to the wasteful use of water. If there are some minor leakages etc.. In the system, great volume of water is wasted because of long duration of flow. This system can be adopted only when sufficient quantity of water is available. In this system, water is not stagnant in the pipe at any instant, and hence fresh water is always available.

SYSTEMS OF WATER SUPPLY: INTERMITTENT SYSTEM

- In this system, water is supplied to the consumers only during some fixed hours of the day ----say two to four hours in the morning and two to four hours in the evening. This method is adopted when either sufficient pressure is not available or when sufficient quantity is not available. Under these conditions, various distribution zones of the city are supplied water by turn.

DRAWBACKS OF THE INTERMITTENT WATER SUPPLY SYSTEM

- THE intermitten system has the following drawbacks:
- Fire demand. If fire breaks in a supply zone during non-supply period, the rescue operations cannot be effectively done. Water cannot be brought from other zones quickly, and fire damage will be more.
- Domestic storage. The intermitten system requires the provison of small storage tanks in individual houses so that sanitary fittings in the house can work effectively during preiods of no supply.
- Pollution in supply. During the non-supply period, the pressure in the supply line may fall below atmospheric pressure. This may induce suction through leaking joints. When the pipe line is laid near the swers et…this may lead to severe pollution and contamination problems.

DRAWBACKS OF THE INTERMITTENT WATER SUPPLY SYSTEM

- THE intermittent system has the following drawbacks:
- Size of pipes. Greater sizes of pipes will be required since the supply of whole day has to be made in a shorter period.
- Wastage from water taps. During the non-supply period, the water taps may be left open unknowingly or due to negligence. This will lead to large wastage of water during the supply period.
- Staff requirements. Since a number of valves of different types are fitted on supply lines, many of which may be automatic, extra staff will be required to operate and maintain these valves.

STORAGE AND DISTRIBUTION RESERVOIRS

- Storage and distribution reservoirs are important units in a modern distribution system. Clear water storage reservoirs are required for storage of filtered water until it is pumped into the service reservoirs or distribution reservoirs. The pumps may generally work for 8-10 hours a day. Hence the clear water reservoirs should have a capacity to store filtered water corresponding to 14 1o 16 hours average daily flow for storage when pumps are idle.

TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS

- Distribution reservoirs provide service storage to meet the widely fluctuating demands often imposed on a distribution system, to provide storage for fire fighting and emergencies and to equalize operating pressures. They may be classified as “surface reservoirs” or “elevated reservoirs” according to their position or classified according to the material of which they are built, such as steal, reinforced concrete or masonry tanks. Distribution reservoirs are mostly of elevated type. They serve the following purposes:

PURPOSES OF DISTRIBUTION RESERVOIRS

- 1- They absorb the hourly variation in demand.
- 2- If pumps are used, the provision of reservoirs makes it possible to run the pumps at uniform rate.
- 3- Their provision results in an overall reduction in the sizes of pumps, pipes and treatment units. Thus the distribution system becomes economical.
- 4- They serve as storage for emergencies such as outbreak of fire, failure of pumps or bursting of mains.
- 5- They maintain the desired pressure in the main constantly. In absence of these, the pressure will fall the demand increases. They provide and maintain desired pressure even in remote areas.
- 6- Operation of the distribution system becomes very easy.

TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS

- Storage and distribution reservoirs may be of three types:
- 1- Surface reservoirs
- 2- Elevated reservoirs
- 3- Stand pipes

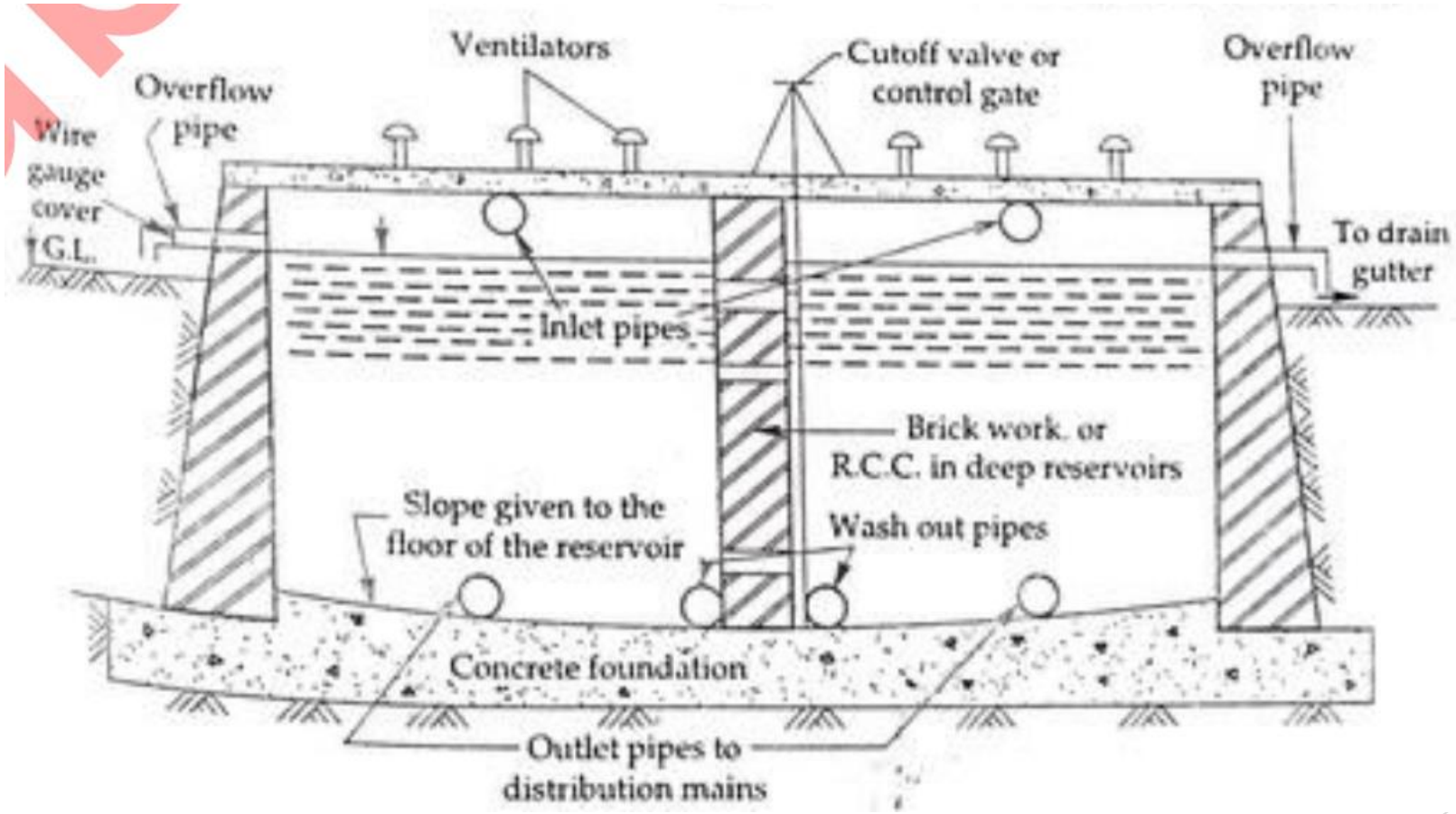
TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS – SURFACE RESERVOIRS

- 1- Surface reservoirs

Surface reservoirs are made mostly of masonry or concrete. Common practice is to line surface reservoirs with concrete, granite, asphalt or asphaltic membrane to check the leakage of water. Sometimes, these reservoirs may be built underground, specially when they are of large size, and a part may be constructed on its top.

It is common practice to construct surface reservoirs in two or more compartments so that one unit can be cleaned or repaired while other units are in operation. Surface reservoirs should be located at high points in the distribution system, so that gravity supply can be done directly. In some cases, however pumps are used to pump water from the clear water storage surface reservoir to the elevated distribution reservoir.

TYPICAL SECTION OF A GROUND RESERVOIR

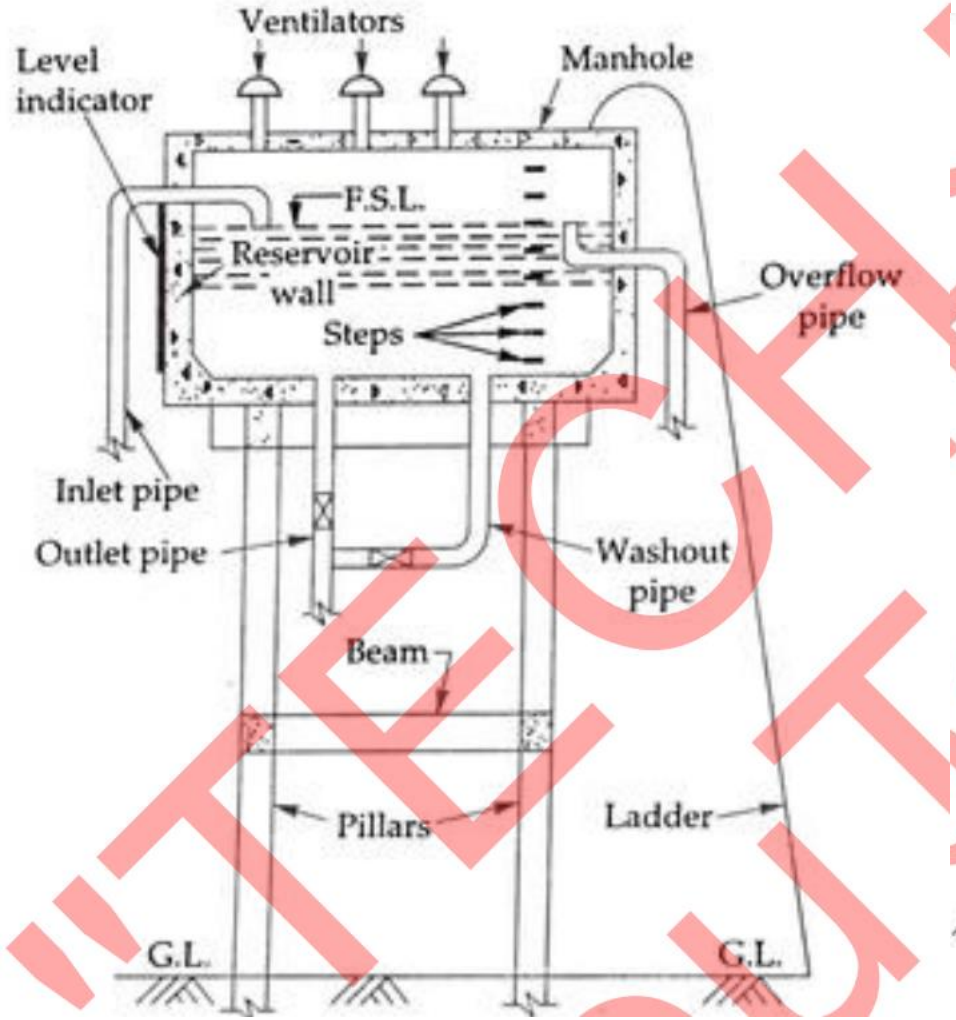


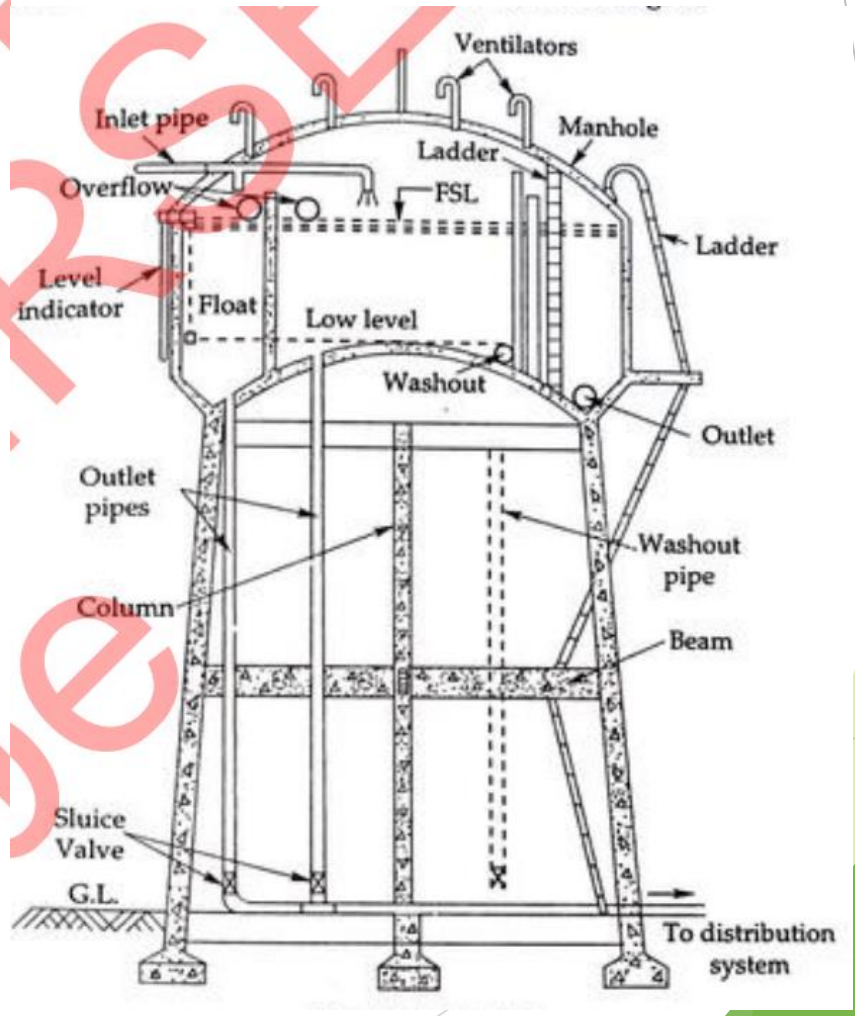
TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS – ELEVATED RESERVOIRS

- 2- Elevated reservoirs

Elevated reservoirs are commonly known as overhead tanks. They may be constructed of stone mansonry, reinforced concrete or steel erected at a certain suitable elevation above the ground level and supported on towers. They are constructed where the pressure requirements necessitate considerable elevation above the ground surface and where the use of stand pipes becomes impracticable.

TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS – ELEVATED RESERVOIRS





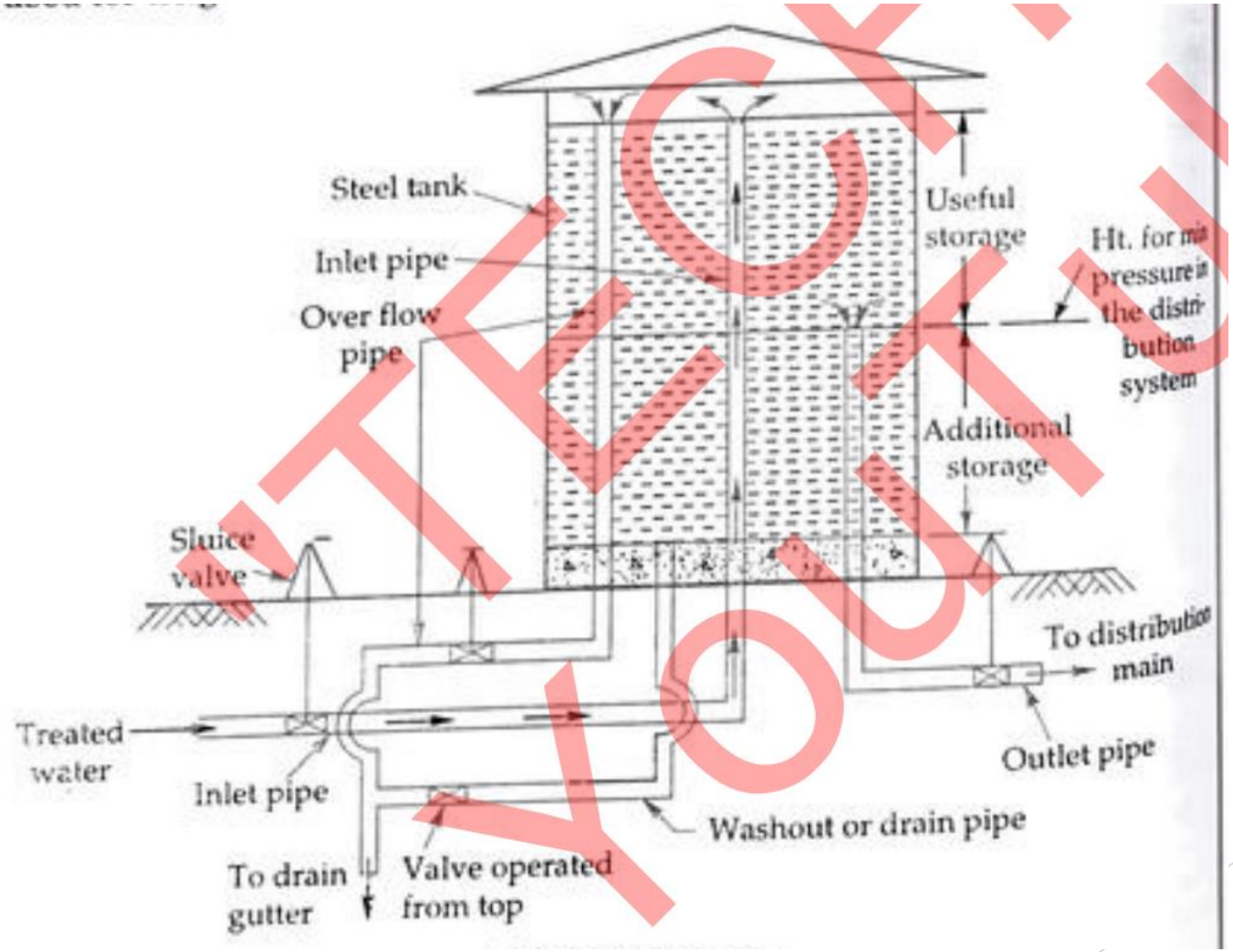
TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS – ELEVATED RESERVOIRS

- Various accessories of a reservoir
- 1- Inlet pipe for the entry of water
- 2- Outlet pipe connected to the distribution mains for the exit of water
- 3- Overflow pipe discharging into drain gutters and maintaining constant level
- 4 – A float gauge or an indicator for indicating the depth of water which can be read from outside
- 5- A wash-out pipe (or drain pipe) for removing water after cleaning of the reservoir
- 6- Automatic devices to stop pumping when the tank is full.
- 7- Ladders to reach the top of the reservoir and then up to the bottom of the reservoir for inspection.
- 8- Manholes for providing entry into the tank for inspection purposes.
- 9- Ventilator for fresh air circulation

TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS - STANDPIPES

- 3- Stand pipes
- Standpipes are normally employed where construction of a surface reservoir would not provide sufficient head. A standpipe is essentially a tall cylindrical tank whose storage volume includes an upper portion (the useful storage), which is above the entrance to the discharge pipe and a lower portion (supporting storage) which acts only to support the useful storage and provide the required head. It is often possible to take advantage of hills or high ground for a standpipe location, with a view toward enabling the entire capacity of the tank usable.

TYPE OF STORAGE AND DISTRIBUTION RESERVOIRS - STANDPIPES



LOCATION OF DISTRIBUTION RESERVOIRS

- Distribution reservoirs should be located centrally or at least as near as possible to the zone that they serve. In large metropolitan areas a number of distribution reservoirs may be located at key points. They should be located on high grounds or at sufficient elevation to maintain adequate pressure. A central location of the reservoir will reduce friction losses in the distribution pipes by reducing the length of pipes. Positioning the reservoir so that pressures may be approximately equalized is an additional consideration of importance. If the tank is not located centrally there will be large head loss, and by the time water reaches the tail end of the supply, the pressure will be too low to serve the community usefully. However, if the reservoir is centrally located, the pressure over the whole distribution area is much more uniform during periods of peak demand, the tank supplies in both the directions (being emptied) while during the periods of low demand, pump supplies water to both the tanks as well as the community.

LOCATION OF DISTRIBUTION RESERVOIRS furthest end of distribution area

- Distribution reservoirs should be located centrally or at least as near as possible to the zone that they serve. In large metropolitan areas a number of

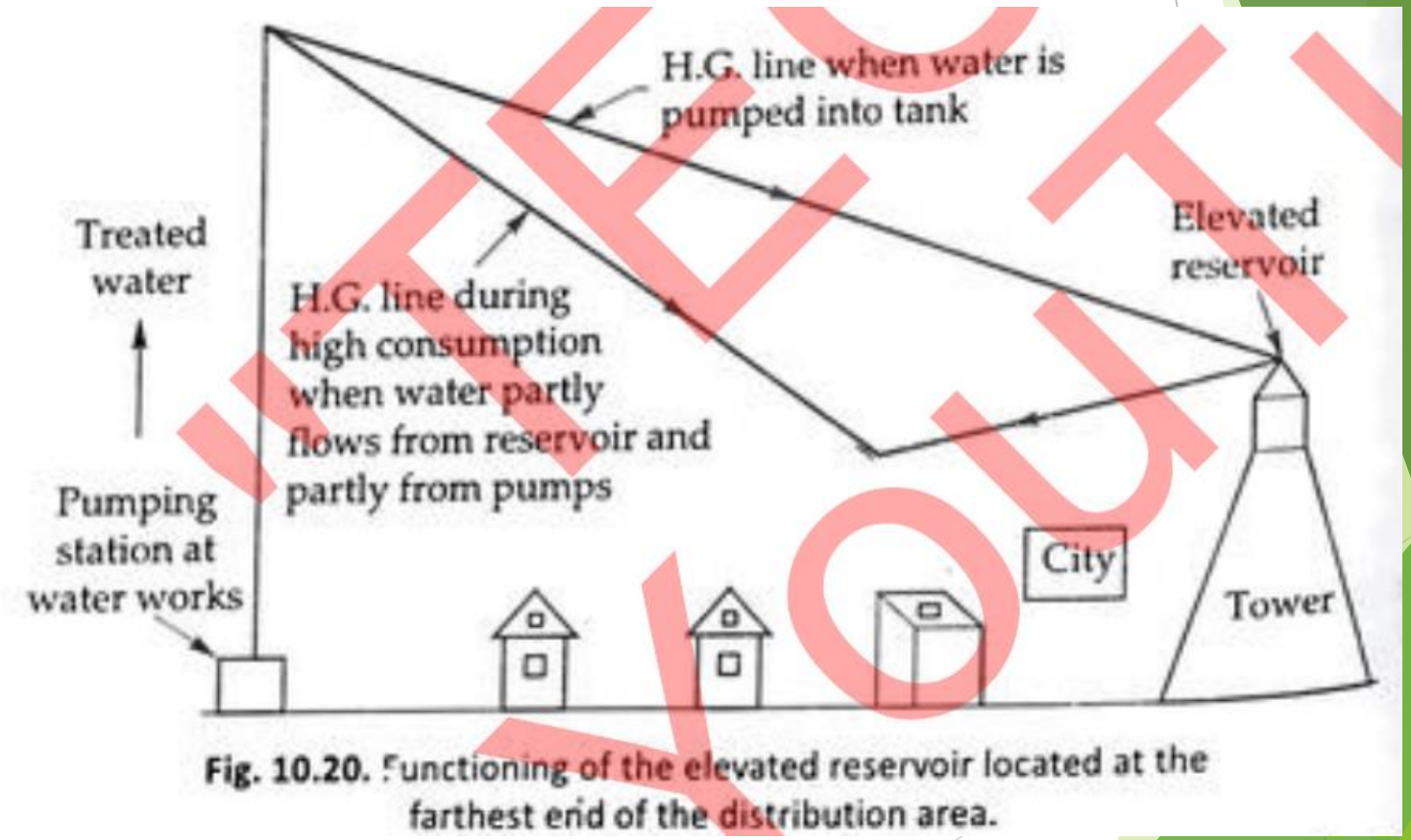


Fig. 10.20. Functioning of the elevated reservoir located at the farthest end of the distribution area.

LOCATION OF DISTRIBUTION RESERVOIRS closest to pumping station

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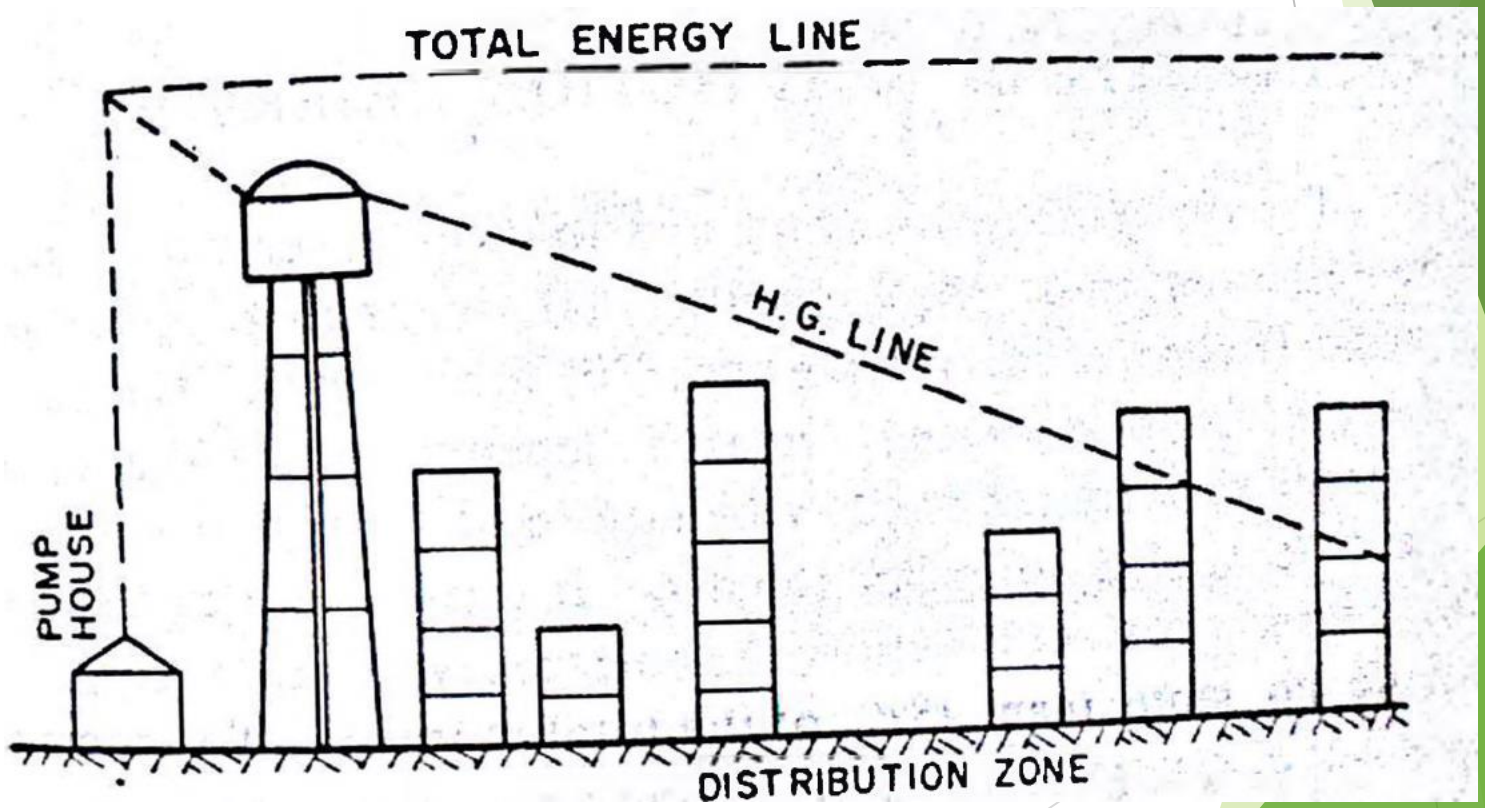

LOCATION OF DISTRIBUTION RESERVOIRS central position

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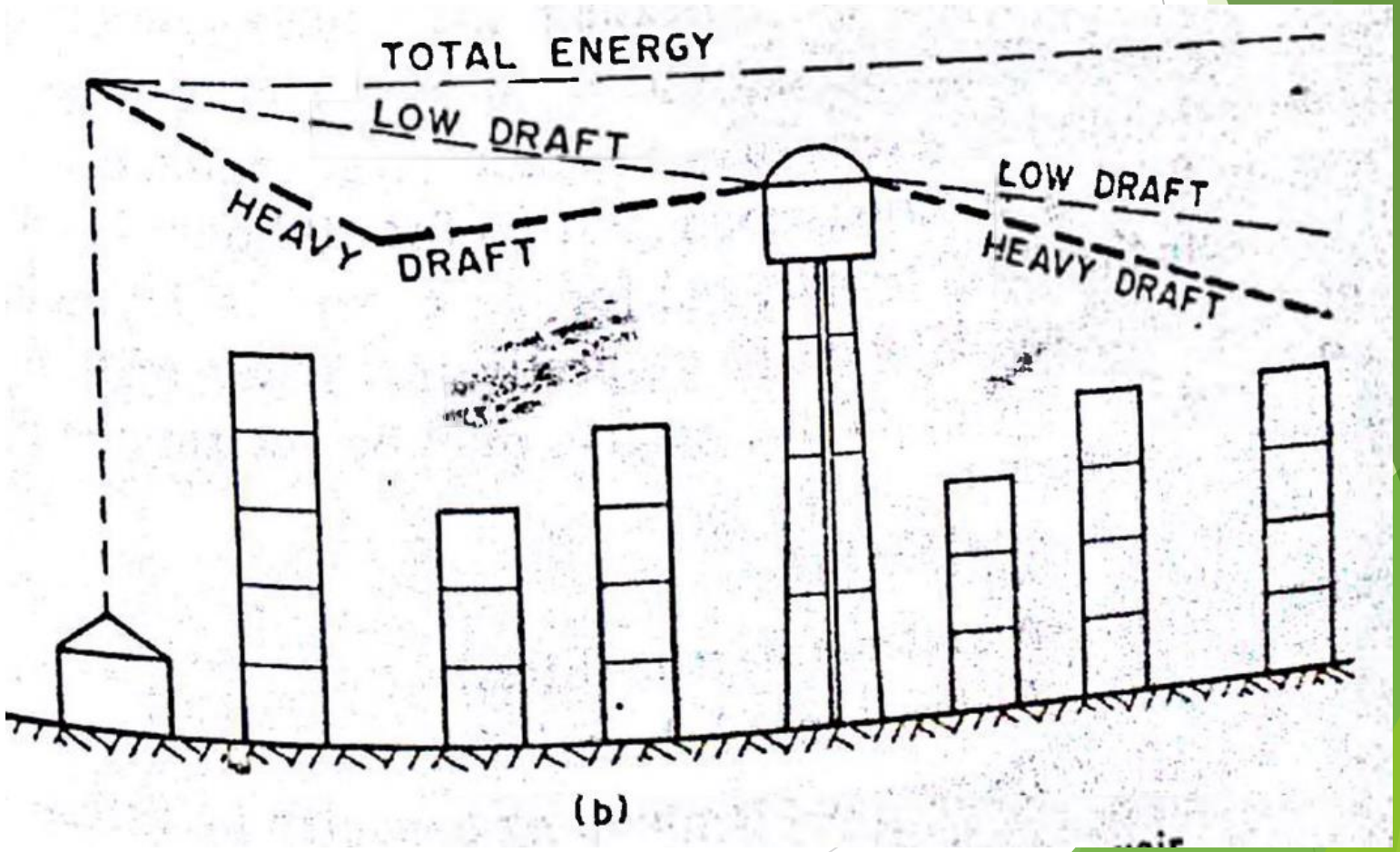


CAPACITY OF DISTRIBUTION RESERVOIRS

- The storage capacity of the distribution reservoir is based on the following three requirements: 1- balancing or equalizing reserve 2- breakdown reserve and 3- fire reserve.
- The magnitude of breakdown or emergency reserve depends upon the danger of interruption of reservoir inflow by failure of supply works and upon the time needed to make repairs. If repairs are expected to last only for a very short duration, the emergency reserve is sometimes made no more than 25% of the total storage.
- To compute the amount of storage required for balancing or equalizing purposes, a mass diagram or hydrograph indicating the hourly rate of consumption is required.

CAPACITY OF DISTRIBUTION RESERVOIRS

- India recommends that distributing reservoirs be made large enough to supply water for fighting a serious conflagration for hours in communities of more than 6000 people, and for 8, 6, and 4 hours in places with 4000, 2000 and 1000 people respectively. When reserve storage is elevated, the amount of fire reserve may be determined from the following expression:

$$R=[F-P]T$$

R=reserve storage (litres)

F=fire demand, litres/min.

P=reserve fire pumping capacity in litres/min.

T=duration of fire, in minutes.

CAPACITY OF DISTRIBUTION RESERVOIRS

- Formula for the storage capacity of reservoirs

e capacity of reservoirs :

$$R = aD + bD + \frac{10}{24}(D + F - P) \qquad \ldots(14{\cdot}2)$$

R = total storage capacity (million litres)

D = average domestic demand (m.l.d.) for maximum month

F = fire demand (m.l.d.)

P = capacity of pump (m.l.d.)

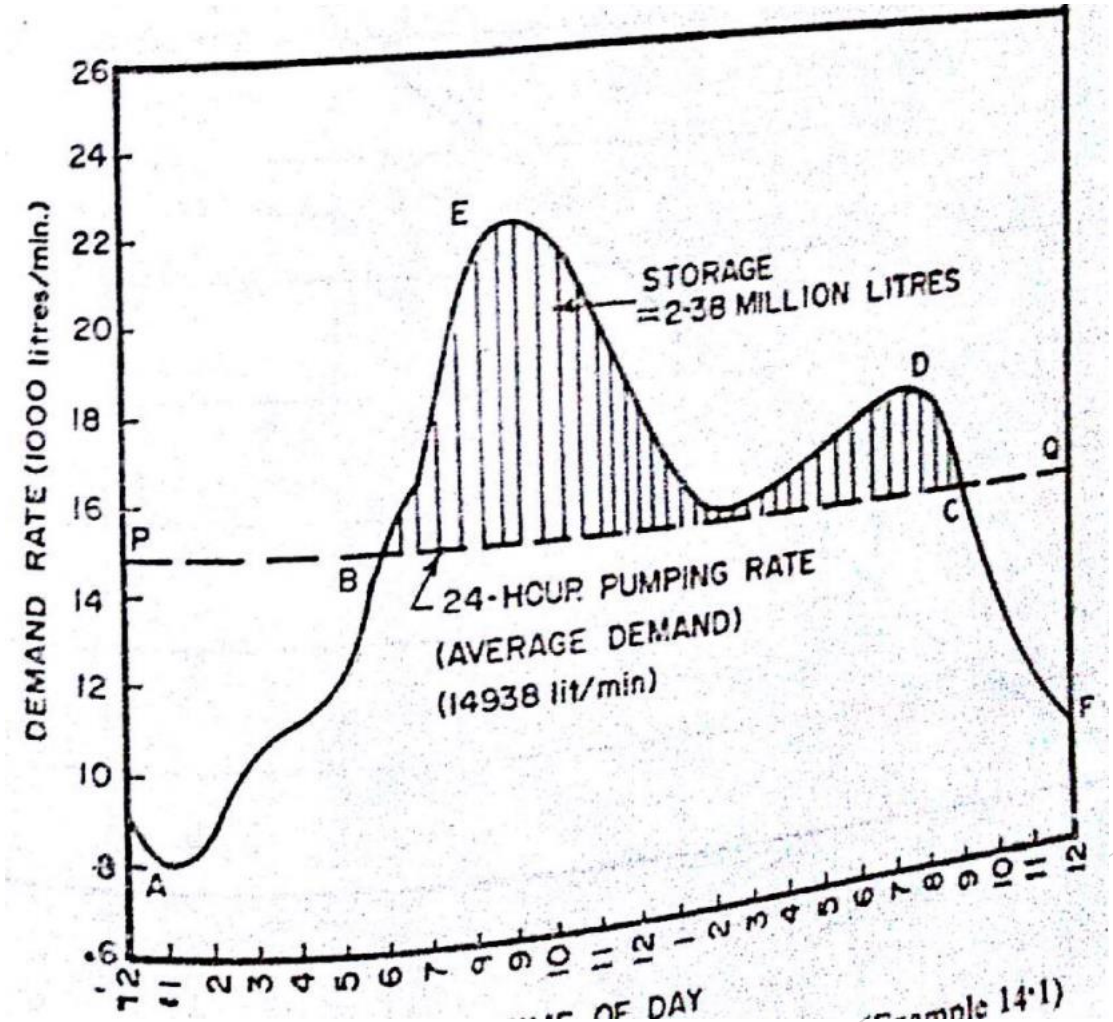
a, b = coefficients, the values of which may be taken as 0·2 and 0·1 respectively.

Methods for determining storage capacity of reservoirs

- When a storage or distribution reservoir is to be designed for the purposes of balancing or equalizing the flow, its storage capacity can be determined by two methods:
- (a) Hydrograph method.
- (b) Mass curve method

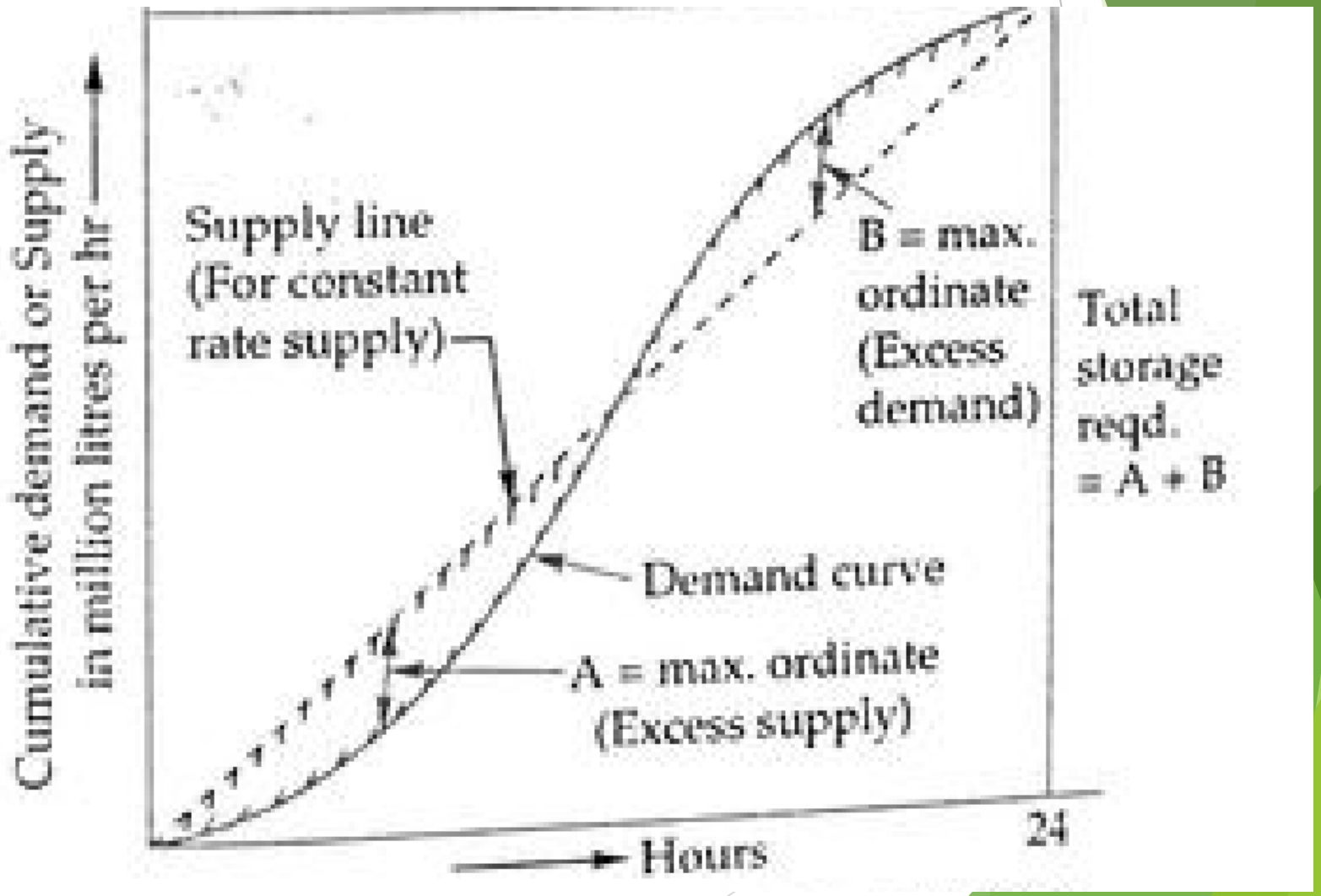
Hydrograph method

- It is well known that the daily hourly water demand rate is not constant throughout the day. The demand is more during moring and evening and less during the other parts of the day.



Mass-Curve method

- A mass curve of demand is the cumulative demand curve, and is obtained by continuously adding the hourly demands and plotting these against time (hours) of the maximum day
- The mass curve of supply is therefore fist of all drawn and superimposed by the demand curve. The amount of balancing storage can then be easily determined by adding the maximum ordinates between the demand and the supply lines.



Yaounde water supply system

- Water supplied to Yaounde citizens and inhabitants of the surrounding cities for their daily needs comes from two water treatment centres; the Akomnyada pumping station in Mbalmayo with a daily yield capacity of 100,000m3 and the Mefou treatment plant with 35,000m3 . Purified water from these treatment plants are transported through pipeline network to storage reservoirs an towers before being distributed households. Concerning the city Yaounde, there are 11 great reservoirs and 14 towers holding total capacity storage of 114,000m3 of water (Table 1).

Table 1: location and characteristics of the potable water storage infrastructures in Yaounde

Location (quarters)	Storage infrastructure	Capacity (m^3)	Total capacity (m^3)
Ngoa-Ekele	2 Reservoirs	20000 x 2	40000
	Tower	2000	2000
Mvog-Betsi	Tower	3000	3000
Etoug-Ebe Lycée	Tower	1000	1000
Mendong	2 Towers	500 x 2	1000
Mont Febe	2 Tower	1000 x 2	2000
Etoudi	2 Reservoirs	3750 x 2	7500
Nkomo II	Reservoir	4500	4500
Mimboman	Tower	3000	3000
Mbankolo	2 Towers	2000 + 1000	3000
Atemengue	2 Reservoirs	6500 x 2	13000
	2 Towers	3000 x 2	6000
Messa	3 Towers	2500 x 3	7500
	2 Reservoirs	4000 x 2	8000
Nkoayos	2 Reservoirs	6250 x 2	12500

***Source**: Realised by the authors from CAMWATER data base and fieldwork (2018)*