Urban Services Planning
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Lecture 41
Street Sweeping and Cleaning of Surface Drains

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Welcome to Module 9. In Module 9, we will discuss about other municipal waste management services. And lecture 41 is on street sweeping and cleaning of surface drains.

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So, the different concepts that we will cover around Street sweeping, Sources of waste in streets, Street sweeping planning, Vehicle equipment and labor productivity, Frequency of

street sweeping, Classification of streets, Manual street cleaning equipment, Mechanical street cleaning equipment, then we will do a Case study on Bangalore. And finally, we will talk a bit on Cleaning of surfaces as well.

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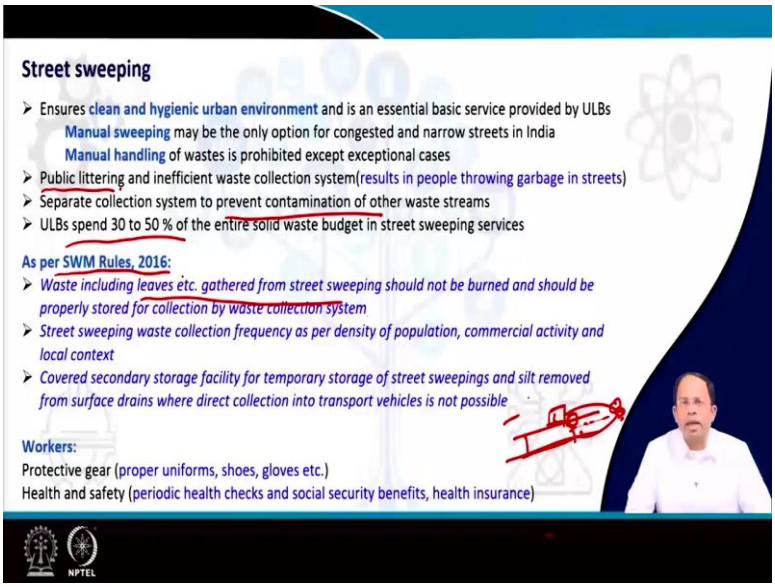

Now, street sweeping is essential definitely, for all urban areas, and particularly in the Indian context, because in many places in India, we do not have a very efficient waste management collection system or waste management system. And lot of people throw garbage on the streets and that request cleaning. So, cleaning of streets ensures that we have a clean and hygienic urban environment.

And it is a very, very basic service that is provided in most ULBs. Now, we can go for both manual sweeping and mechanical sweeping. But in most cases, we find that in many parts of India, we have very narrow and congested roads. So, the only option is to go for manual sweeping. And because we are going for manual sweeping the entire planning has to be done in such a way.

So, that group of individuals, maybe they could be informal, waste workers or they could be workers under a contractor or a worker who have informal workers who have formed a self-help group together, they have come together to provide this kind of services. Sometimes this kind of staff also belongs to the municipality as well, because municipality has lot of staff who are cleaning staff.

And most of them in many cases have shown their interest that okay, they do not want to clean the or collect the garbage from houses or residences. Instead, they are more, they will,

they are involved in the street cleaning part. So, street cleaning is provided by both municipalities, or ULBs using their own staff as well as contract employees or via self-help groups using informal workers.

So, even the manual sweeping is the only option but manual handling is not. That means even though you are using workers to clean the streets, but we should make sure that they do not have to handle the waste manually. So, that means we have to give them adequate equipment and protective gear. So, both their health and hygiene is being taken care of as well as the interior walking becomes more efficient.

Now, public littering is the one of the biggest problems in India is public littering. And of course that is because partly its risk our we are be responsible for that that means behavior wise we are not that we can say that we are not that civilized and we throw our garbage in the streets. But in sometimes it is not a question of behavior, it is a question of, it is a question of the system that is in place the waste management waste collection system that is in place.

If the agency which is supposed to collect waste does not turn up every day for collection of waste, or maybe they are supposed to turn up but they failed to turn up in that case people will throw the garbage in the streets or people will store garbage in the streets for agency to come and pick up but in meantime, dogs and other audience can spread the garbage around. So, all these issues are there and in an Indian condition, the other problem is many of our roads are not paved, and it we have the carriageway but the pavements are not there.

So, that requires a lot of dust and all which also creates which also creates this kind of dust and other kinds of little problems. So, whenever we are doing street cleaning or differently, we will generate waste. So, we have earlier talked about street cleaning waste and partially it is that we will have leaves we will have inert material like dust, we have certain plastic and other kinds of material which are thrown away by the people.

So, all this system needs to be collected and stored and or you mean we can store it for something then we can transfer them or we can directly put it in the vehicle which will transfer them. So, in any case when we are doing this, we have to make sure that this particular waste does not mix this mix with the other waste that we are collecting from the generators in the ULB. For example, residences, or maybe some institutions if you are collecting waste.

We are we will categorize those waste into dry and waste or even hazardous waste. And then we will transport them to the respective recycling centers or processing centers, or to compost plants or to the landfill site based on the waste streams characteristics. Now, this waste stream, we have to make sure that this particular street sweeping waste does not mix with the other waste trips, because usually, this waste is more contains a lot of contaminants, including heavy metals and all.

And if that get mixed with the other waste, it actually will contaminate those waste as well. And sometimes street sweeping is not done a lot. That means drains which are not that deep, shallow drains are also cleaned along with the street sweeping service. So, the silt from the drains or the switch from the drains or the sludge from the drains also get mixed with the waste, which may contain pathogens.

So, it is better to keep this waste stream totally separate from the other municipal waste street. Now coming to the cost of this kind of services, first, we understand that it is a essential service it has to be provided, otherwise, our streets will be filled with garbage. And but at the same point of time, because it is a manual operation, it has to be done for every street, and almost every day, in that case will be also spent around 30 to 50 percent of the entire solid waste budget in street sweeping services.

So, it is a very, very costly part of the overall solid waste management process. Now, as far as Solid waste Management rules, 2016 it is states that waste including leaves, etc. Gathered from street sweeping should not be burned, and should be properly stored for collection by waste collection system. So, obviously the leaves and all that is gathered in the streets from the surrounding vegetation or, or the trees which are planted in the streets itself.

So, those would be collected. And we can actually utilize those street for those kinds of waste for composting. But we have to careful that it does not get mixed with the inert waste on the dust waste, because that is where a lot of contamination may also get into mix with the organic waste part as well. So, we do we should not burn this leaves, which creates pollution in the streets, but we should make sure that those are collected. And if possible, they can also go for composting as well.

So, even though this is not supposed to go for composting, the sweeping waste, but because it is organic waste, we can consider composting to a certain extent. Now street sweeping waste collection frequency should be as per the density of the population, commercial activity and

local context. So, that means actually the street sweeping collection frequency is for roads, So, the roads and which road we should collect how much depends on the cated population around that particular road.

That means how much population stays around that road and use that road amount of commercial activities that we will see how much amount of waste it generates, as well as attracts like people will come here and they will also create litter in this area. Because commercial areas attract a lot of outsiders and at the same point of time, because these are commercial operations, the it is there may be packaging waste and other kinds of waste, which are also generated over here.

Finally covered secondary storage facility for temporary storage of streets sweepings and silt removed from surface drains where direct collection into transport vehicle is not possible. So, what we can do is we can manual, waste worker can actually sweep the streets and then he can store the waste and put it directly into a vehicle and then the vehicle could be taken for further transport or further transferred. But if he feels that no, that is not possible. Or if he does that that is inefficient. Why? Because he is working in a particular street. After working for maybe 50 meters, the vehicle gets filled.

So, I have to take it to the transfer station to dump the waste. And again, come back and start walking over here. So, if you feel that no, that is not a good option. So, instead, I will work here and I will have a storage container over here, where as soon as the vehicle gets filled, I will store my waste over there and then use the vehicle or use whatever container I am using to do the same and then keep on storing this waste in containers later on a vehicle will come at certain time and then it will pick up this waste on all these containers and take it for disposal or to some treatment facility.

So, both the models are fine. So, depending on the context, depending on the kind of street depending on amount of waste, we have to design, which is a better system for this particular area. So, all workers should be given protective gear that is protect proper uniform shoes gloves and also that they are protected because they are handling waste and health and safety has is a primary concern.

There has to be periodic checks and they are also not only it is, we are talking about physical health, but also financial health as well. And we have to make sure that they are well protected with health insurance and other kinds of social security benefits, because there is a

chance they are they are dealing with the waste of society and there is a chance they will fall sick and society has to take care of them.

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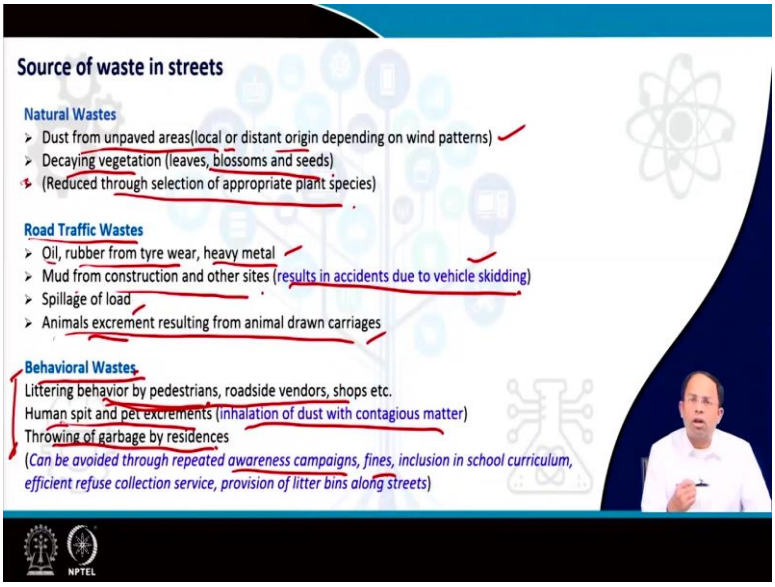

Now, where are the waste, coming from the waste that is coming into streets. So, one part is of course, natural waste, which is dust from unpaved areas, but the thing is in Indian areas even though some cities are very very well paved still we find a lot of dust the reason is because of the wind pattern, because of the surrounding land use, because of the nature of soil or how much aerate distinct both the dust that we find in a particular area is both from local as well as distant origin that means it may be originated far away but because of wind it is being blown into the city.

So, that is where the first source of natural waste comes from, then became vegetation leaves blossoms and seeds from plants which are planted along the streets, they actually fall on the ground and that is what needs to be collected. And but this part would be definitely reduced, because we can select appropriate plant species which does not hit the leafs very often maybe these are perennial trees instead of deciduous instead of trees which shade the leaves during either winter or maybe some other seasons and so on.

So, accordingly we can choose certain vegetation which are long lasting and which will not shade that leaves so much. Then the second source of waste is artificial which is road traffic waste oil from the cars, rubber from tyre wear, heavy metals, which comes out of the fuel unburned fuel and again from rubber and all. So, all this falls on the street and remains in the street then marked from construction and other sites are vehicle move into a construction site

or maybe some other site and then comes out with the mud and it spreads that into the entire street.

And this actually results in a lot of skidding for other vehicles and all. Because if there is a lot of mud in the street, then two wheelers and others can skid and there could be a lot of accidents from that, then vehicles can spill their load sometimes you see that vehicles which are not covered properly, they will spill including many municipal waste management vehicles, they do not cover it properly they have a cover, but still from the gaps you will see waste spilling out from this particular vehicles and finally, animal excrement resulting from animal drawn carriages.

So, in some cities, we are still using animal drawn carriages or sometimes even those animals are not supposed to roam inside our cities, but still they are and from their experience also the roads get contempt, all this garbage also arguments. The final thing is of course, the behavioral waste that means this this part of the waste we can actually through proper awareness campaigns through proper teaching of the people we can actually solve this problem.

So, this is all based on human behavior, littering behavior by pedestrians roadside vendors shop. So, even though sometimes our garbage bin is provided people, roadside vendors and shops will not throw their but they will throw somewhere else or people who are using those roadside vendors they will be throwing somewhere else or littering maybe on a pedestal all this play a role.

Then human spit and pet extremists sometimes for domestic pet we will take them out for a walk. And that also results in this kind of animal experiments, humans spitting behavior. So, these are again behavior which we can change and the problem is dust and all there is a lot of dust in the Indian roads, it will get mixed with this contagious matter then we will breath that and that will lead to other kinds of diseases.

Then throwing up garbage by residences, this is more of a reason because other options may not be present or that may not be affordable. So, people just throw garbage in street. So, this kind of behavior can be actually prevented. So, this can be avoided using repeated awareness campaigns in a city fines So, it is not always a positive by doing positive taking positive measure we can prevent that we have to incorporate fines then inclusion are in the school curriculum.

So, that kids are taught about all this efficient refuse collection service if they refuse collection services efficient and all then there should not be any problem and provision of litter bins along streets. So, we have discussed this earlier as well.

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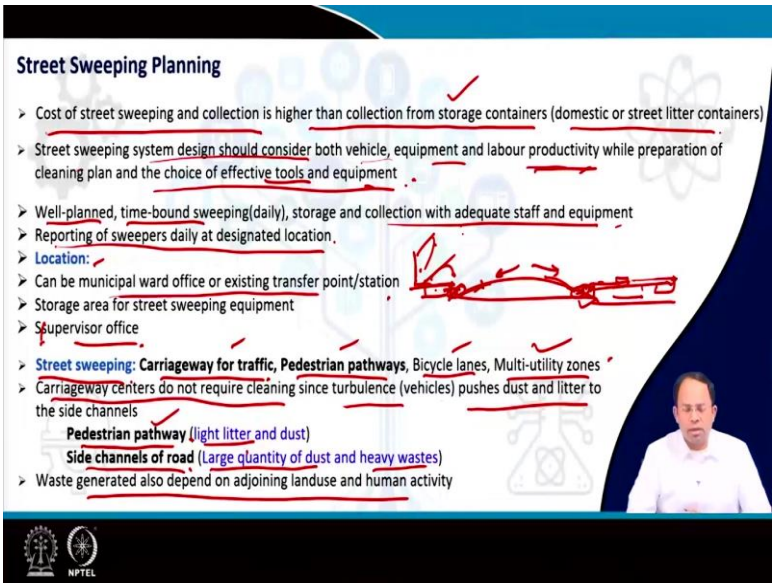

So, then how do I plan for street sweeping the, so, as we have learnt earlier, the cost of street sweeping and collection is very high, and it is higher than the collection from storage containers. That means if a person throws a garbage in a storage container, then it is easy to collect that garbage instead of first cleaning the streets gathering the garbage and then putting it in the container or putting it into the vehicle directly.

So, it is always better to put adequate number of litter bins along the street. So, that people throw their garbage inside those particular bins, because it will reduce my cleaning time it will make it will require less than number of people to clean those particular streets. So, we have we can give domestic and both street litter containers for this particular purpose. Street sweeping system design should consider both vehicle equipment and labor productivity while preparation of cleaning plan and the choice of efficient tools and equipment.

Street sweeping system design incorporates human beings because in most cases we are using manual training, sometimes it may involve larger vehicles or equipment for mechanical cleaning, a lot of tools and equipment are also required to support these kinds of activities, but all this we have to understand which mix of all these are which models of all this result in the most efficiency or rather the most productivity sometimes we have seen that if the area is

very dense and all we have discussed this labor and vehicle productivity earlier for solid waste collection.

The same concept also applies over here, that means when we have a road stretch, if you find that the it is very dense lot of waste is being generated in the streets. So, my wheelbarrow will get filled very, very fast. And that was whenever it gets filled up to take it to the point of disposal. So, alternate way could have been something like where I take instead of this I use a street cleaning vehicle or mechanical vehicle, which can cover a larger section of the street and at the same point of time, because it can take care of it can take care of many workers that would be otherwise would have been employed over here.

And it can, because it has got a larger continue to be efficient to run this particular operation, both in terms of cost and all. So, it depends on where what which model will work, but maybe in the same city, the mechanical vehicle, the road is of not the design where a mechanical vehicle could be deployed. So, all this leads to a selection of appropriate mechanism. So, that is what we have to actually find out.

So, other than that, the street cleaning services has to be well planned, it has to be time bound, that means within a certain time, it has to be cleaned till the if there is a storage container till it gets filled on every day for that matters. And in certain cases, even less than every day that is maybe twice a day. So, storage and collection with adequate staff and equipment. So, both these are all required. So, we have to make sure that how many of these are required. So, that estimate we have to make.

Then we have to also give areas or we have to designate locations where sweepers will report every day, because it is a big manpower that reports every day and take up certain stretches for cleaning, there has to be supervisors for looking into what kind of work who will walk in what streets, they have to see if they are working properly, all this thing needs to be planned. So, but everybody has to come to a point where they come, they may change they may take the equipment and then they will go for work.

So, that is why the location is very important, it can be either a municipal ward office or either a transfer point or station where all this equipment all these things are stored. So, in addition to that, there may be a supervisor office over there changing rooms, all these cleaning rooms, all these things could be also present here. Now, when we talk about street

sweeping streets are of different types, it could be carriageway for traffic, it could be pedestrian pathway, it could be a bicycle lane, it could be a Multi-utility zones.

Multi-utility zones are parts in the footpath where the footpath is large and we can have other sorts of things, maybe some eating shops, which from where you can buy some food materials or fast food shops and all this one maybe a small plaza kind of area. So, all this is part of the multi utility zone. So, similarly bicycle and pedestrian pathways carriageway. So, these are all different parts of the roads section which needs to be cleaned.

Now the main carriageway usually the one where vehicles travel usually do not require cleaning often because of because why because vehicles move through those particular pathways and because of the movement or because they create turbulence in the air. And because of that it pushes the dust and litter to the side of the streets or to the side channels of the street.

So, in most cases the profile of the street section is like this. So, everything will move on two sides and usually this is the curve this is where it gathers. So, this is where we have to clean it from. So, either we have to clean the pedestrian pathway which is beyond this I am not considering bicycle lanes, bicycle lanes could be a separate part of the this beyond the carriageway or it could be part of the carriageway as well.

So, pedestrian but significantly pedestrian pathway and bicycle lanes if they are together side by side, they can be considered together. So, I this is like where we generate a little bit of light litter and dust, people while walking the throw some plastic packet or something. So, that is the pedestrian pathway. Whereas at the side channel of roads at this particular corners, here we generate a large quantity of dust and heavy waste. So, that means all this waste will come to the side and gather over this particular corners.

So, the waste generated also depends on adjoining land use and human activity obviously, if along this particular area, if you have a continuous stretch of litter is, definitely the waste that will be generated as per whatever shop are there along the particular streets.

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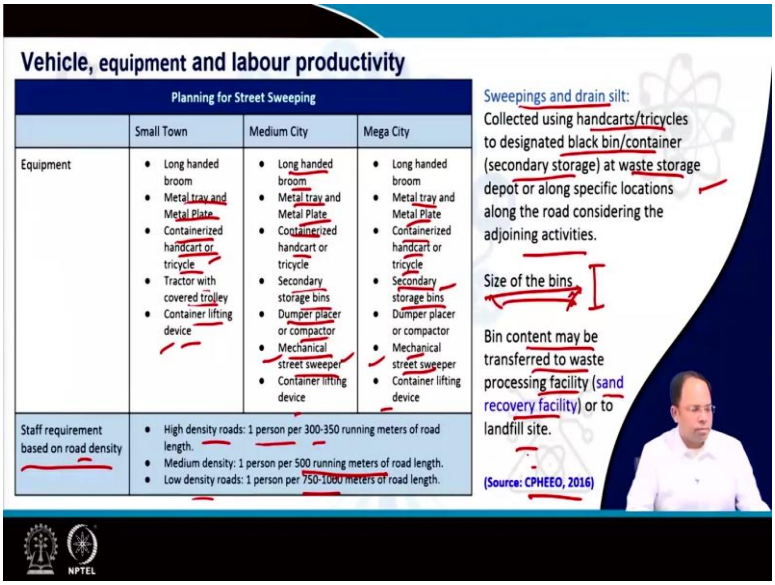

Now, this is suggestions for preparation of procurement of equipment or how many staff you require for different kinds of cities. So, you can see over here staff was, let us start with staff requirements based on road density this is given by CPHEEO manual it says that for high density roads we require around 1 person per 300 to 350 running meters of road length for cleaning around 350 meters of road you require 1 person per day.

For 500 running meters of road in medium density road a person can cover around 500 running meters and for low density roads around 1 kilometer of roads to be covered by 1 person. And similarly what kind of equipment is required that depends on which kind of city you are. Now the primary differences the basic cleaning equipment is same, you require a long handed broom or for any kind of broom for that matters a metal tray and metal plate why because these are used to scoop up the waist we are stuck like some mud part and all.

So, you need to press with them metal plate and all and then take it once it gets loosened up you can put it in the tray then there is a need for a containerized handcart or tricycle as you can see in all the cities, because that is where you put your waste first initially, then in some cases, you can have a secondary storage bins that may as we discussed that the vehicle gets filled very fast. So, I better keep it stored and then keep on using the vehicle otherwise, again, I have to take it back to the point where I want to dispose it.

So, a secondary storage bins is required it has to be in certain distances. So, that I can quickly come back with the vehicle after you are putting the waste there, then tractor with cover trolley can directly take the contents of the handcart and then take it to the landfill site. Or it

could be if it is it could be a container lifting device as well. So, any one kind of vehicle could be there.

In case of medium sized city we can have similar kind of vehicles for carrying this larger bins to the final processing either the compost plant or the landfill site or for any other kind of treatment site. Whereas we can also mechanical street sweepers in both medium or mega cities and the you know the rested model is same. So, that was mechanical sweeping is only possible in larger cities where we have wide roads and proper ROWs planned ROWs whereas in small cities and all we do not usually a footpaths not properly panned ROWs the roads are too thin, so, it is better to not go for mechanical sweeping there.

So, drain silt as we said that drain silt is also collected along with roads sweeping. So, we can collect drains, sweep both road sweepings and drain silt with using handcarts and tricycles and they could be taken to designated black bins or containers which are secondary storage at waste storage at waste storage depot or other specific locations along the road considering the adjoining activities.

Maybe it is not possible to have that secondary storage at every 50 meter or every 100 meter stretch of road. So, we have to do that amount of movement to a point where we are able to store there is adequate space in the road where we can set up this kind of storage secondary storage containers or secondary storage this bins and all. Now size of the bins also needs should be determined based on what kind of waste is generated character of this city, density all this we have to determine on the size of the bins.

Because we can have general we can increase the frequency of collection, but definitely at one point beyond that you cannot improve upon it or it will be too costly. So, maybe we have to go for larger size bins and being contained may be transferred to waste processing facility where we can recover sand ore to landfill sites. So, in case of inert compost waste, we can take it to a compost site, compost plant whereas, for inert waste or other kinds of road dust and this kind of waste, we can take it to a waste processing facility where we can recover sand from that particular waste, whereas, everything else can be taken to the landfill site.

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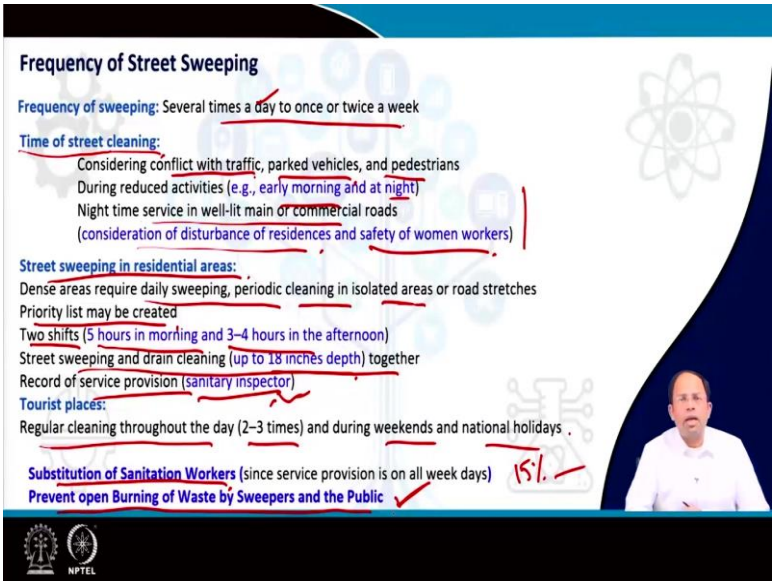

So, frequencies of sweeping could be several times a day to or to even once or twice a week. Now, the time for street cleaning should be such that it does not hampers other activities. For example, we can start in the morning then give a break during the peak hours and then again in the non-peak hours we can complete the cleaning process and also the shift required because we cannot make people walk more than 8, 9 hours. So, we have to also plan our shift accordingly.

And this operation goes on for the entire week in most cases it is every day of the week. So, as you understand, the same person has cannot keep on working 24, 7 days a week continuously. So, he has to be given breaks. So, that is why the total number of staff required is more than what we will estimate based on the distance we service the number of people required to cover certain amount of distance per day.

So, that means you have to keep some more staff in reserve. So, that somebody could be always people can take holidays on a rotational basis. So, the time of street cleaning is again dependent on the city itself, which time it is we are having peak hours based on what activity is going on along that particular state all this plays a role. So, it is based on we considered conflict with traffic that is peak hours, park vehicles and pedestrians. So, all this helps us in determining what kind of time it would be suitable to do street cleaning services.

So, usually it is early morning at night when there are less amount activities. Nighttime service could be done but it should be in well-lit and particularly in commercial roads, it is fine, but we have to be careful about disturbing the residences and also safety of human

workers. So, nighttime street cleaning is also done in many street particularly mechanical cleaning is done probably at nighttime, but when the roads are absolutely empty.

So, street sweeping in residential areas density is required daily sweeping periodic cleaning in isolated areas or road stretches. So, the more denser and more activity spaces it will generate more amount of waste. So, definitely we have to clean it more frequently compared to isolated areas or areas which are much less dense. And so, we can create a priority list for each city that which roads needs to be cleaned, what should be the priority of cleaning for each of these particular streets and there are there could be two shifts for cleaning 5 hours in the morning and another 3 to 4 hours in the afternoon in between you can give a break to your workers.

Street sweeping and drain cleaning can be done together particularly drains up to 18 inches depth could be taken care of by the streets cleaning team record of service provision. So, all these activities that are happening reporting starting from reporting of the street sweepers along with what eddy stretch is been covered in a particular day, where how much quantity of waste is generated, where which vehicle was used to transfer it to get to the final destination or to a processing site, all these records are maintained.

So, that in future we can predict how much amount of staff and cost we require for street cleaning services or we can do more efficient street cleaning services. So, a sanitary inspector actually from that ULB site is in charge of operations he will oversee he will record and probably he will take help from the operators for that street cleaning service as well which will be private operators or self-help groups and so on.

Now, tourists spaces also request special attention they require regular cleaning throughout the day, sometimes even 2 to 3 times and during weekends and also during national holidays. So, there is no break from this kind of services. Now because it is so, it is emergencies you can say it is one form of emergency service that is every street need to be cleaned and all. So, there has to be substitution of sanitary workers because everybody cannot work every day.

So, usually a 15 percent extra from the normal required strength is required because we have to keep on working during holiday and in other times of the year. So, the thing that we have to be very careful about, many street sweepers and even the public, they burned the waste in the streets. So, this practice is made in banned and we should make mandatory that this is not practiced in any urban areas.

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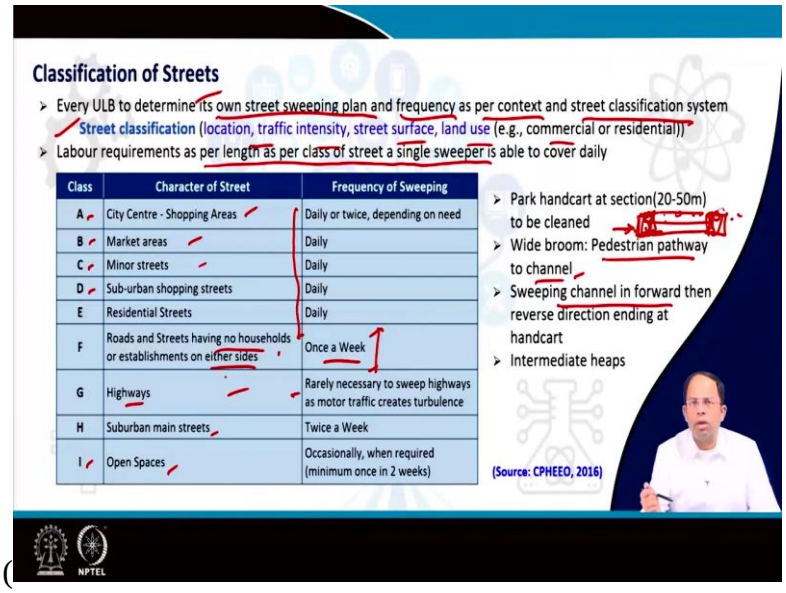

Now, these are some of the classification of streets as per location traffic intensity streets surface the surrounding land use. Now, based on this street classification system, we have to create a every UBP determines its own street sweeping plan and frequency as per the local context and as per this street classification plan. So, that means, depending on how much amount of waste and what kind of activities are happening in that particular street, we determine how often we need to clean it and where at which time of the day I want to clean it and so on.

So, labor requirement is given as per length as per class of the street as an both it depends on the length of the street, how much you can sweep and also on the class of street because for each class you have to the width of the roads are bigger and the amount of dust is also more so, all these things plays a role in determining what length a person can cover for, different classes of streets.

For example, over here, we have first shown the different classes of streets starting from A, B, C, D, until up to h and i. So, i is open not actually a street, it is an open space, whereas G is a highway H is a suburban main street, F ABC or the city center area A is not a street but a city center area with some lot of streets of course, and a lot of pedestrian pathways plazas and all this, and B is a market area C minor street and so on.

So, as and these are the suggested frequencies which are given over here and as you can see that highways require rare cleaning because as we have discussed turbulence takes the waste away, and also people do not keep the windows closed in highways. So, they do not throw

garbage out. But in other streets, maybe that practice happens and in highways also there are not too many pedestrians also.

Whereas for areas which does not have too much many number of people all around the streets, there are no houses and all at either sides of the street, then that cleaning once a week is adequate. So, this is how we have to decide on frequency of cleaning based on different types of urban streets. So, usually the way the streets are cleaned is you park your handcart at a particular area and then for the next 20 to 50 meters section that part is actually cleaned.

And usually the pedestrian walkway is cleaned first and whatever dust is gathered in the pedestrian pathway dust and other litter is first put into the channel space of that particular carriageway and then we then the channel is swept forward most in forward direction till the end point is reach, and then again it you can come back from the other side of the road and then reach the same point then load the garbage into that vehicle and then move the vehicle to the next point.

So, that is how it keeps on going on happening. And so, in between if you feel that no my wheelbarrow is getting filled and all in that case, I can just create intermediate hips over at this point and then a person with a wheelbarrow can come and then they can pick up the garbage. So, either I push the wheelbarrow in this way or we keep on making hips and then we intermediate points we can keep our keeping this wheelbarrow and then I can pick up the garbage by taking the wheelbarrow there.

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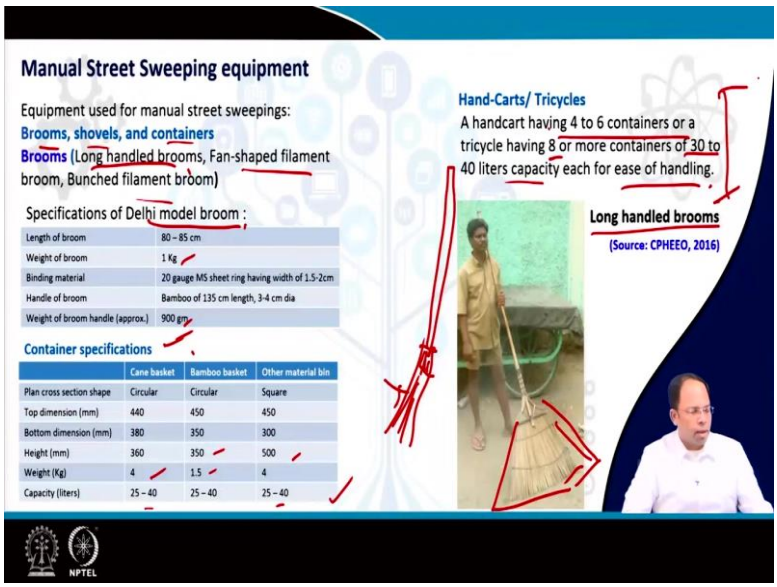

So, these are some of the equipment that you can see in this picture for street sweeping we require brooms, shovels and containers. So, these are obvious. So, you can see this is the long handed broom, this is the typical design whereas a daily broom is something like which is, looks like this and then there is a bamboo pole fitted at the top this one is more spread out right. So, there are different specifications of that long handle brooms, fan shaped filament brooms, bunch filament boom.

So this is a bunch filament broom kind of thing. So, this is called the Delhi model broom and you can see it weighs around 900 grams. So, handle is around 900 grams broom is around 1 kilo grams and that is how this thing looks like. And the containers could be of different sizes So, that they could be easily handled. And you can see containers of 4 kilograms or 1.5 kilograms height is around 500 To 350 to 500 millimeter capacity is around 25 to 40 millimeters. So, that is more or less the size a person can handled.

And similarly, a tricycle can have multiple containers fitted inside that all these containers can go inside the tricycle and it could we have more 6 to 8 or even more containers and usually the containers are 30 to 40 liters capacity each because that a person can lift a 30 to 40 liter container beyond that it will be too heavy. So, that is why this kind of design is a both for the vehicle as well as for containers is that opted for street cleaning.

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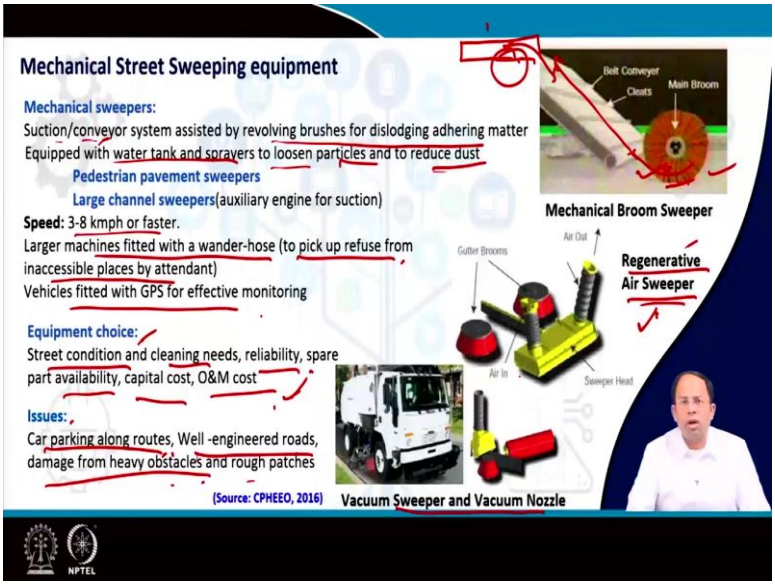

Now, coming to mechanical devices, they can they could be based on either a suction system or a conveyor system. And in both cases, these are assisted by revolving brushes, which the purpose of the brush is to dislodge the adhering garbage from the streets. So, the brushes

rotate at a higher speed and that actually loosen the dirt and other the garbage and then the either using the conveyor system or the suction system, we can take the garbage into the vehicle itself.

So, vehicle is sometimes it could be a water tank and sprayers. So, that because when you spray those on the loose particles and one is because you are putting water the dust will be reduced the other is to loosen up the particles, so that when the broom goes around over it, it will be able to break it up and then you can push it up. So, over here you can see the same broom is working over here and this is a conveyor system that broom pushes the garbage on this and the conveyor pushes the riser takes the garbage up to the vehicle which is the loading arm the loading part of the vehicle is over here and the garbage is put inside the vehicle.

The other option in the suction part is there could be different kinds of suction mechanism regenerative air sweeper or vacuum sweeper vacuum super is pretty understood you have the broom system, the broom dislodges and it pushes the waste towards the vacuum nozzle and the waste is sucking. In the Regenerative Air Sweeper air is itself used to loosen up the dirt and then in the same nozzle we have the vacuum system as well the loosen dirt is again sucked up by this particular system.

The speed of this vehicles around 3 to 8 kilometers something like that. So, based on that you have to determine how many vehicles are required to clean the segments of road that you are planning to clean using mechanical system. Usually you find that arterial roads and bigger wider roads are cleaned by this kind of vehicles whereas smaller roads and all are clean manually. larger vehicles are also fitted with a wonder hose. So, it is just a separate hose which a person carries which is used to pick up refuse from areas which are inaccessible by this mechanical broom.

So, we there are many parts in the street where this will not reach. So, that is where you just like a normal vacuum cleaner you use take this pipe and using suction you can suck the waste stuff. Vehicles are also fitted with GPS for effective monitoring of operations or their movement and all these things. Now that which kind of vehicle is suitable what scale of vehicle is usable again there are different kinds of scale there are small size vehicles there are large size vehicles and so on depends on capacity speed and all these things efficiency of that particular vehicle.

Now street condition and cleaning needs reliability of the vehicle spare parts availability, capital cost, operation maintenance cost all this thing plays a role in determining what sort of vehicle would be suitable for my urban area, then some issues with mechanical cleaning, that is car parking along the routes, if people park their car at night along particular road stretches you cannot clean those because the silt and all this dust gather at the side channels right.

So you cannot access those side channels there well engineered roads may not be there. So, that could be an issue that means this, this request very well properly laid out roads and all the surfaces should be smoother and all but sometimes it is not then sometimes because of presence of heavy obstacles or some rough patches the system gets damaged and we have to repair it and sometimes the spare parts are also not available.

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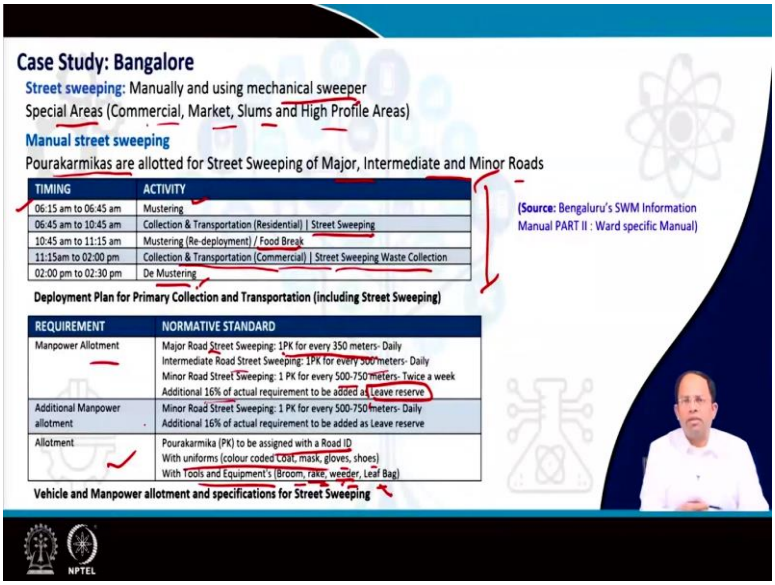

So, we will do a quick case study of Bangalore. So, here both manual and mechanical sweeper are employed both system manual systems and mechanical system manual sweepers and mechanical systems are employed. So, also special areas are covered like commercial market slums and high profile areas are also covered for street sweeping services in addition to the streets. So, usually, these manual workers are known as Pourakarmikas in Bangalore. And they are allotted to major intermediate and minor roads.

And usually they report around 6 o'clock in the morning 6:15, they gather and then at 6:45 they are transported to the different areas from where they will start collecting and then they start their street sweeping process from 10:45 to 11:15. This is the peak hour they will do, they will take a food break and sometimes they are redeployed to some other areas as well

11:50 to 2:00 to a again collection and transportation as street sweeper they do another phase of street sweeping happens after they are taken to the location from where they will connect.

And then finally at 2:00 to 2:30 they will return again clean up and then the day's work ends. So, this is the basic schedule of waste street sweeping in Bangalore. The manpower allotment one Pourakarmika for every 350 meters for major roads for 500 meters for intermediate roads 500 to 750 meters for minor roads and around 16 percent of actual requirement is added for people to take leaves or for leaves reserve.

And the same goes for Pourakarmika to be assigned with road IDs, uniforms, color coded coats, masks, gloves, shoes, tools and equipment like broom, rake, weeder, leaf bag, leaf bag is storing for leafs and some other bags for inert waste maybe that is stored directly into that particular vehicle. Then weeders, rake, weeders are for cleaning of weeds, and rakes as you can know brooms for lifting rakes or for scraping and all. So, all these things are also given to the workers.

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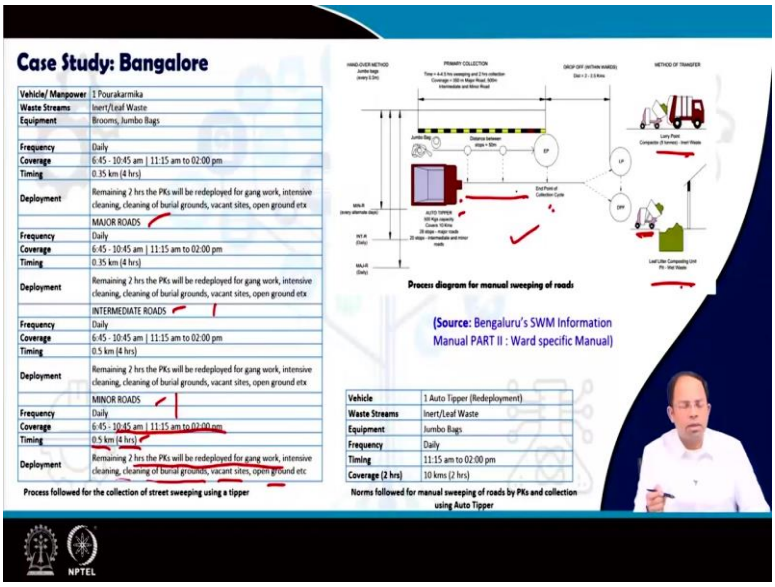

Now over here, you can see at for different kinds of roads, major roads, intermediate roads, minor roads, what is the time of operations is approximately around 0.5 kilometers is covered in 4 hours' time period, and remaining 2 hours the PKs will be redeployed for gang work intensive cleaning, cleaning up burial grounds vacant sites and open ground. So, primary street cleaning happens for 4 hours and other 2 hours for other cleaning of other kinds of public areas.

So, more or less it same for all the streets and only if the number of workers deployed in different sizes of streets are different. Over here you can see the same thing as auto tipper with 500 kg capacity is waiting over here that is the vehicle that this cleaner come with then they have bags with them they for every 50 meters they will travel and this is the endpoint of collection cycle once from here.

They will transfer the garbage to a vehicle like this which will either take it to a compost plant the leaf waste and the or it will take it to a bigger to transport it to the landfill site. So, this is how they have done their plan and this is how vehicles manual laborers are deployed for collecting garbage.

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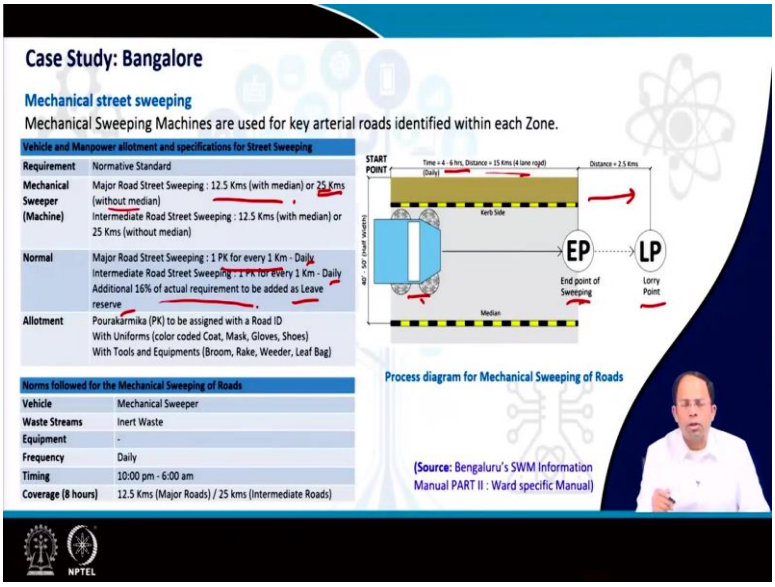

Similarly, for mechanical sweeping also the rate is around 12.5 kilometers with road with medians that means divided roads, because you have to clean from both sides. So, your work doubles almost at 25 kilometers without median. So, you can one vehicle can cover around 25 kilometers if there is no media. So, in addition to that, there is one PK for a Pourakarmika for every one kilometer and major road sweeping is done daily intermediate road sweeping is done daily.

And again additional 16 percent people is required as a backup for leave reserves and so on. So, this is how it is more or less works you can see the vehicle this is the vehicle being deployed, it reaches end point of sweeping then it transfers the load to a lorry and maximum they may travel another 2.5 kilometer to do this kind of transfer and overall over here it was a

4 to 6 hours distance is around 15 kilometers for a 4 lane road. So, this is a case study for street sweeping services in ULB.

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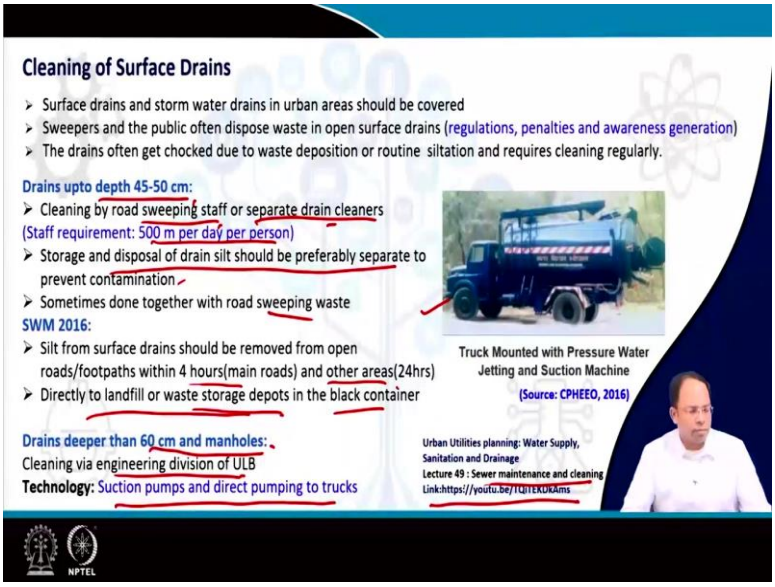

Now coming to cleaning up surface drains. Of course, surface drains in urban areas should be covered and the rest is of course there should be a sewage network but in many cases, surface drains in our country are not covered or maybe in people also because of deposition of set or deposition of the normal deposition even though suppository should be designed so that it has got adequate self-freezing velocity it should be clean but still siltation happens in all and it needs to be cleaned at certain intervals.

So, drains up to depth of the 45 to 650 centimeters is done by the roads sweeping staff themselves or we can have another group of staff in the same team like drain cleaners who can take care of this. And staff requirement is similar almost 500 meters per day per person. So, that is how much staff you require. Based on the kilometer of road you can determine for cleaning up drains in addition to cleaning up streets.

So, storage and disposal of drains silt should be preferably separate to prevent contamination. Sometimes it is taken together with road sweeping waste, but if possible, we have to even segregate between road sweeping waste and the waste which is from coming from drains. The silt from surface drain should be removed from open roads, footpaths within 4 hours, main roads and other areas we should be within 24 hours.

And directly this kind of waste is taken to using black containers they are taken to this waste storage depot or to the landfill sites directly and drains which are bigger than deeper than 60

centimeters and even the manholes, this cannot be cleaned by road sweepers and also there we have to deploy mechanical equipment. And it has to be done by the engineering division of ULB.

So, it is a it is a planned service where we use suction pumps and direct pumping directly to the truck such as this trucks such as this and we can clean the streets by using various mechanical means. Now for cleaning up underground sewers and all in that case, if you are interested you can look at this particular lecture which is available in YouTube and this is lecture 49 sewer maintenance and cleaning from the NPTEL course Urban Utilities planning urban supply, water supply, sanitation and drainage.

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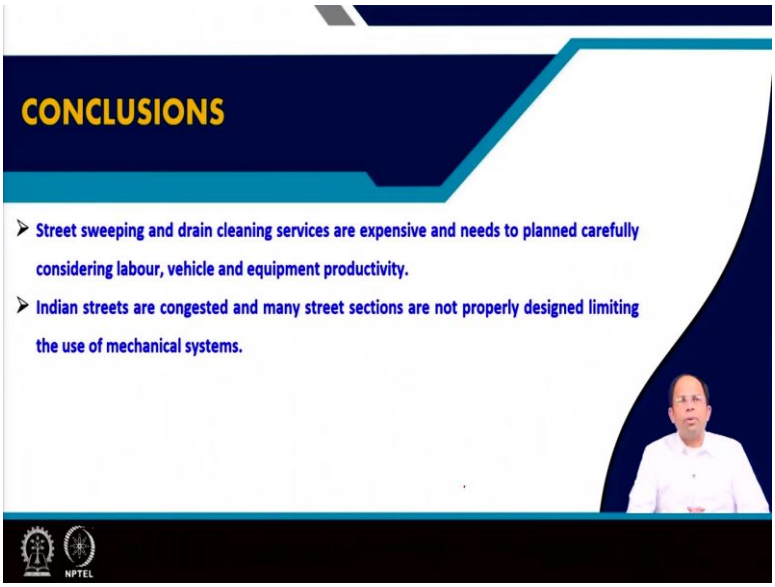

So, these are some of the references you can use. To conclude street sweeping and drain cleaning services are expensive and it should be planned carefully considering labor vehicle and equipment productivity and Indian streets are congested and many street sections are not properly designed limiting the use of mechanical systems. So, in many cases, we have to plan for manual operations and entirely but in some cases we can also use mechanical operations. Thank you.