Water Supply Engineering
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Lecture-42
Basic of Water Distribution System

Hi friends, so we are now in the 8th week of this course water supply engineering and this week we will talk about water distribution systems.

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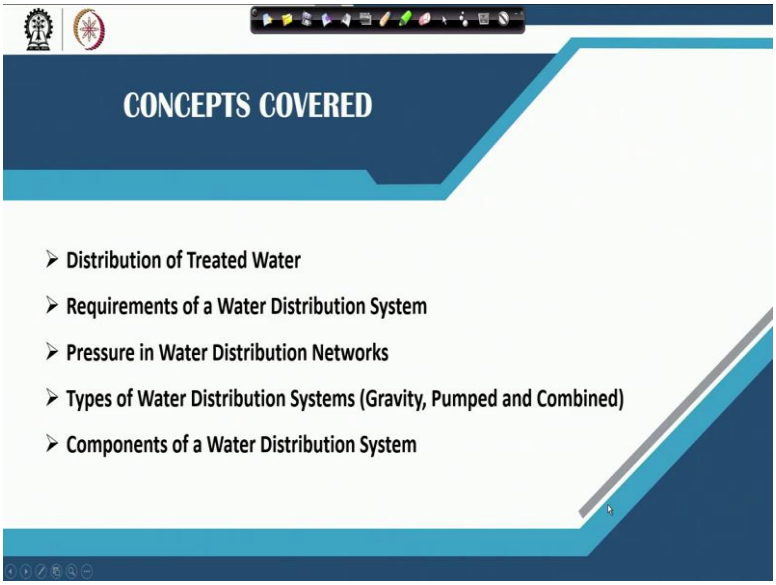

So, this particular lecture will cover the basics of water distribution system so what we are going to talk about what is the distribution of treated water. What are the basic requirements for a water distribution system. We will be covering the concept of pressure maintenance or pressure management in water distribution networks then what are the various types of water distribution systems including gravity system, pump system and combined system. And we will then discuss upon the various components of a water distribution system.

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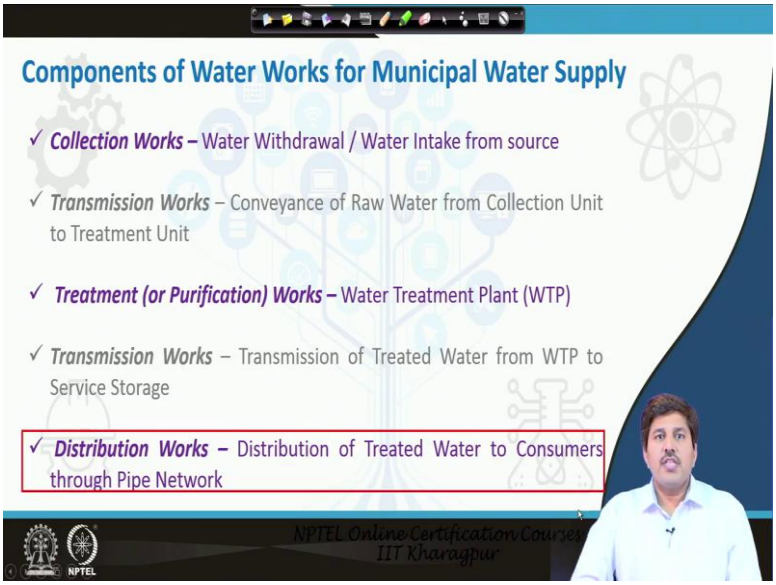

To begin with if you like again revise what we discussed earlier that what are the different components of a waterworks for municipal water supply? So, we started with the collection works where we basically collect water or withdraw water through water intake from the source. Then there is a transmission works which is responsible for conveyance of raw water from collection unit to the treatment unit that also we discussed.

Then the another important pillar of a water utility is the treatment works or purification works which is essentially water treatment plant and that we covered in the last three weeks. Then there is again transmission works is involved for transmission of treated water from the treatment facility to the service storage level. So, that is similar to the earlier transmission works means like in earlier we use raw water mains.

And for transmission of the treated water we use treated water mains which essentially go to a storage system and then from that storage system generally we distribute water to the end consumers and that is achieved through distribution works. So, what will be primarily focusing on is the distribution work in this particular week of course the transmission work is also in a way part of the distribution network.

So, when we talk about the water distribution system essentially we talk about the treated water so this is your water distribution system which basically covers the supply of the treated water to the end consumers which involves in fact taking bulk of the treated water to a storage system usually storage reservoirs or what we call MBR smash balancing reservoirs. And then it is distributed through a pipe network to the end consumers.

So, these both in combination is known as water distribution system but our primary focus will remain on this as this is very similar to the raw water transmission.

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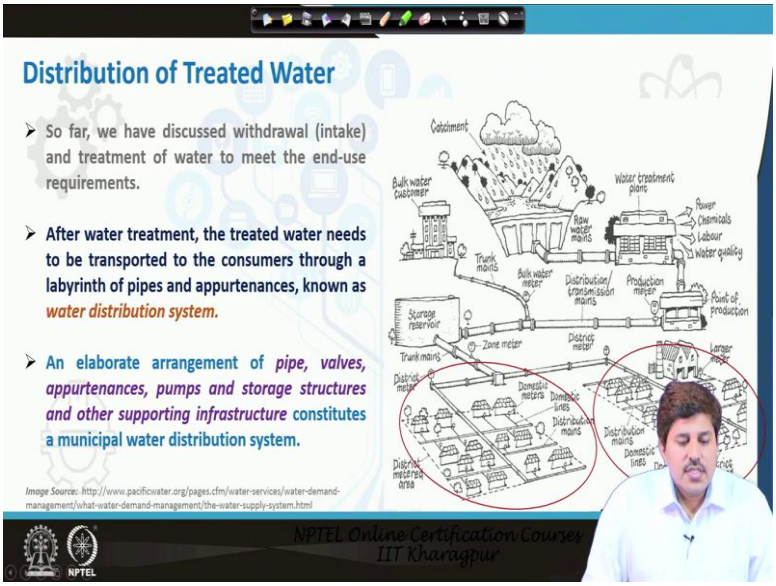

Now if you see the distribution of treated water so far we have discussed the withdrawal in take part and treatment of water to meet the end-use requirement. Now after water treatment the treated water needs to be sent to the end consumer this is the; what is basic purpose of a water utility it has to supply water to the end consumers. So, these are the various stages in between where water uptake or water intake is one stage water treatment is another stage and then water supply is another stage.

So, we are like on to the third stage which is achieved through basically connection of the pipes and these networks and this is typically known as water distribution system. Now this water distribution system essentially is an kind of arrangement of various pipes walls pumps storage structures and other type of infrastructure present in this distribution network.

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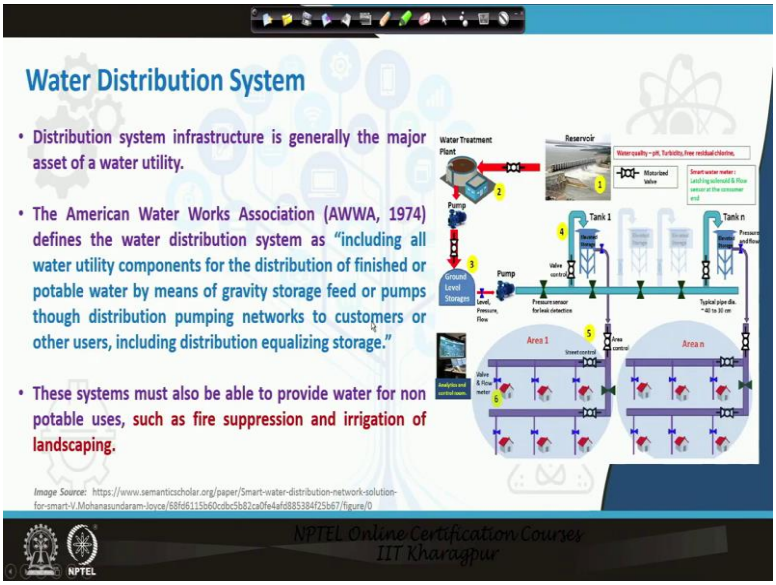

So, essentially if you see we get the water and then through if this is basically the point of purification or treatment facility. So, from treatment facility we put the water again the water through distribution mains or treated water mains to a service storage or storage it is a wire label and from there we basically put it to a distribution system. So, water distribution system is basically interest is one of the major asset of a water utility in terms of infrastructure.

And if we go by the American Water Works Association definition so a water distribution system is basically a system which includes all water utility components for the distribution of the finished or potable water by means of gravity storage feed or pumps through distribution pumping network to consumers or other users including distribution equalizing storage. So, after treatment plant we need to pump that water to a storage level and then we pump we may need to pump it to the elevated storage level or we directly pump it to the elevated storage level and then we may have intermediate storage reservoirs as well.

And from there we supply to the different area so the different storage reservoirs are elevated storage reservoirs may supply the different area. So, like this is say area 1 this is your another area that way so this one will be supplying 1 this one will be supplying 2 this one is supplying through that way this is say an area. So, similarly like this will supply the nth area. So, this system must be able to kind of provide water for potable as well as non-potable uses.

And in non-potable uses like fire suppression and irrigation of the pumping also must be covered through these distribution networks ideally.

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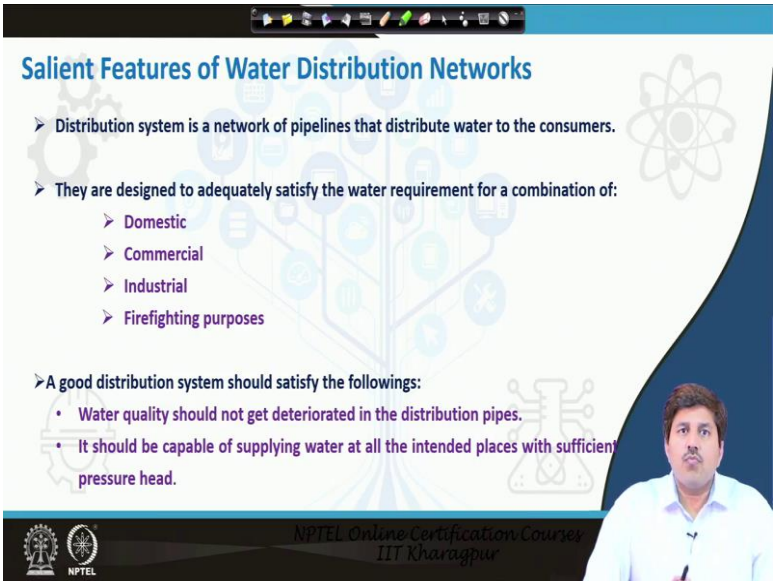

Now a typical water distribution network is a connection or network of pipelines that distribute water to the end consumers and they are designed to kind of satisfy the water requirements for domestic purpose for commercial purpose for industrial purpose for fire fighting purpose and often a combination of these. Industrial supply maybe separate at times but generally domestic commercial and fire fighting applications are met with this single network.

The normal municipal water distribution network usually covers the domestic requirement commercial requirement and fire fighting requirement it may cover the requirement for small-scale industries at as well but for large scale industries many times a separate connection or separate supply line is provided. So, because the requirement might be very high and concentrated at one particular point so it is not fed with the normal conventional normal municipal water distribution networks.

Because then it will basically impact the sizing of the network and eventually may make the large fraction of the network uneconomical so many times it is rather a better option to supply the municipal demands through a separate distribution network and demand for the large industries through the separate pipe connections. Typically a good water distribution system should meet these conditions one of the conditions is that the water quality should not get deteriorated in the distribution pipe.

So, as we discussed earlier also like it is essential that the water because these supply treated water so water has been treated or purified beforehand so an ideal distribution network should

ensure that there is no chances of decontamination into that so that water quality does not get deteriorated within the distribution system. And the consumer gets the water which is actually coming out from the treatment facility without any further contamination in the distribution system.

Another major requirement that distribution system should satisfy is that supplying of the adequate quantity of water at all intended places with sufficient pressure head.

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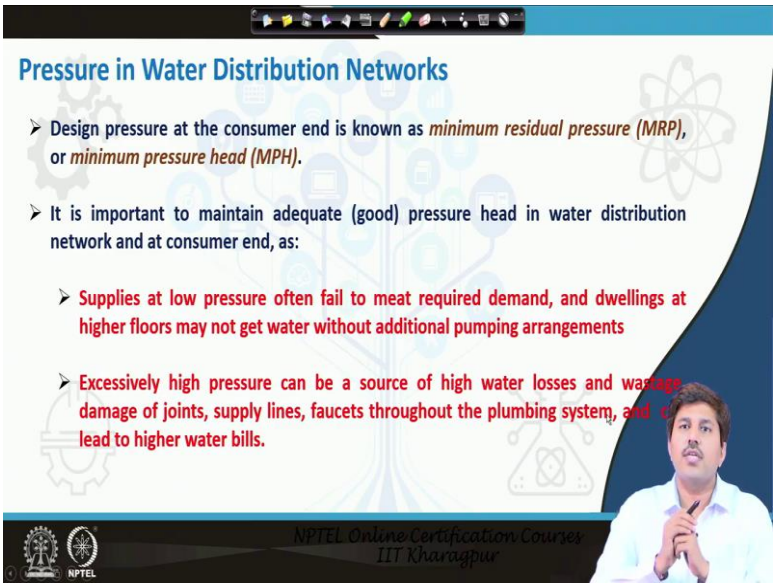

So, pressure head maintenance in the water distribution network is a very high importance we must share like we must ensure while designing a system that the pressure at the consumer end is adequate and which is typically liked for design purpose it is known as minimum residual pressure which is MRP or minimum pressure head MPH. So, we should ensure that these requirements are met. It is important to kind of maintain adequate or good pressure head in distribution network.

Because if we do not do that we are going to suffer either even if the pressure is high or pressure is low. If pressure is low so basically that that means we are looking at the supplies at low pressure. So, these will often fail to meet the required demand it will basically fail to meet the required demand and as in like if the pressure is not adequate somebody is getting water at low pressure heads it will take much longer time for bathing purpose metal much longer time for filling just a bucket for say.

So it unnecessarily like put burden on the user it is un-convenient to user to get the same amount of water the same amount of water which you could get say in a minute if you need to wait just 10 minutes for filling a bucket. So, it is highly un-convenient and particularly the households which are at higher floors the dwellings which are at higher floors may not get water without additional pumping arrangement.

So for that purpose we must ensure that a minimum pressure is available at the consumer. And but if we go for high pressure so high pressure can be a source of high water loss and wastage it can damage the drawings it can damage the supply lines it can damage the various facets which are there in the plumbing systems. So, all these problems it can create in addition it will lead to higher water bills.

So, because people be consuming more water if you are just taking say shower for 10 minutes the pressure head is say 10 meter you will get certain amount of water pressure head is say 20 meter you will get certain amount of water pressure head is say 15 meter you are going to get certain amount of water. Obviously the water discharged in the same time say in a minute is going to be higher when the pressure is high. So, if you are taking a shower from a shower head which is working at 20 meter pressure you are going to probably get too much of water in a minute's time.

So, if you are bathing for 5 minutes you are consuming more water so that leads to basically higher water losses and wastage. And since you are consuming more water so if it is a build system so you will be basically paying higher water bills as well if it is a volumetric uses based billing system. So, these are the major like problems or major requirements with the with the high pressure in the water distribution network.

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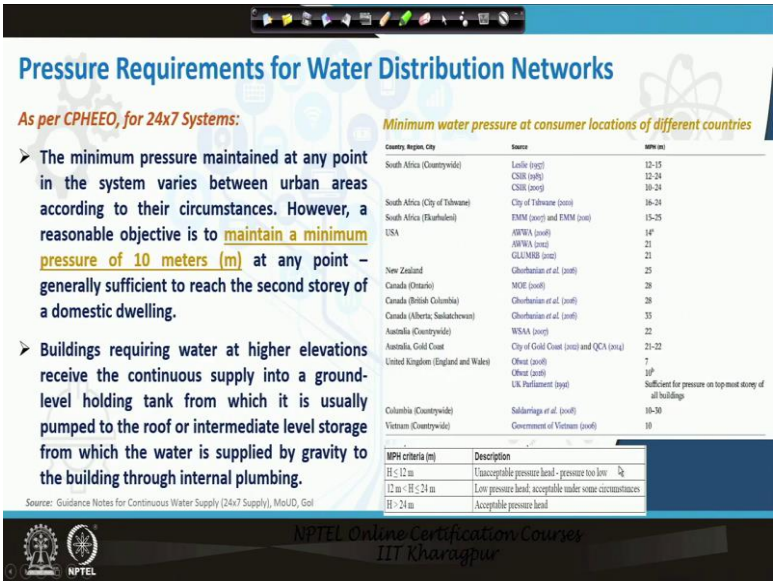

And that is why we must ensure to maintain just adequate pressure. Now what is that adequate pressure again the adequate pressure depends on these circumstances so if you see the CPHEO Manuel so for 24/7 supply system they say that minimum pressure maintained at any point in the system where is between urban areas according to their circumstances. However they say that a minimum pressure of say 10 meter must be maintained at any point and this should be generally sufficient to reach a second story of a domestic dwelling.

Now if it is to be pumped at higher elevation then generally all say multi-story building or high-rise building generally water is supplied by municipality to a intermediate level storage to basically a groundwater storage usually. And from there it is pumped to the either say rooftop storage systems or intermediate level storage systems and from there it is supplied by gravity to the different levels in the building.

Now if you see minimum water pressure minimum pressure head in the different countries. So, in South Africa it is typically from 10 to 24 so 12 to 15 means different studies have given the different numbers this is basically a countrywide average again in the different cities we may get in this range. So, practically you can see that variation ranges between 10 to 25. In US it is say around 14, 21, 21 then that way New Zealand it is 25 Canada it works at a higher pressure 28.

So I am at like in some places like Alberta or Saskatchewan it is as high as 35. Australia countrywide average is 22 in the Gold Coast again it is in the similar range UK works at relatively lower pressures. And Columbia again 10 to 30 Vietnam 10 generally pressure less

than 12 meter is considered as low pressure hit at is considered unacceptable at many places but again as we said that say as per Indian CPHEO. The pressure head at around 10 meter is also considered sufficient and we should maintain minimum 10 meter pressure head though recommended pressure is higher than that.

12 to 24 meter is considered as acceptable under some circumstances and higher than 24 meters is more acceptable but again to high pressure head creates problem as we discussed. So that is also not recommended.

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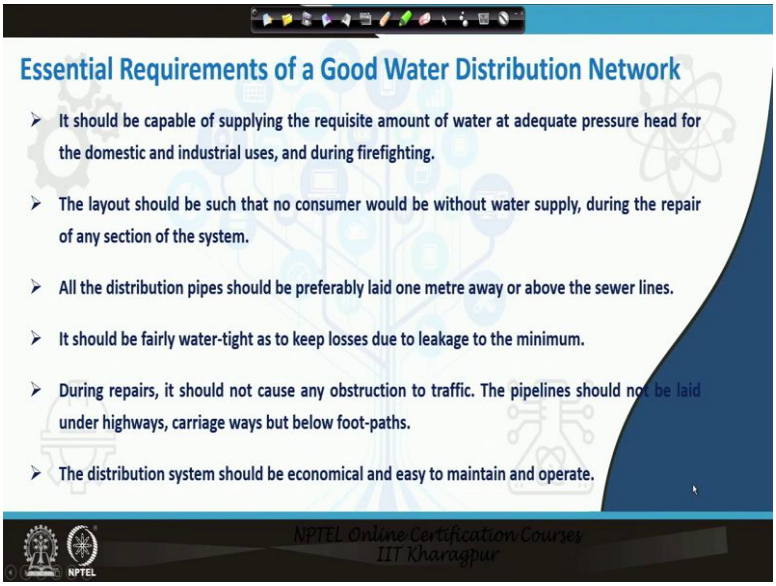

Now if we see what are the various essential requirement of a good water distribution network. So, like the first and foremost thing it should meet its objective and what are the basic objective basic objective is to supplying the required amount of water at adequate pressure head for different type of uses domestic uses industrial uses and during fire fighting. It should the layout that we provide should be such that no consumer would be without water supply during the repair of any section of the system.

So, like in the branch ton network this is problems that if you are say having a network where basically you are feeding some people from this branch and there is no alternate source of supply if you start doing some repair work here so the supply to this line essentially is disconnected and these people are not going to get any water till this repair work is complete. So, there is not an ideal network that way we should ensure that no consumers remain without water supply during the repair work as well.

Again all the distribution pipes should be laid at a safe distance from sewer line and generally this safe distance is considered at it should be laid at least one meter away or one meter above the sewer line. It should not be placed below the sewer line because if there is a leakage in the sewer line that is likely to flow the downwards and it can actually sort of pollute or contaminate the water supply lines. So, it should be generally away that even if there is a leakage in the sewage line it should go below and should not come to the water supply line.

Again it should be fairly watertight as to keep the losses due to leakage to the minimum there should not be like we should ensure that it is a watertight system cracks and leakages should be minimized. During the repair's it should not cause any obstruction to traffic. So, generally like if you lay a supply line in middle of the road so in the repair you have to basically dig out the road and then your entire traffic is disrupted.

So that why these kind of utility lines should ideally bits not just for water actually it is for all other utility line it should ideally pass along with the footpath or those places and should not interrupt the major road traffic. And the last point but one of the most important that it should be economical and easy to maintain and operates these are some of the basic requirements for the basic requirements for a good water distribution network.

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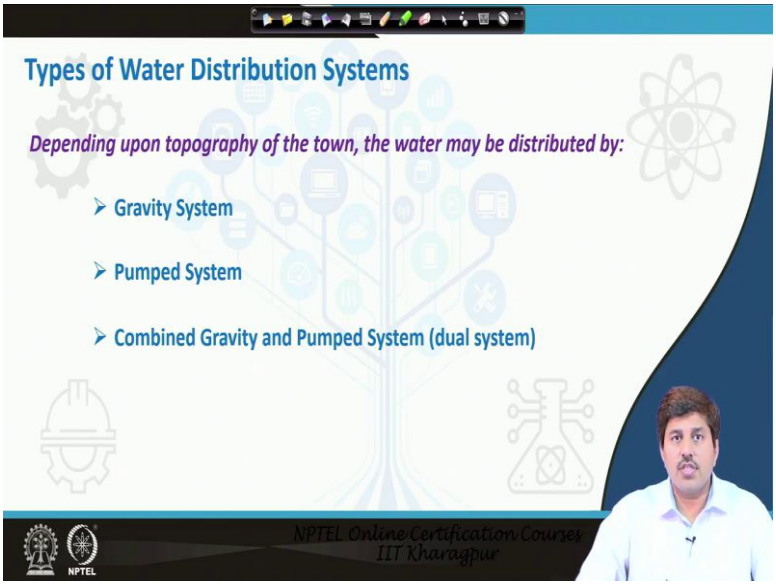

Now there are 3 types of water distribution networks there have a gravity system there is pumped system and there is a combined gravity and pump system which is known as dual system.

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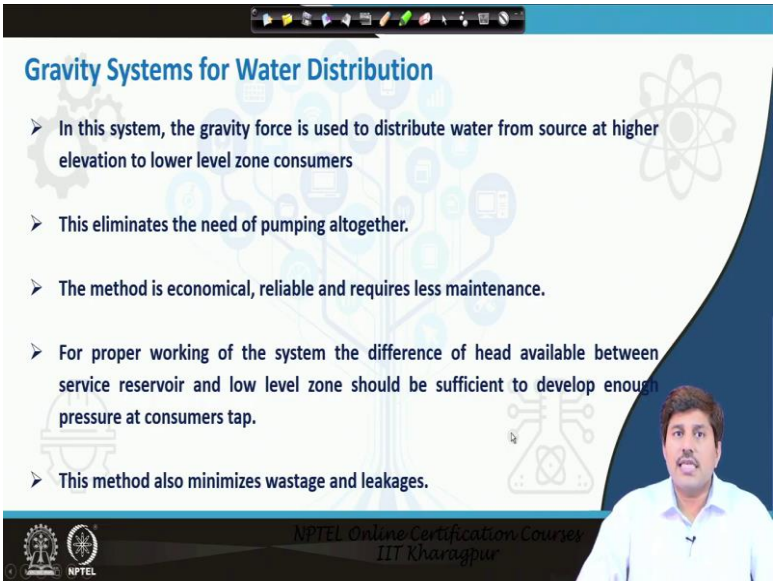

If you see the gravity system it's the system where the supply is by the force of the gravity and since we are talking about supply only by the gravity gravitational force that means that comes a basic condition that our source has to be at higher elevation. And supply zone has to be a lower elevation then only we can supply by gravity. Because if our source is at higher elevation we get sufficient head so that we can meet the meet the kind of consumer zone or the supply zone with the head which is already available at the source.

In these systems we do not need any pumping because this is a complete gravity system so we there is no requirement of pumping altogether this method is economical reliable less maintenance is required. Again for proper working of this system the difference of head that is available should be sufficient enough so that water comes at the consumer end with the sufficient pressure.

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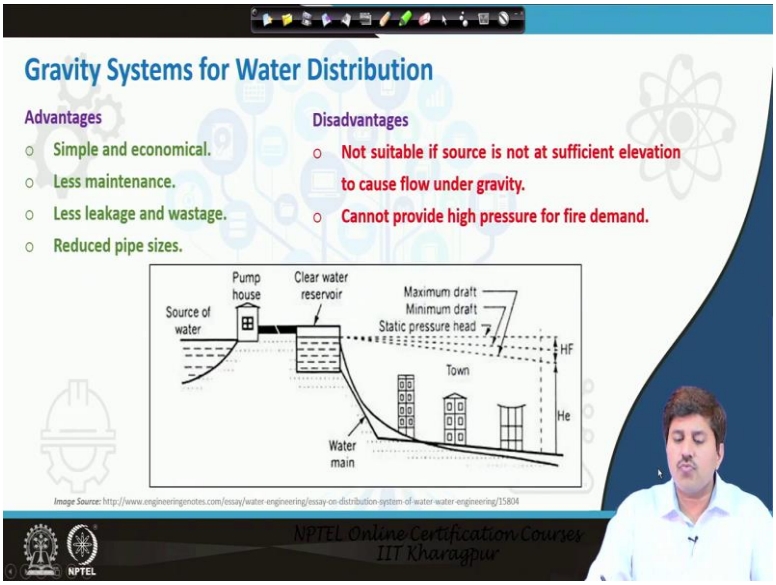

Also water wastage and leakages are minimized in such system because we are not providing any additional pressure so the advantage include that the system is simple and economical it requires less maintenance there is less leakage and wastage. There are relatively reduced pipe sizes for the flow. The disadvantage is; it is not suitable if the sufficient head is not available at the source. So, that is the very basic criteria that source should have the sufficient head.

And second problem is that whatever the gravitational force is there that will guide the flow and we cannot provide additional high-pressure supplies if needed for fire fighting demand without pumping. So, we may need additional pumping for that kind of system.

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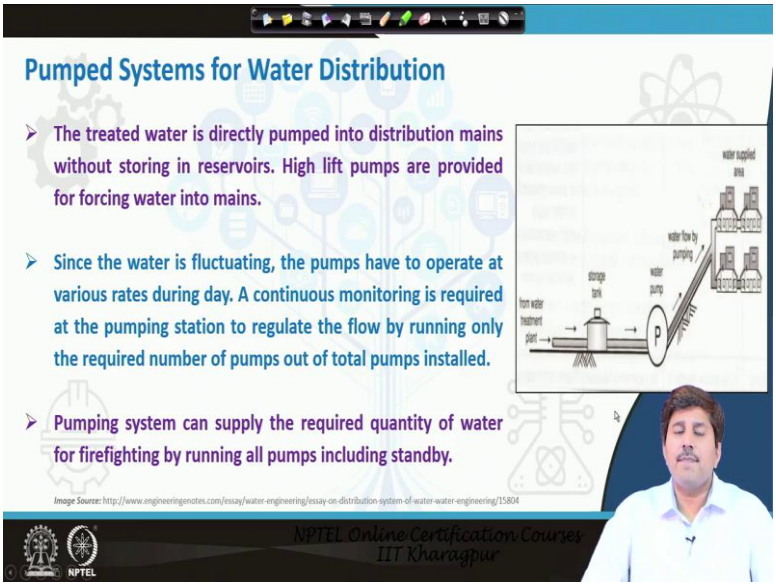

Then there are a pump system for water distribution these are basically the directly pumped into the distribution means without any like other storage reservoir or we may provide a

storage reservoir we may need say MBR or mass balancing reservoir at times but otherwise it may directly be basically sending to the elevated storage reservoirs. So, here the water might be basically fluctuating so pump have to operate at various rates during the day period.

Continuous monitoring may be needed it we might put extra pressure on the pumping station we need a manpower to regulate the flow at the pumping station. So, all those essential requirements would be there it can supply the required quantity of water for firefighting also by running all pumps including the standby pumps.

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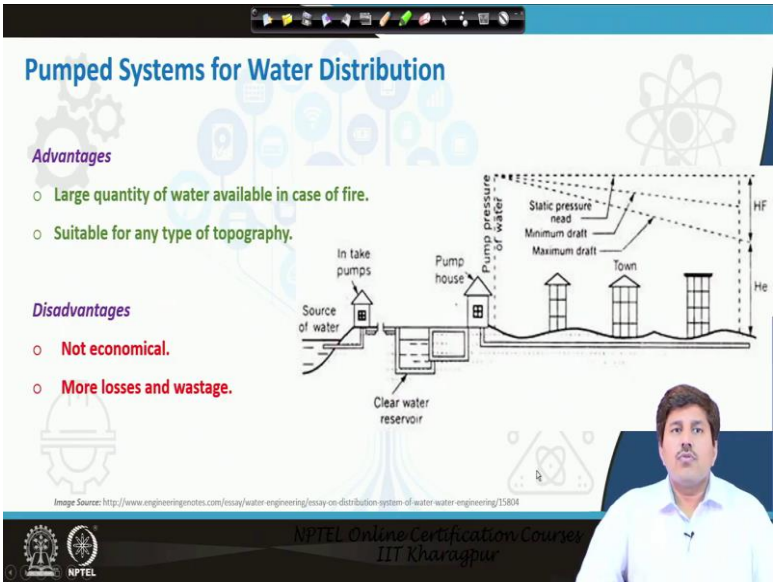

So the advantage include that large quantity of water is available in case of fire or in case of any emergency and second thing it can be suitable for any type of topography. Because we are not relying on the gravitational forces available for supply of water. We are providing additional forces through pump so we can use it for any kind of topography. The disadvantages include that it is not economical and there are going to be more losses and wastage because we are pumping the water altogether.

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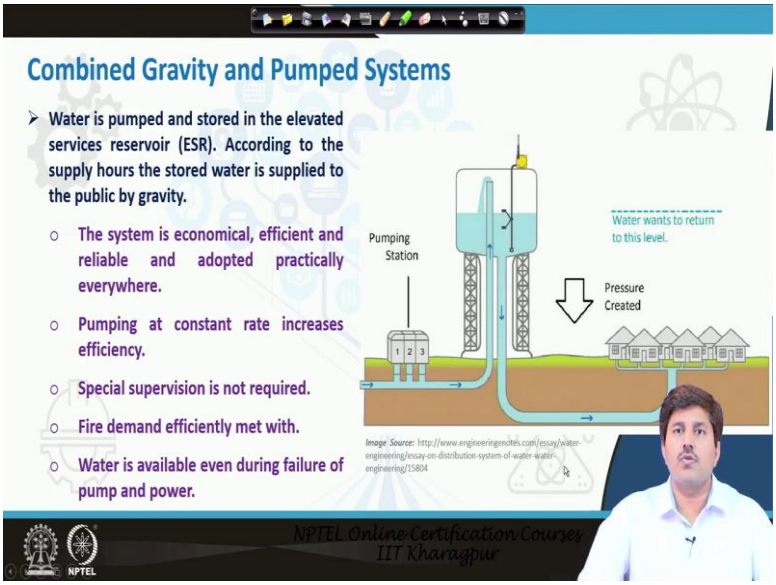

However generally none of these 2 systems are very common the one that most common is the combined gravity and pumped system or dual system where water is pumped and stored at an elevated service reservoir and then which is basically a kind of place where we do all the; we store water for supply purpose and then from there we supply water at the rate desired and in case of emergencies we can use these storage for supplying additional water as well.

So from this storage level the water is usually supplied by gravity so that we are not kind of providing too much of pumping or pumping at each and every place. So, that is why this is called as combined gravity and pump system. So, we are using pump we first lift the water and then using gravity we supply the lifted water to the our service area. So, the system is economical, this system is efficient.

This is much more reliable because we are already having a storage system you are not relying only on pumps if you are; few of the pumps failed in supplying water then in a pure pumping system you might face a problem of no supply to certain areas whereas here because pumping is done to lift the water to the storage reservoirs and from there it is supplied. So, that is there is always a practical possibility that there is enough water in the reservoir to basically supply and in the meantime the pumps can be get repaired.

There is a additional advantage is that we can do pumping at a constant rate and that will increase the pumps efficiency because otherwise in the direct pumping system we need since we need to meet the different levels of demand so we may need to basically pump water at different rates but here because we are lifting water to just a reservoir storage system so we

can use a constant rate of pumping and the variable demand can be met by the gravity from that storage reservoirs.

We do not need too much of special supervision then we can meet the emergency demand including firefighting demand that is also an additional advantage over here and water is available even during failure of the pumps. And power so that is why this is practically the most used system everywhere the combined system or dual system for pumping.

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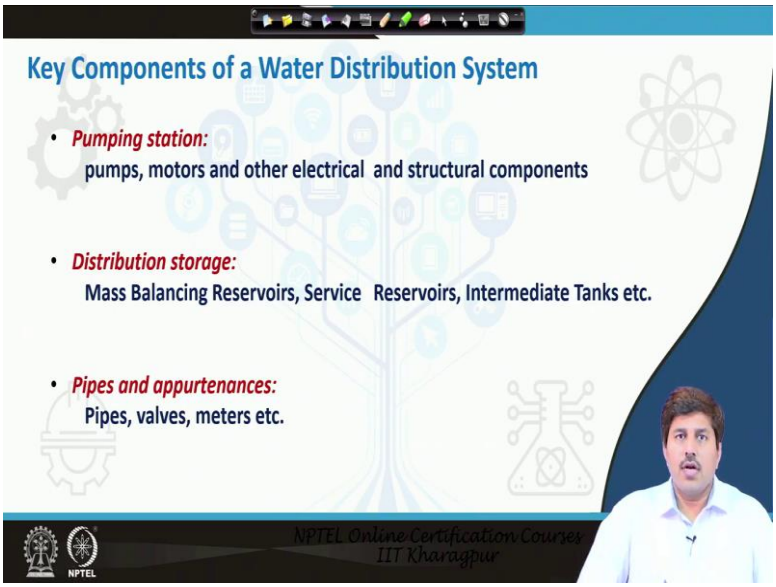

Now a typical water distribution system has 3 major components or three key components there is a pumping station which includes pump, motor or other electrical and structural components. There is a distribution storage which includes mass balancing reservoir or service reservoirs or at times intermediate tanks and then there are pipes walls meters those kind of facets which are there in the distribution network.

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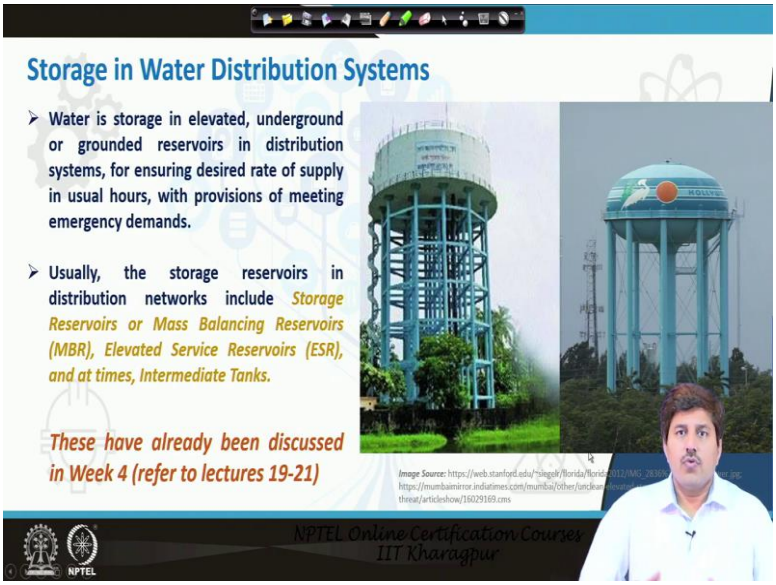

So, if these in these 3 network in these 3 basic requirements the storage in the water distribution system is one of the key kind of component of a water distribution system. So, water is typically stored in the elevated underground or ground reservoirs depending on the topography available. Many times just underground reservoirs are used many times the like partially underground and partially surface or partially grounded reservoirs are used and many times elevated reservoirs are used.

And the role of these reservoirs is to ensure these desire like fulfil the desired rate of supply in the usual ours and they must have a provision of meeting the emergency demands as well in case of say firefighting or any other occasional emergency when more water is needed. Usefully these storage reservoirs in distribution network include the storage reservoir or mass balancing reservoirs. There would be elevated service reservoirs so the from major storage reservoir the water might actually be going to the ESR's.

So, from stories are aware or MBR to the ESR and then from ESR at times it may go to the intermediate tanks as well but again it is not always that intermediate tanks are to be provided. So, it can actually go from just one years or for a direct supply. So, we have already discussed this storage part during our week 4 discussions you can refer to lectures 19 to 21 of the week 4 where we have talked about the treated water storage.

And we have discussed all these storage systems and how do we estimate the capacity of these balancing reservoirs, so that portions are already discussed during the week 4. The another component is basically pumping or the pumping stations. So, pumps in water

distribution networks are required for lifting water or providing additional pressure or head in the supply lines, There are different type of pumps are used which depends on their like functional requirement what the capacity is required what is the budget available what kind of power systems are available so all.

Depending on all those criteria's the pump might be chosen. We have discussed pumping systems as well or pump as well so we have discussed basically different type of pumps and how they function. In week 3 so you can refer to lecture number 16 for the details on the pumping which already have been covered? So, we will basically be concluding this class here and in the next class we will start talking about the distribution network system.

So what kinds of pipe arrangements are made for the distribution of the treated water. So, that will be discussing in the next class see you then thank you for joining