Geoenvironmental Engineering (Environmental Geotechnology):
Landfills, Slurry Ponds & Contaminated Sites

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Lecture – 42
End-Of-Course Review

Welcome to the last class of this course Geoenvironmental Engineering or Environmental Geotechnology as you would like to call it. We have done 42 lectures in total including today's lecture. And today we will just review what we have done in this course. And what have we learned over the last 42 lectures. So, in the beginning if you recall we had talked about some learning objectives do, you recall any other learning objectives that we had talked about. There were 3 learning objectives to this course. So, what we will do is we will go back to the first set of slides, which we which we saw at the start of this course. And see how much of that we have accomplished and did we actually achieve what we wanted to achieve.

So, anyone if you have your course notes here what are the 3 objectives?

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Maybe I will have it I will have it in the next slide. So, this is what the first slide was when we started the course we said it is a course on geoenvironmental engineering also sometimes referred to as environmental geotechnology. It will deal with waste disposal landfills slurry ponds contaminated sites.

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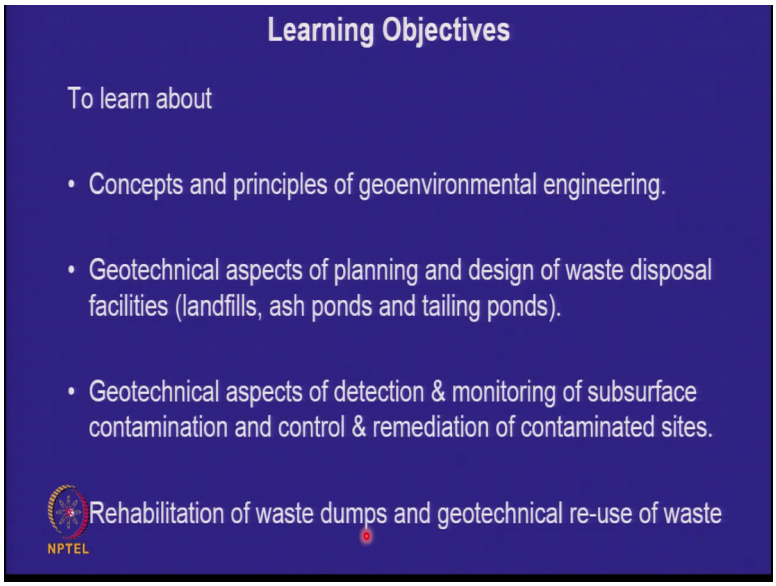

And there would be 3 lectures per week, and these are the learning objectives which we had sought to achieve. Concepts and principles of geoenvironmental engineering. So, it is a new topic new terminology what is geoenvironmental engineering what does it cover.

Then the major part of the course would deal with geotechnical aspects of planning and design of waste disposal facilities, which include landfills ash ponds and tailing pond. And we would also look at geotechnical aspects of detection and monitoring of subsurface contamination and control and remediation of contaminated sites.

So, that is the 3 learning objectives, as you have completed this course I can add a fourth learning objective. We also wanted to understand how do we rehabilitate the old waste dumps or the garbage dumps that we have, and we also want to learn about the geotechnical reuse of waste materials, the how do we reduce the footprint of waste which is accumulating at various places.

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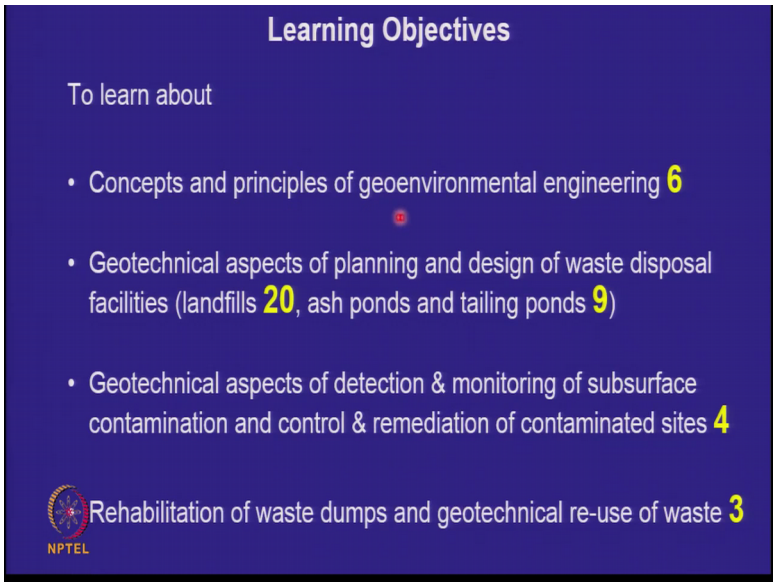

So, when you look at the lectures that we have done, the first 6 lectures were on concepts and principles of geoenvironmental engineering. And after that we spent a bulk of our time on landfills.

So, half the course is a 42 lectures 20 lectures have been on landfills. So, 50 percent of the courses on landfills and about 25 percent of the courses on slurry ponds. Balance on detection and monitoring of contamination and the remedial measures 4 lectures rehabilitation of waste dumps and geotechnical reuse of waste three.

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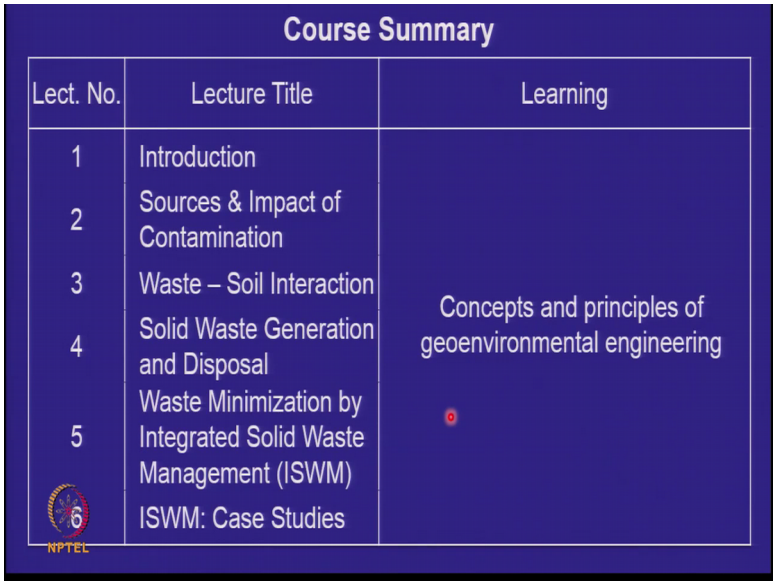

So, that is how the course was divided into various segments. So, the first 6 lectures and I will go down the sequence is what we did we had an introductory lecture, we looked at sources and impact of contamination, we looked at waste soil interaction, we looked at advective flux diffusive flux, we looked at how much waste is generated and how it is disposed. We also examined the principles of integrated solid waste management with the name that the solid waste reaching the landfills should be minimized and we looked at some case studies.

So, with these 6 lectures we basically met the learning objective of concepts and principles of geoenvironmental engineering, all these were new concepts and new principles. And there was not much about design here, but definitely what was the scope and what are the guiding philosophies for the various topic.

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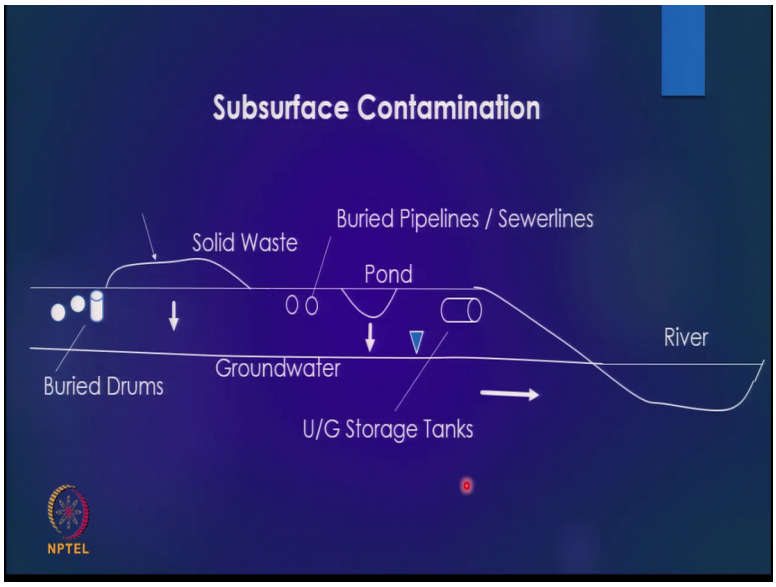

So, one thing we became familiar with was this diagram that everything which was put on the ground causes something to reach into the ground and contaminate the subsoil as well as the ground water you know buried drum drums solid waste ponds pipelines underground storage tanks and that can affect the quality.

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So, one thing we also for the first time looked at the magnitude of the problems of municipal solid waste dumps the huge heights they were reaching in megacities and the leachate that is accumulating.

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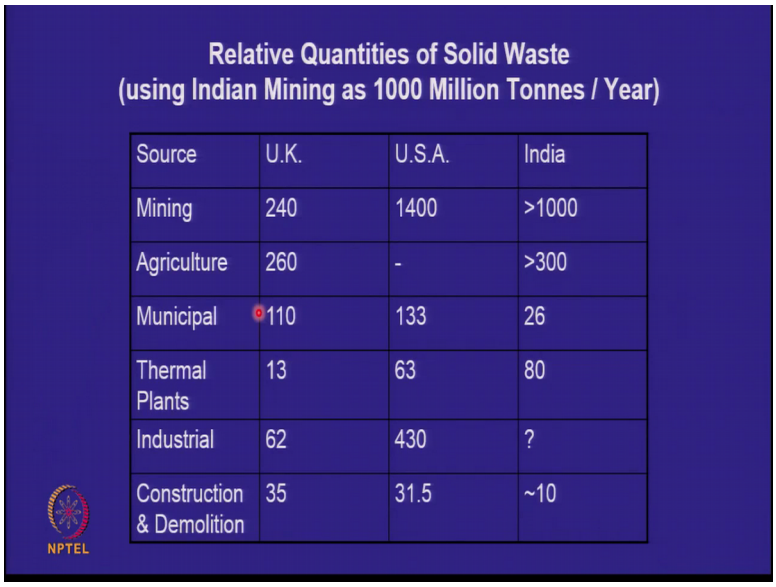

Source	U.K.	U.S.A.	India
Mining	240	1400	>1000
Agriculture	260	-	>300
Municipal	110	133	26
Thermal Plants	13	63	80
Industrial	62	430	?
Construction & Demolition	35	31.5	~10

While municipal solid waste dumps are only present and visible to us nearby the larger picture was that municipal solid waste is not the predominant waste.

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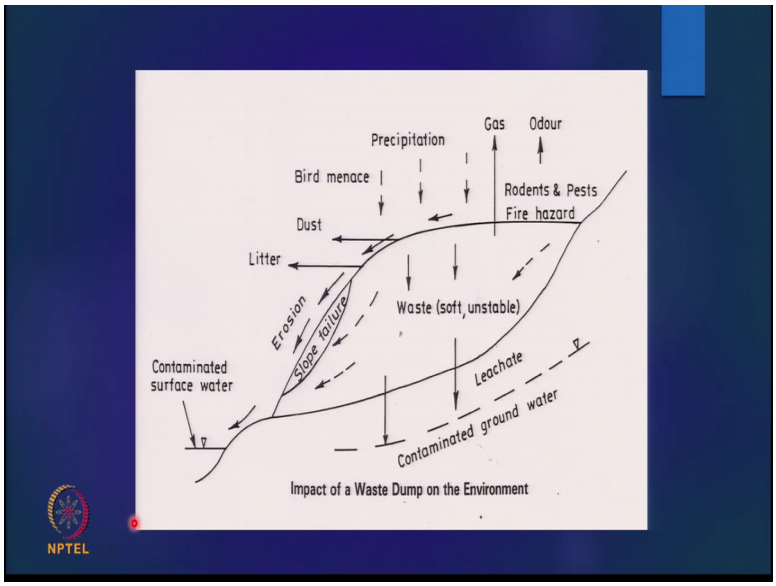

We have a lot of mining waste which comes out; we have a lot of agricultural waste which comes out, apart from that thermal power plant industrial waste and construction and demolition waste.

And then we recognized that once you have a waste dump it is not one or 2 things it does it does a lot of it creates a lot of problems and for different people different things have different importance is for the person who is driving or flying an aircraft bird menace becomes very important for people living adjacent to the dump order is a huge issue. The greenhouse gases for climate change.

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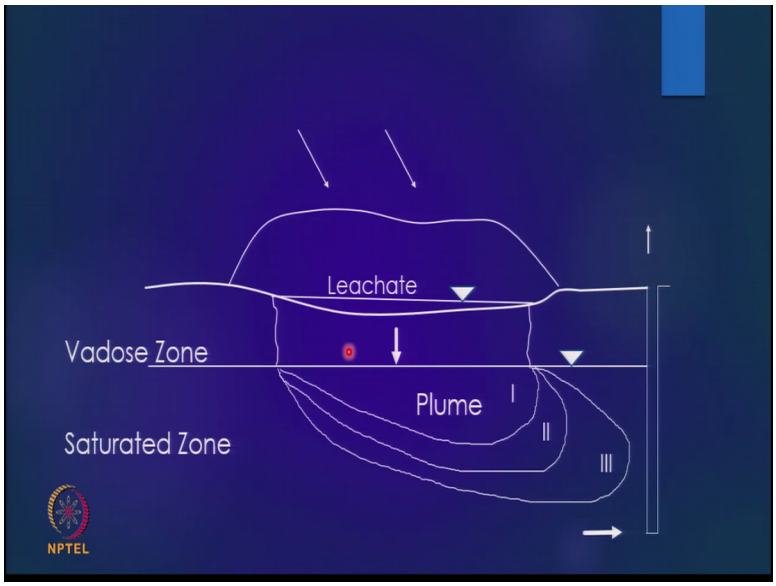

And various other kinds of aspects. And we also recognize that once a plume is form the non reactive constituents travel further ahead that. And there are actually 3 zones one in which the attenuation capacity is completely depleted an active zone and one become one has the non reactive components.

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And under integrated solid waste management we looked at the efforts that were underway to decrease the amount of waste reaching the landfills we talked about various

kinds of composting plants waste to energy plants that would reduce the magnitude of the waste dumps.

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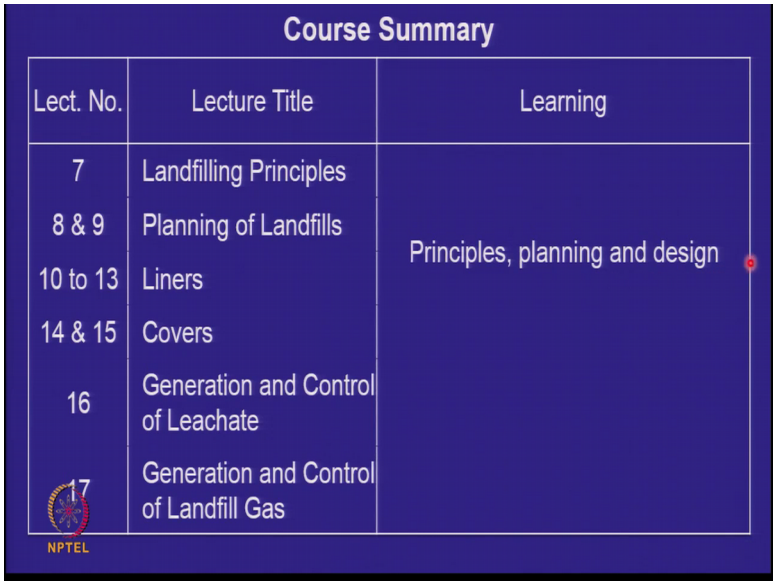

After the first 6 lectures we then of course, got onto the next 20 lectures on landfills and land filling the landfill. Design practices we started with the principles we talked about planning of landfills we spent a large amount of time on liners because they are critical to good performance of landfills talked about covers and how they control infiltration. And we had a lecture on the principles of control of leachate this is more a hydraulic design and control of gas. So, this was a course on landfill engineering then of course, you would have done many more lectures on both of these, but this is a course on geoenvironmental engineering which means geotechnical aspects of environmental engineering.

So, when we did these 10 odd lectures.

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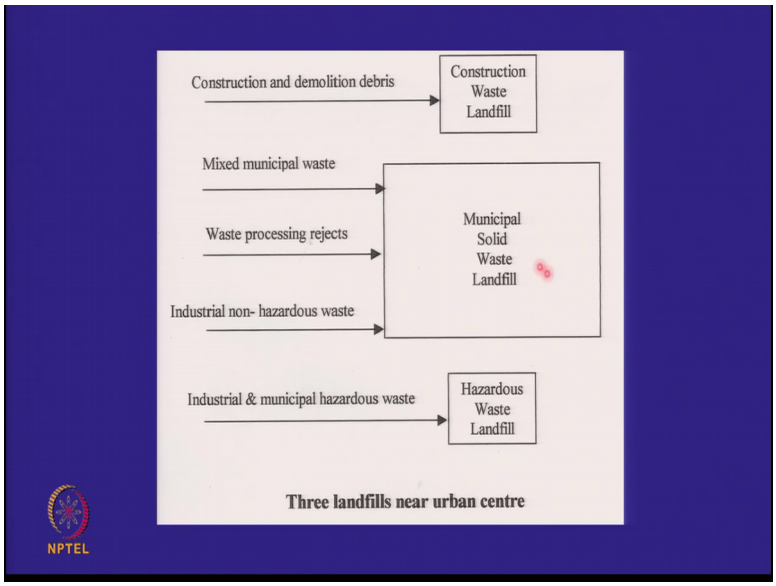

So, in doing all this we looked at principles of design the planning aspects how do you plan a landfill. And of course, the design aspects. Just a quick recap we talked about the fact that cities should have 3 types of landfills. One for construction and demolition waste which can be reprocessed for landfill use one for mixed municipal solid waste. And one for hazardous waste. And this municipal solid waste would become smaller and smaller if all the initially collected waste was kept in it is segregated form and you could do composting of the biodegradable components and you could do energy recovery from the combustible components.

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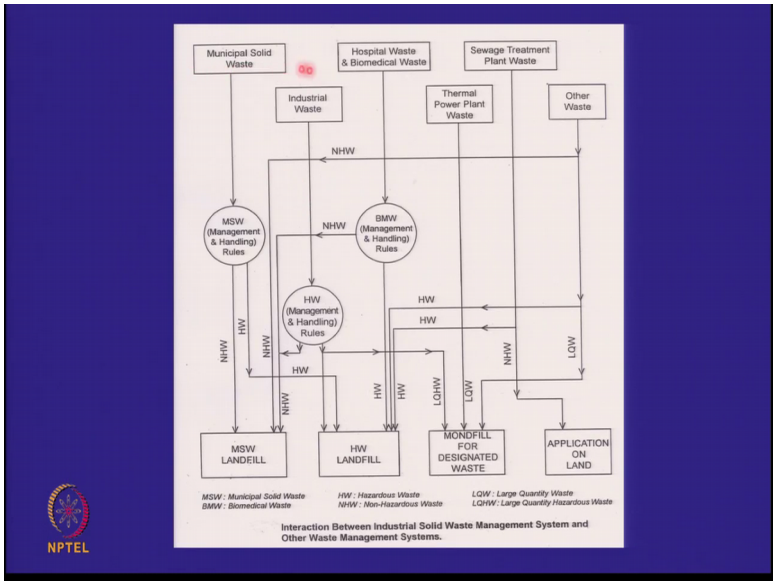

And we also then recognize the various types of wastes which are coming out in an urban center, and if you have different types of landfills. The municipal solid waste management system has to interact with the hazardous waste management system because from the industrial area then non hazardous wastes would come here. And so, the biomedical waste the thermal power plant waste the sewage treatment plant waste and other types of weste.

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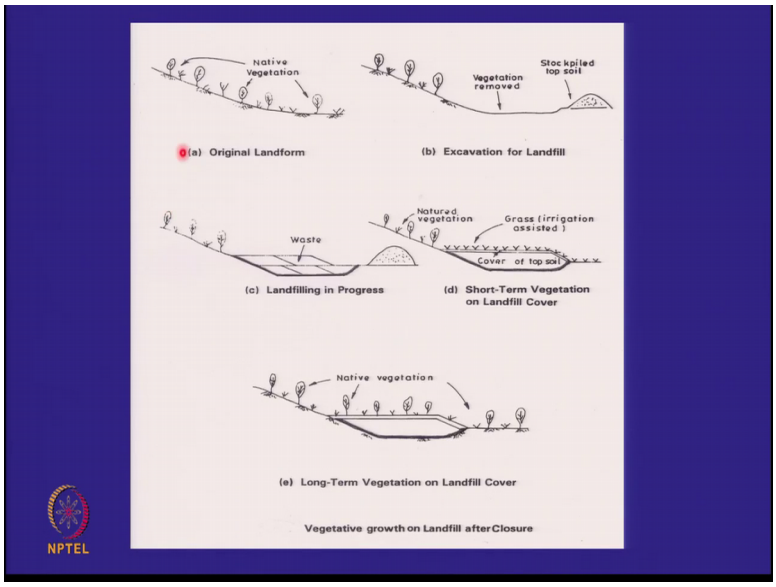

So, here are the complete interaction between various systems. We also recognized that making a landfill did not mean burying the waste, but it meant that we are preparing a site to receive the waste, we have to bring the land back to it is original form it may be a little raised ground, but the same vegetation should come back at the top of the landfill.

And over a period of time this waste should stabilize and then only it can be considered to be permanently stored. If it is not going to stabilize say after 100 years which is the design life of a landfill 50 to 100 years then it is only temporarily stored; that means, if the waste is still something which can damage the environment. And your liners and covers are not going to survive beyond 50 to 200 years. You have to dig it up and do whatever you can with the waste and replace it with new liners and new covers.

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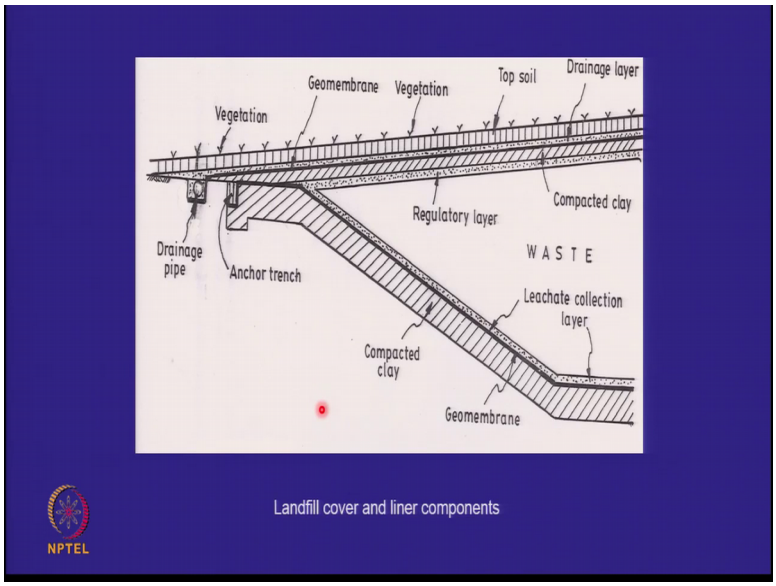

Gradually we developed the concept of multi layered system for the covers and for the liners and we started to look at what a landfill actually looks like in section.

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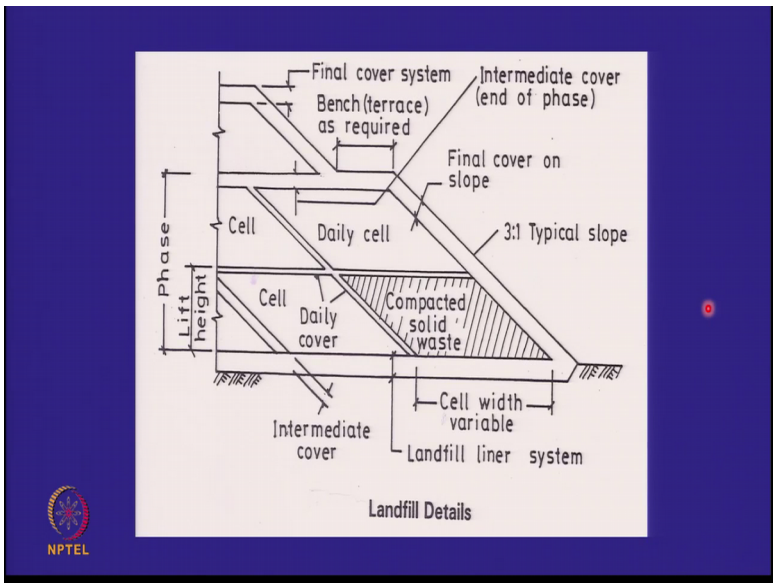

And also we looked at how the waste is placed in daily cells with daily covers and finally, a final cover system.

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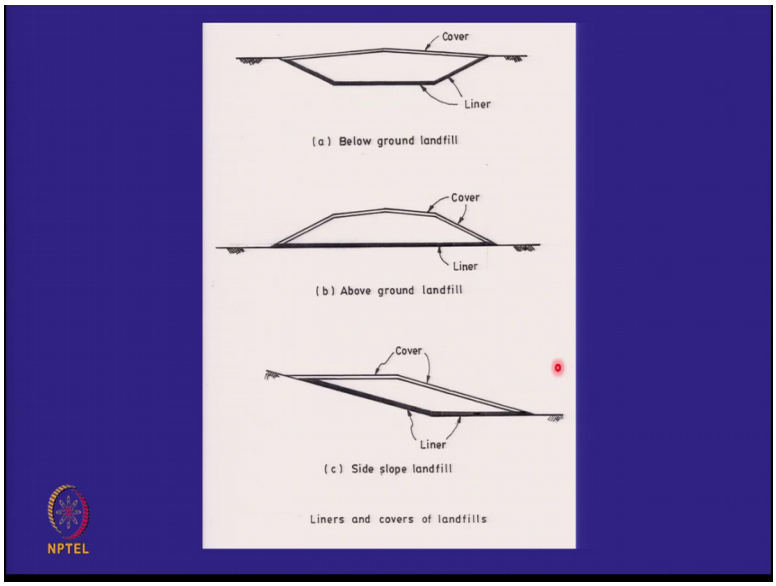

And we recognized there are different shapes and sizes of landfills and we talked about below ground landfills above ground landfills and site slope landfills.

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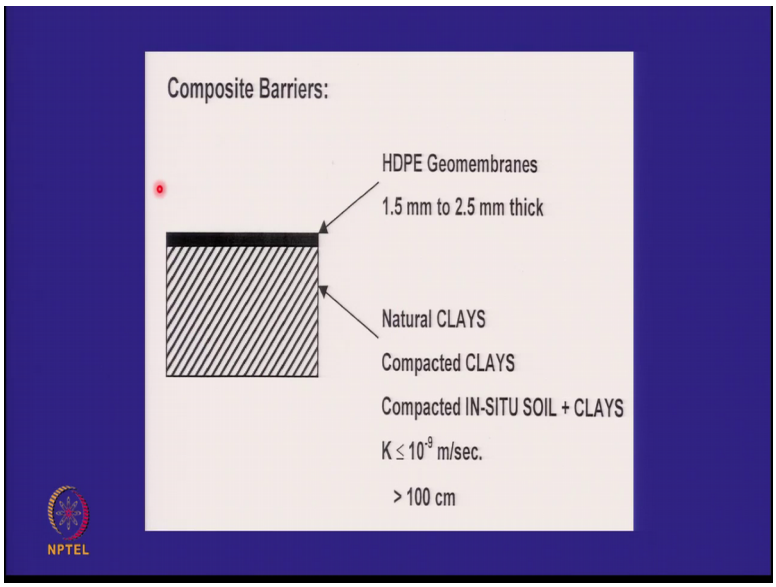

The composite barrier was a completely new type of liner that we evolved through our discussions why is it a composite barrier? How is it advantages over the other types of barriers we discussed?

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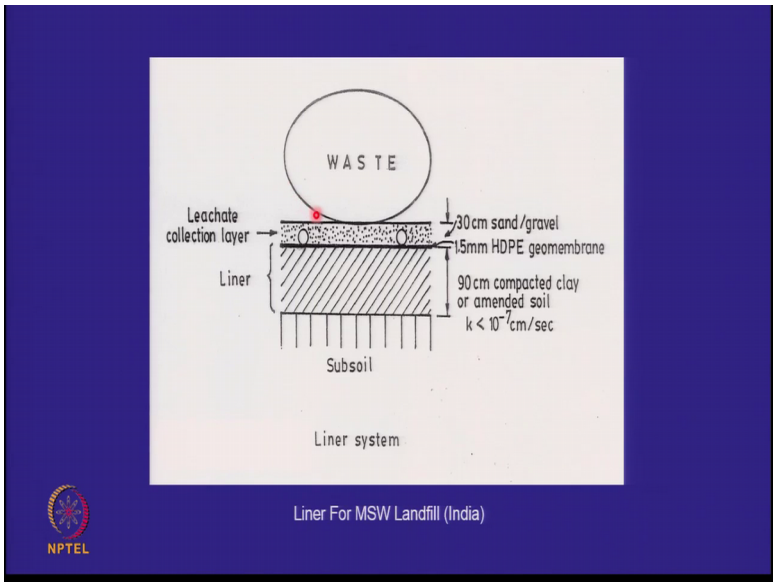

And how it then it was there in various types of guidelines and manuals.

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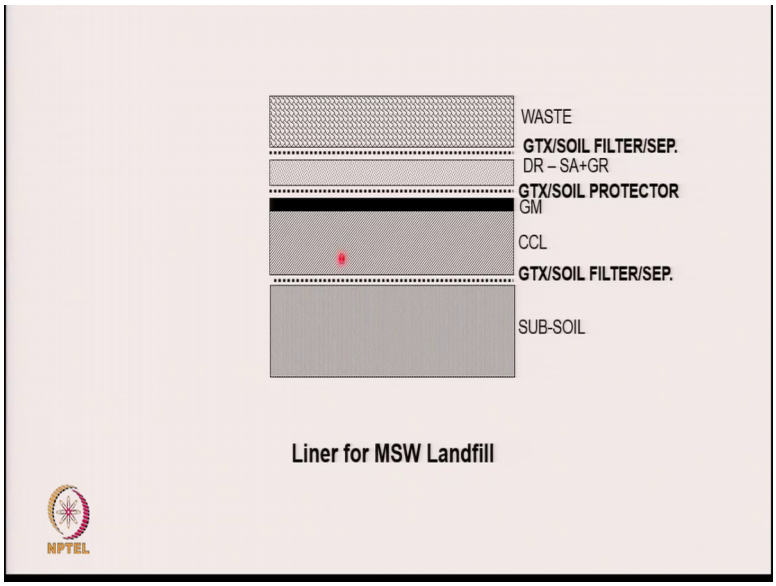

And how it In fact, was not one layer or a 2 layer system, but several layers with separators and protectors and filters and the composite barrier being the key component of the liner system.

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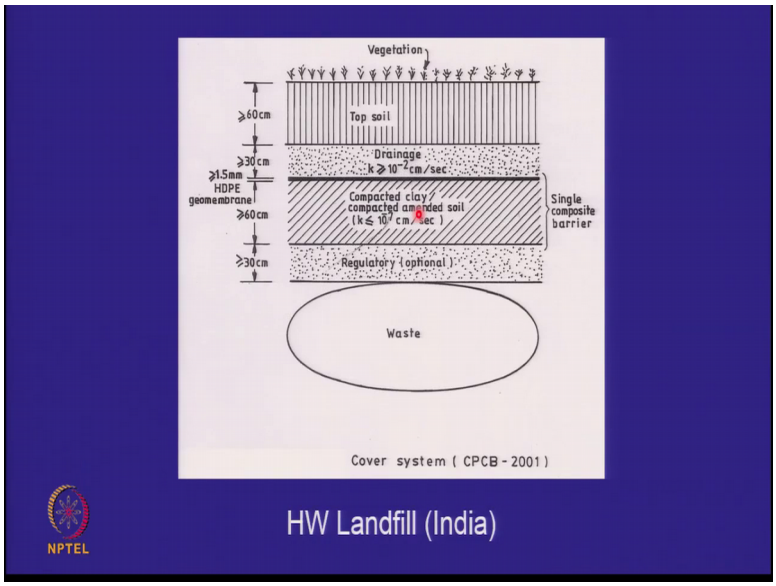

Similarly we developed the concept of the cover system and in the cover system we also talked about various kinds of geosynthetic elements which can replace natural soil.

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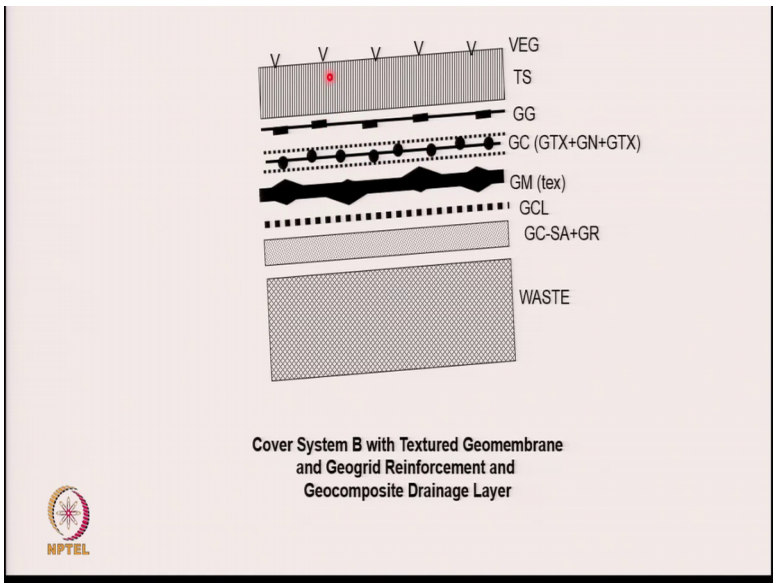

So, that you can have steep covers and we discussed them in detail.

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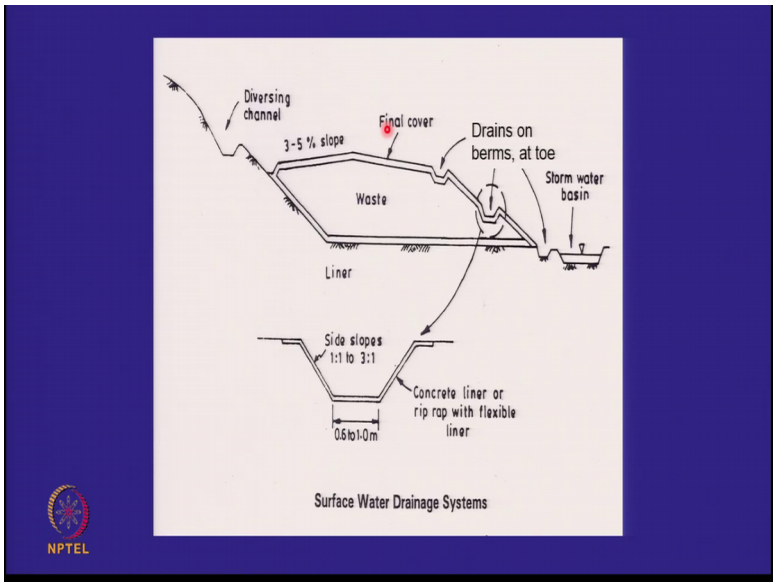

Surface water drainage was another area that We briefly touched on we did not do much detailing of surface water drainage because again it was hydraulic design, but we do not want any water to remain on top of the landfill. We do not want any water to come into the landfill from ground which has a higher elevation than the landfill.

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And what kind of diversion channels and drains and storm water basins that. We have to provide we looked at the case study of gorai waste dump which has been closed several years ago. And we looked at how it is height was increased and how a green cover was

established, along with the gas collection facilities and the leachate collection pumps and including a sheet pile wall vertical barrier around the base of the landfill.

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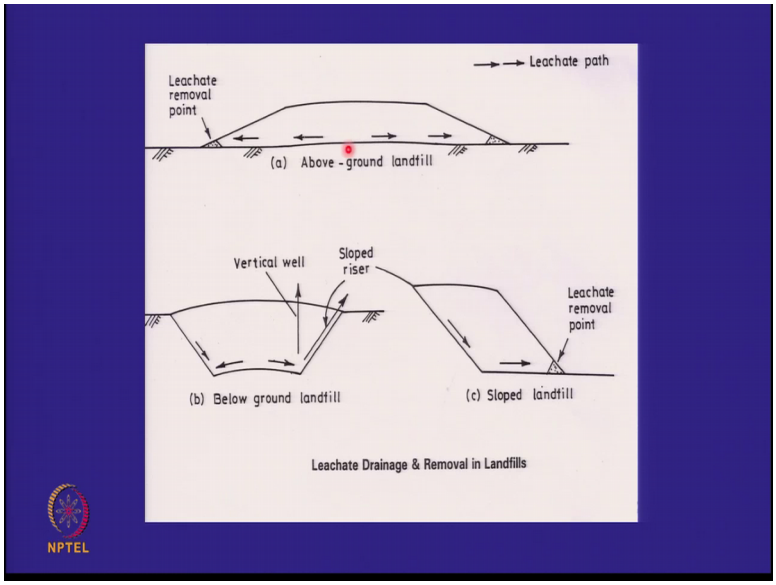

We briefly touched upon how to collect leachate by gravity flow through vertical wells and site slope risers and by gravity flow in slope landfills.

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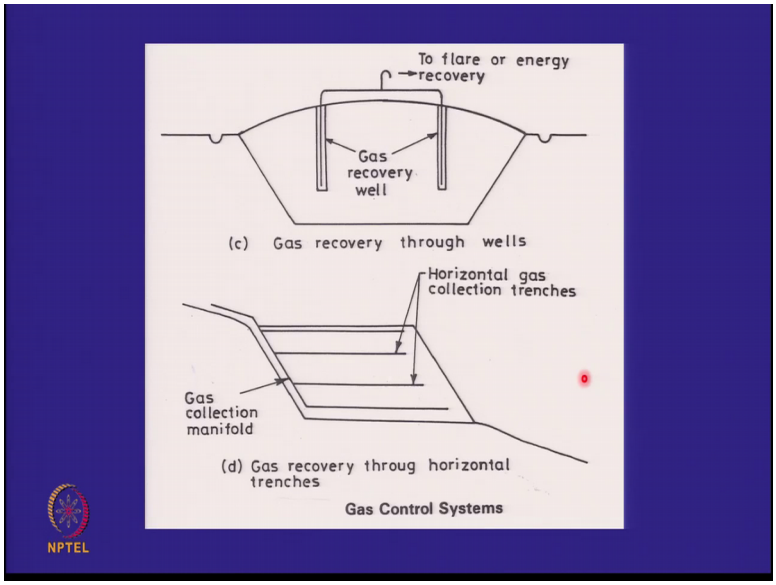

We also discussed how we collect gas through active systems and passive systems and through wells and through horizontal collection pipes.

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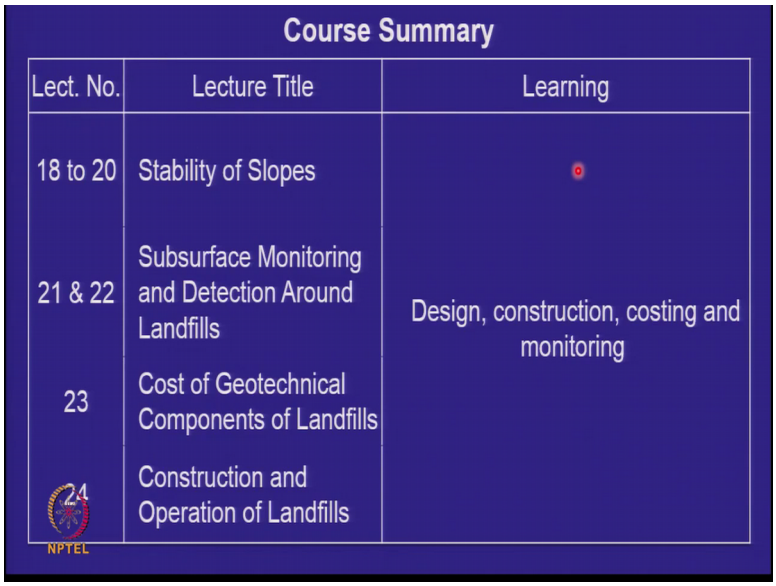

So, after the first 10 lectures looking at covers liners principles planning and looking at leachate and gas we then looked at some other aspects one of the main concerns was slope stability of waste dumps. And we also looked at how do you do monitoring around the landfill for detecting whether they will leak. We also did an interesting exercise on costing of the geotechnical components how much it was the cover cost and how much to the liner cost per square meter, and we looked at how landfills are constructed and operated in phases. So, again in this stability was all analysis in design. Construction and operation covered construction aspects we had costing aspects and we had monitoring aspects.

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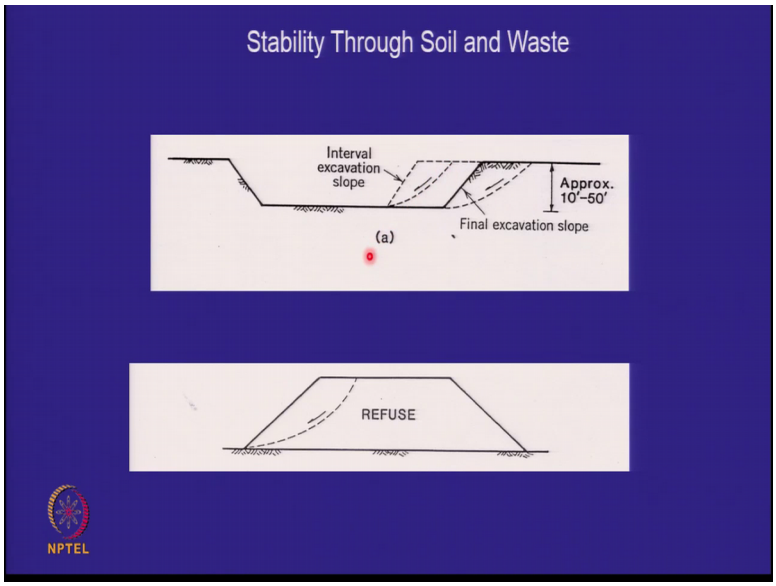

So, we were bothered about failure within the waste, we were bothered about the failure in the cut that we make to place the waste we were bothered about failure through the waste of the above ground landfill.

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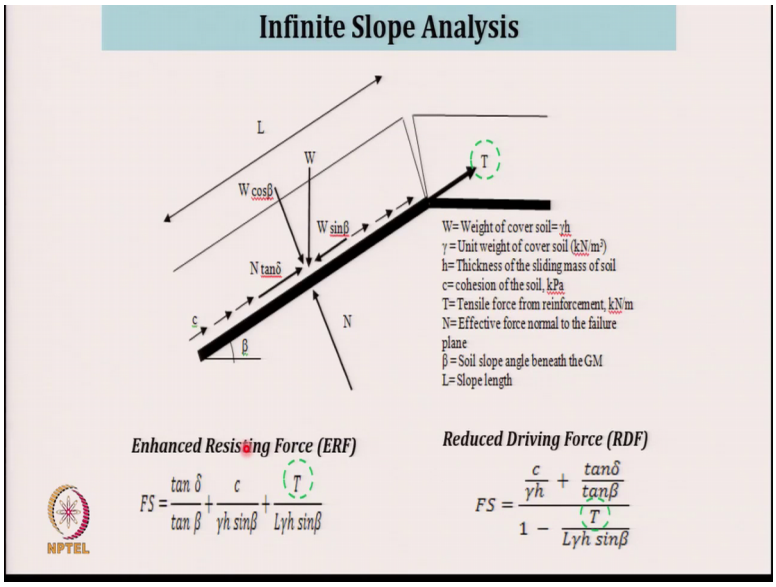

We were we recognize that one of the critical aspects is the failure of the soil or sloping surfaces above the geomembrane and how this was often found to slip and we had to take adequate measures.

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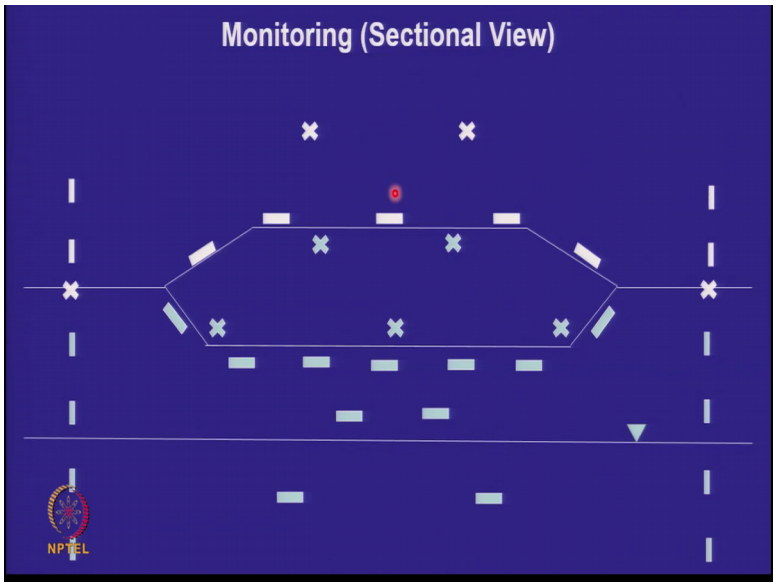

So, we looked at monitoring. How we are monitoring beneath the landfill above the landfill and the boundaries of the landfill So that we detect early and one of the philosophical thoughts was if you are very keen that we should detect leakages early that we might have to have a double liner system. Because that was the only system through which you can actually know that leakage has occurred at a point, otherwise even if you put a lot of sensors beneath you will not be able to detect early because your leachate could leak from another point. And we brought about the concept of a cluster of wells So that you are monitoring the well or water groundwater quality at different depths on the upstream.

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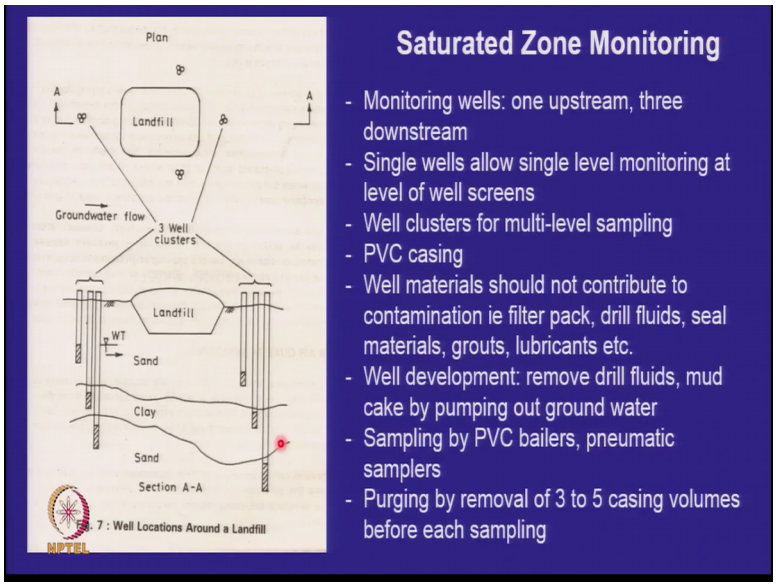

And the downstream direction and we also became familiar with the concept of multi port devices.

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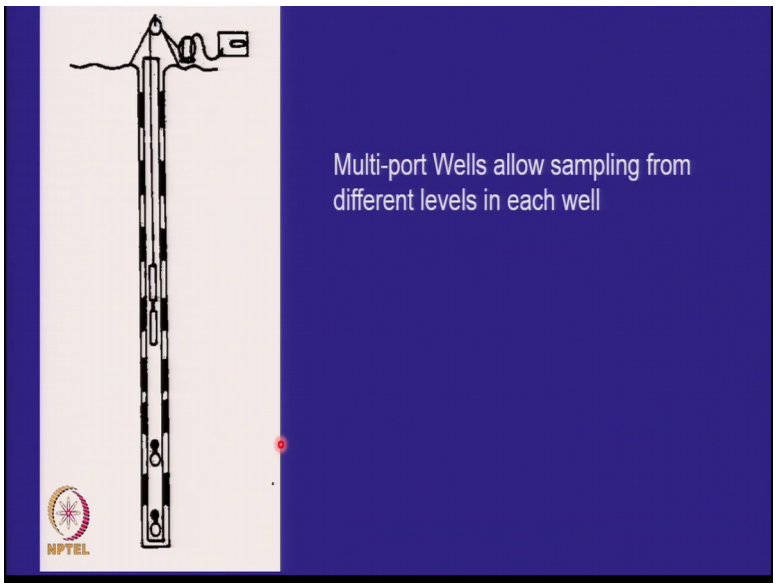

That means, in one well how you can take samples from different depths.

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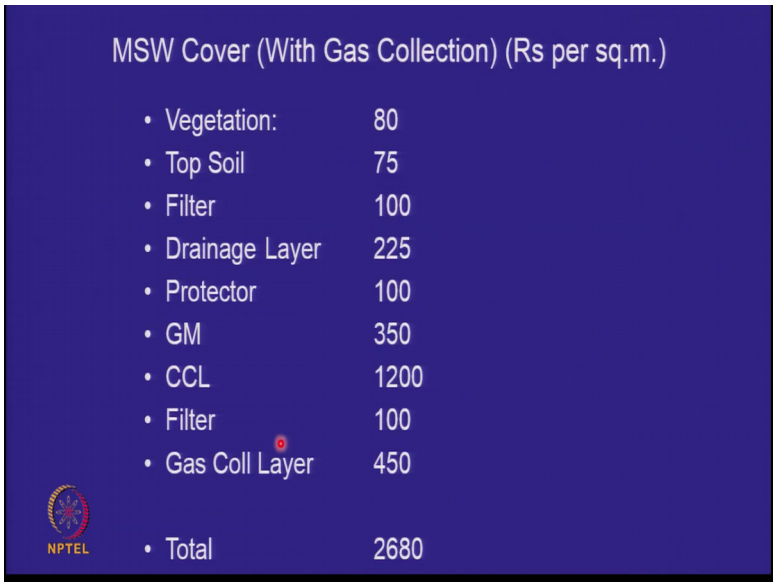

Where did a very simple method of doing costing of liners and covers where we were doing per square meter the cost of each of the component which you could do all and then come up with values as to how much of one square meter of floor area does the cover cost another liner cost. What is the total cost and if you were to divide all the costs by the height of the waste converted into mass then you could tell the cost of waste disposal per ton of the waste.

And would any of you remember the cost of disposal for ton of the ways that we had one which is an important figure, pardon?

Student: (Refer Time: 17:03).

500 800, 1000, 1500 there are a large spectrum of course, depending on what the materials cost the local materials cost. And how the landfill is how rigorously the landfill has been made does it have a double liner system a single liner system so on and so forth.

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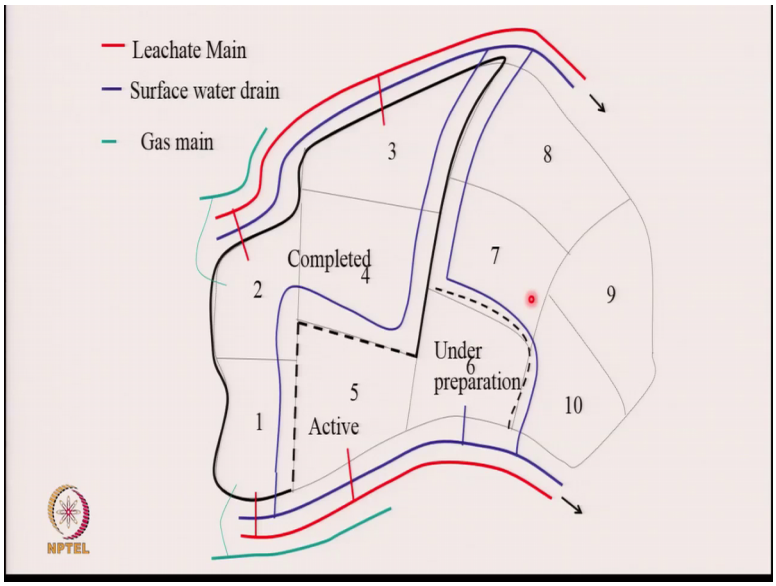

Then we looked at the fact that a landfill cannot be constructed in one go, but for you have to construct it in phases. So, example here is the landfill, which is constructed in 10 years. And how every year you complete and close a phase, there is an active phase and there is an under preparation phase and how the surface water drainage systems the leachate collection systems the gas collection systems have to be developed as the landfill moves forward year by year.

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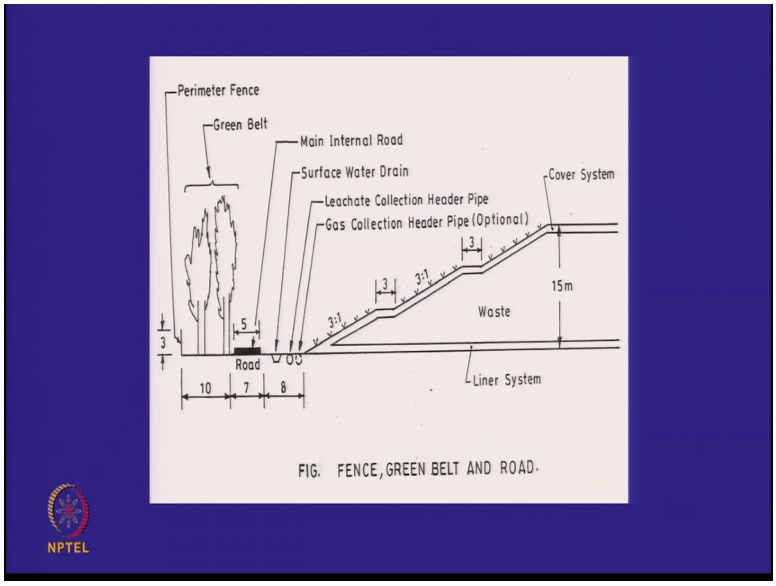

And how the final closure of the landfill with measures, such as the perimeter fence the green belts the major header pipes and drains.

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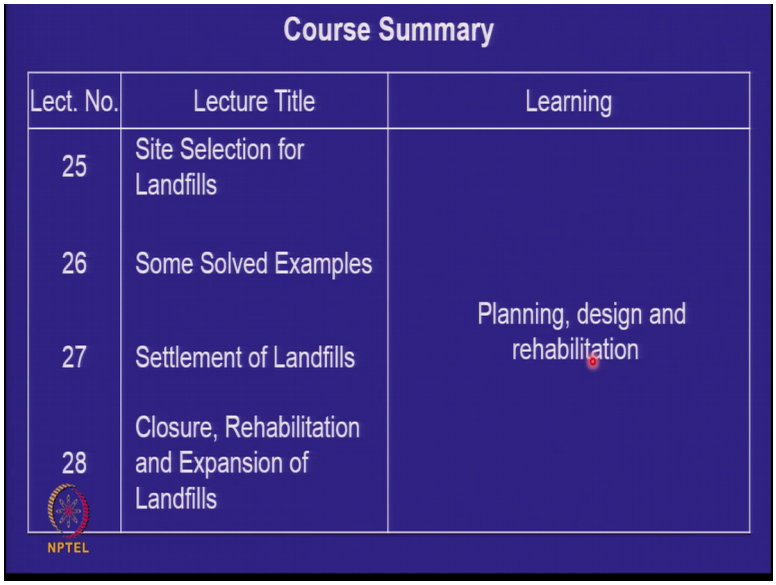

We looked at that having done a slope stability construction costing we moved on and we did some lectures on site selection settlement closure and rehabilitation. And we also did some solved examples.

And again in this site selection is a part of the planning process and settlement is a part of the design process and the of the closure is part of the rehabilitation process. So, the important thing is maybe the some of these lectures could have been structured a little early or at different locations, but this is the way the program evolved.

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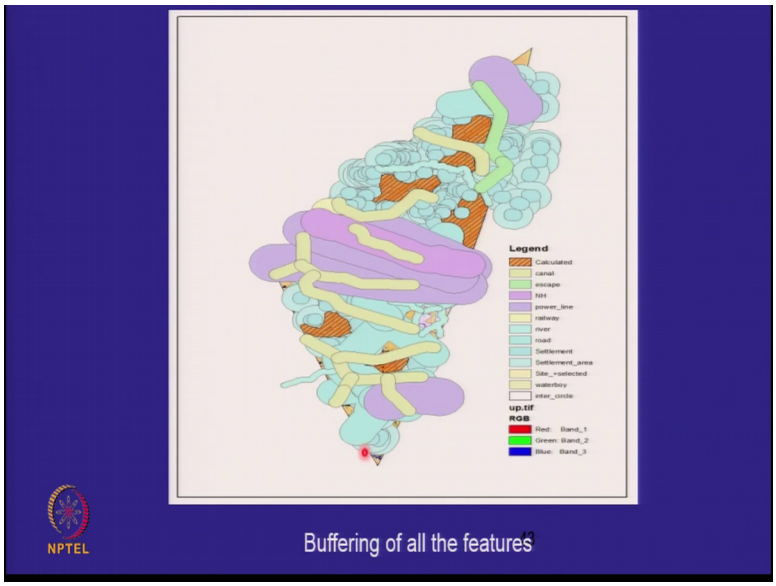

And we looked at an example in which you know by putting the buffer zones around roads around water bodies, we could only find for example, in this figure this brown spots where landfills could be located because everything else was excluded by the landfill location criteria.

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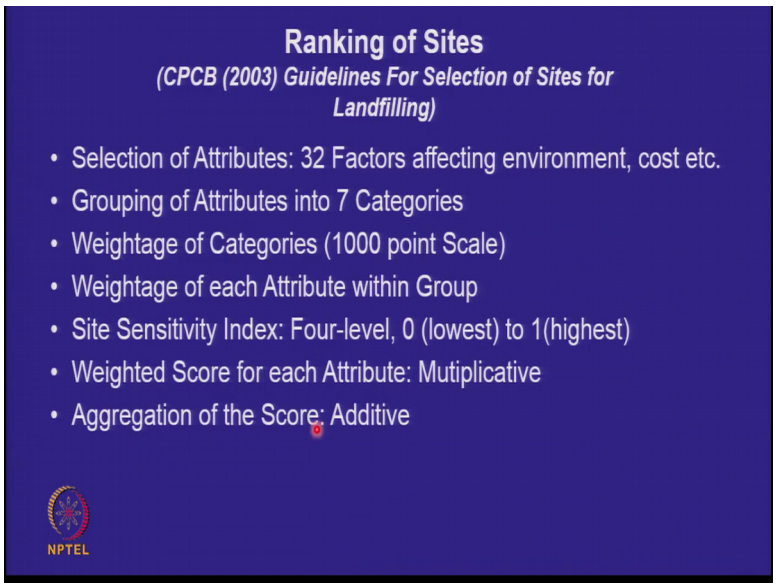

And then we looked at the methodology of cpcb 2003 for selection of sites and ranking of sites and looked at how many factors are involved.

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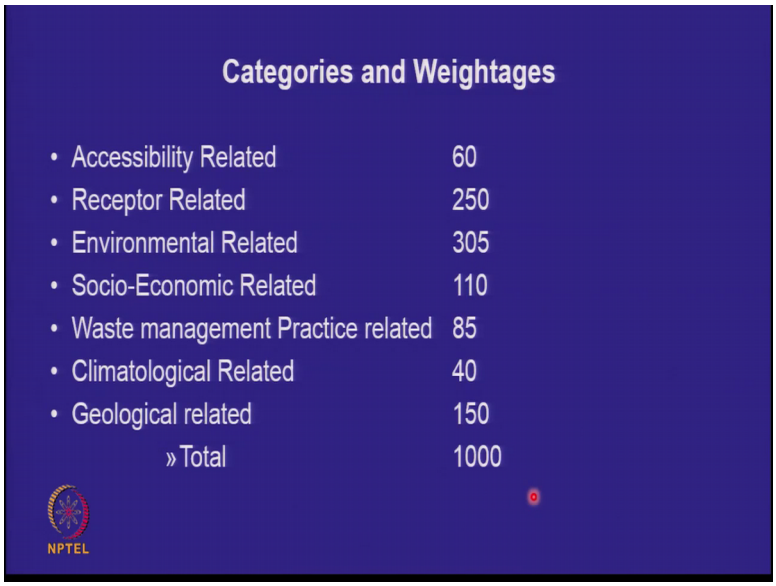

And then we looked at the weightages and how to arrive a site rankings. We also talked about the settlement of landfills both the base and at the top.

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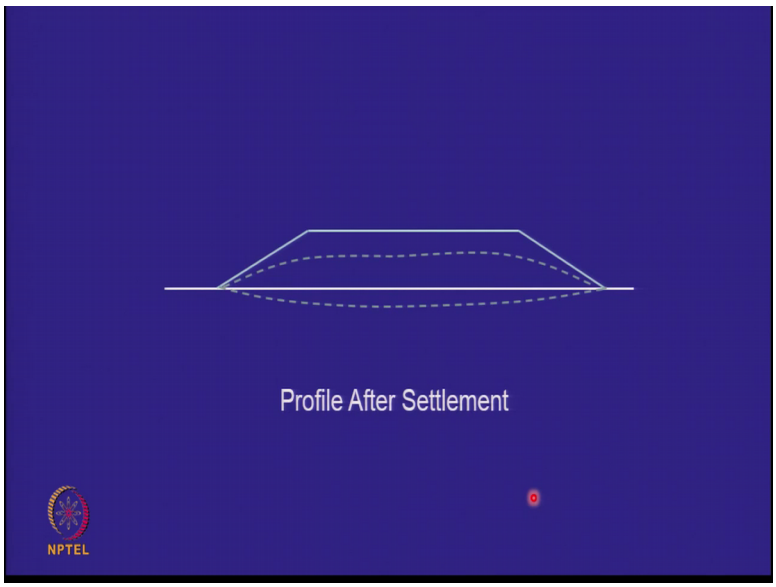

And for the first time we talked about time dependent settlements due to bio degradation of the material.

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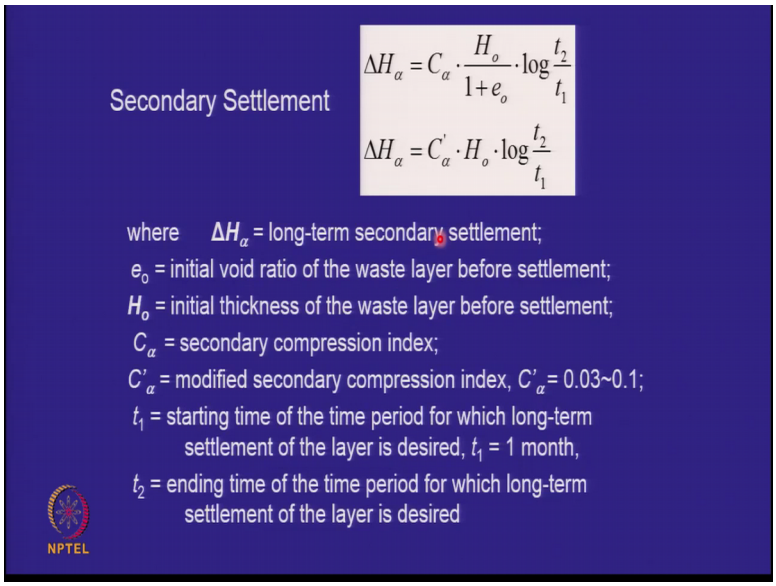

And we talked about this being very significant in comparison to the primary and secondary a primary settlement of the soil beneath it.

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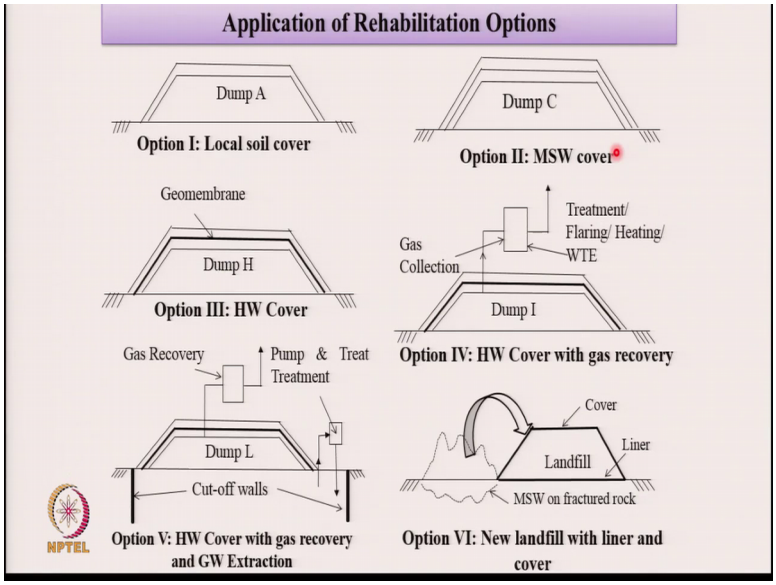

We looked at old waste dumps all across the country. And we looked at what kind of solutions that one would have to adopt and we from simple covers to municipal covers to hazardous covers to gas recovery to cut off walls. And to moving and placing in a new in a totally new landfill all these options we looked at.

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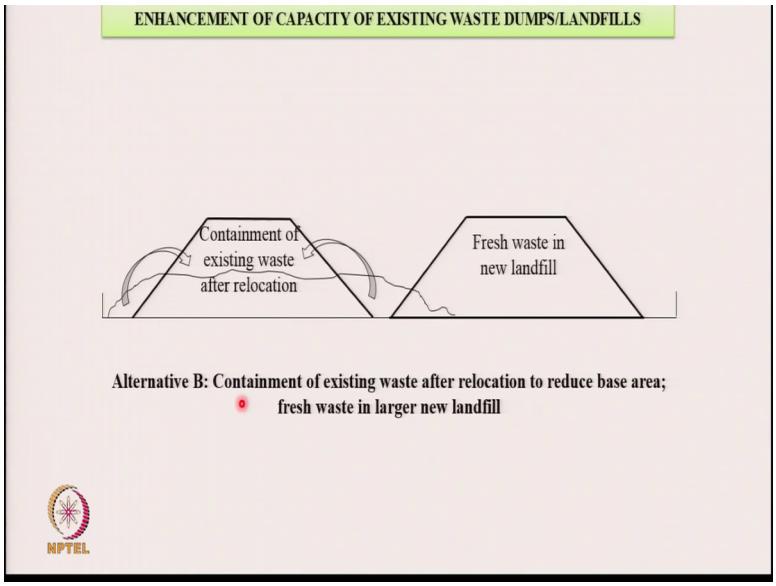

And we also looked at how to enhance the capacity at a site where the landfill. The waste is spread a very low height, but very large area or to relocate the waste increase the height of the landfill and make a new landfill.

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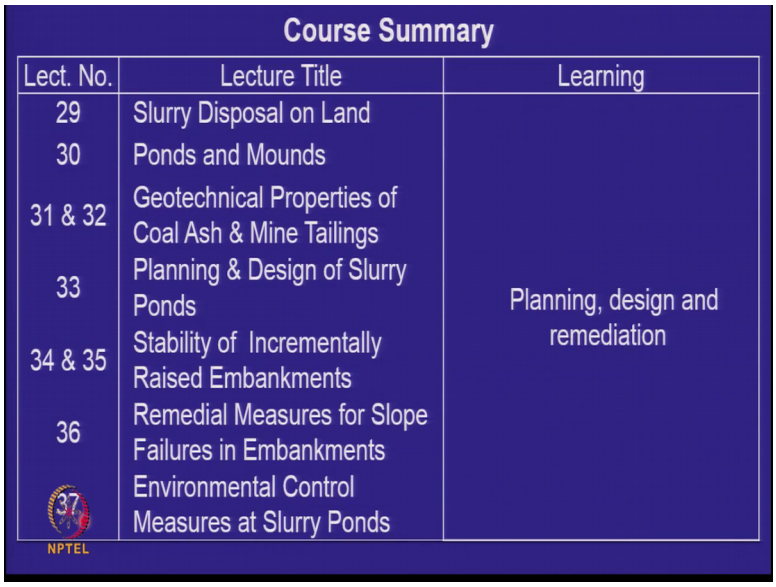

And we looked at the example of the (Refer Time: 20:33) we looked at the example of the (Refer Time: 20:38) landfill in this case. With that we completed our 20 lectures on landfills and we came in to the next set of problems associated with vegetable disposal and that was for a slurry type of waste, which is predominantly for from thermal power

stations coal ash and from all mining activities which produce tailings. And we talked about slurry disposal on land the comparison between ponds and mounds main concentration slurry disposal medium concentrations slurry disposal high concentrations slurry disposal the geotechnical properties, where the coal ash and mine tailings are like soil the planning and design of ponds how to incrementally raise the embankments.

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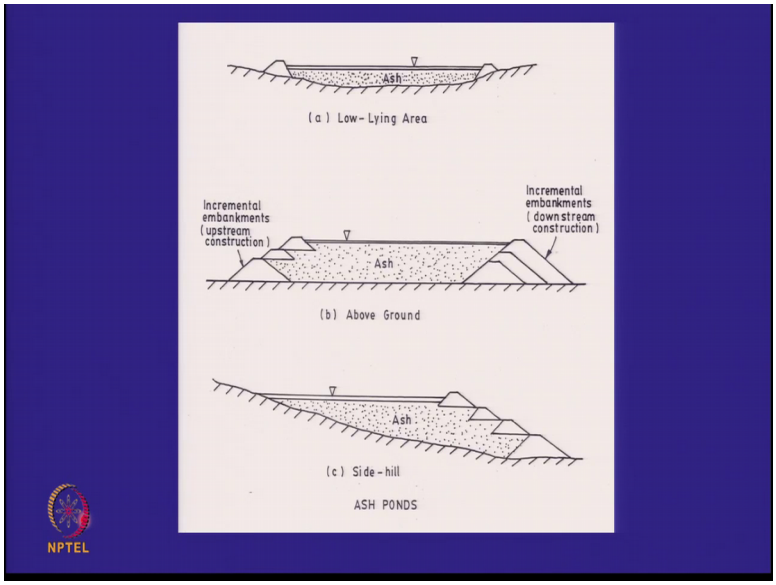

How to do remedial measures in case these embankments fail and also environmental control measures at this point. So, we spent 9 lectures on this topic of slurry ponds. And again we did a lot of planning and design aspects and remediation aspects. So, we look at all these concepts of a raising of the dike multiple raising by upstream and downstream methods different configurations on flat ground on sloping ground on low lying areas.

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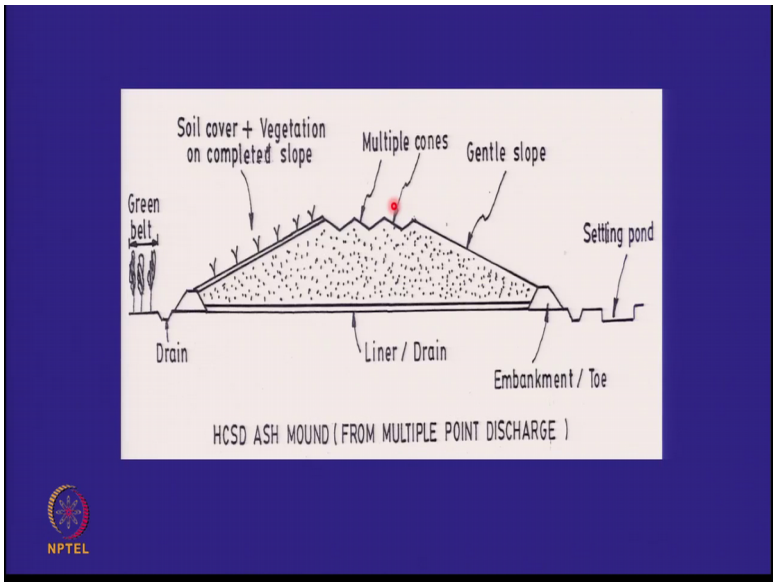

We also looked at high concentration slurry disposal technique, which is just coming to India.

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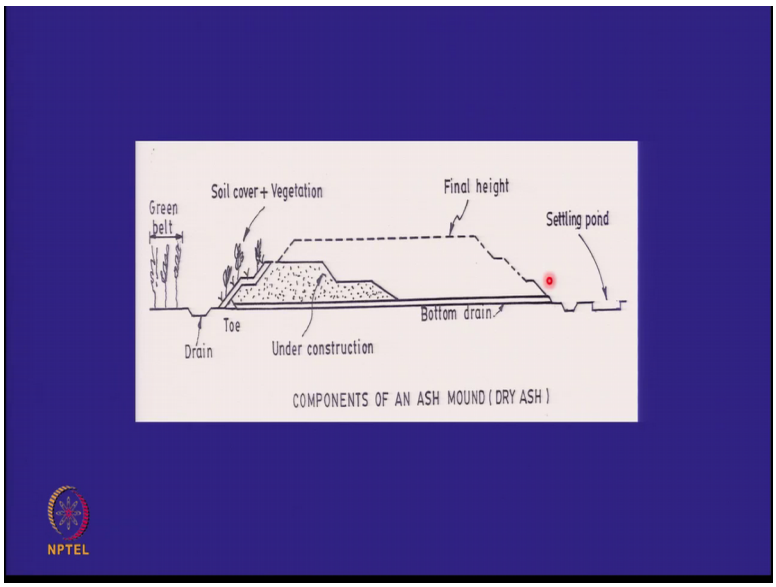

And also the how ash mound or a dry disposal for such materials is done.

In our main focuses on slurry pond. So, we looked at the how to plan upon what does it look like in plan and section.

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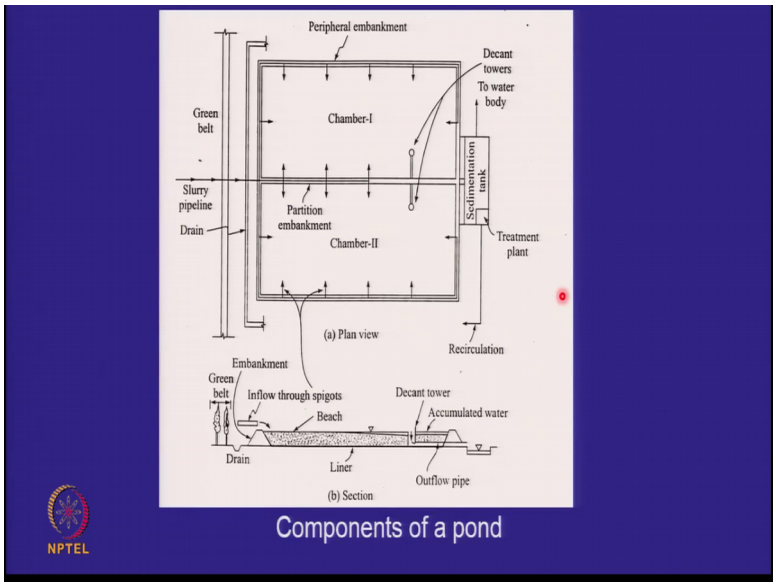

We concentrated on how the leachate collection systems affect the stability of the dikes. Whether they are closed far where the fine material gets settled on the upstream side or course material.

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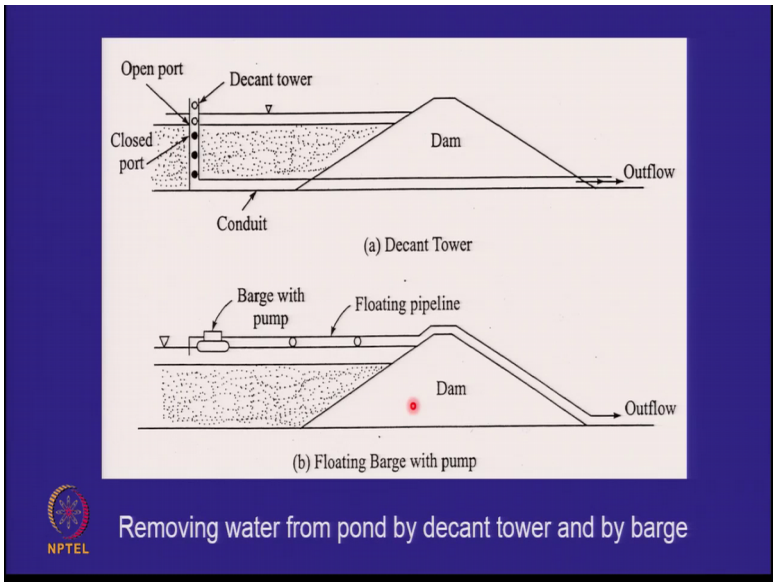

And how it affects the upstream raising stability.

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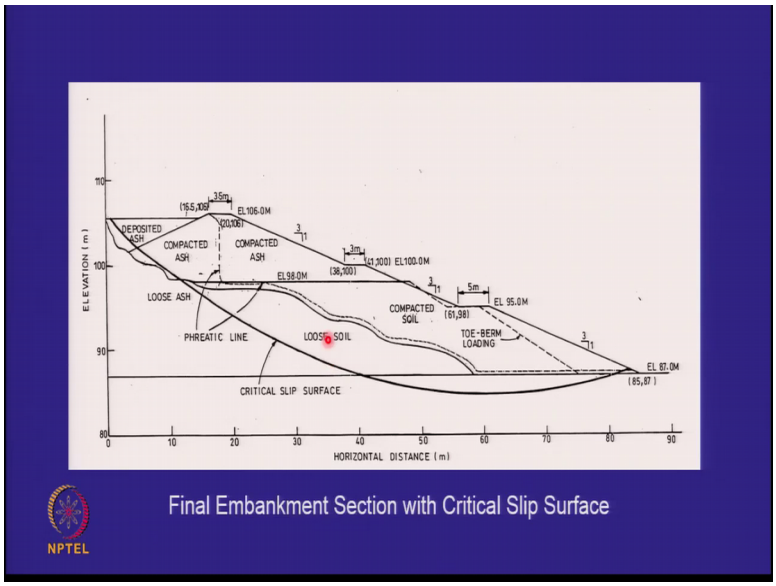

And we looked at some of the failures which had taken place in incremental raised embankments and the kind of solutions of remediation.

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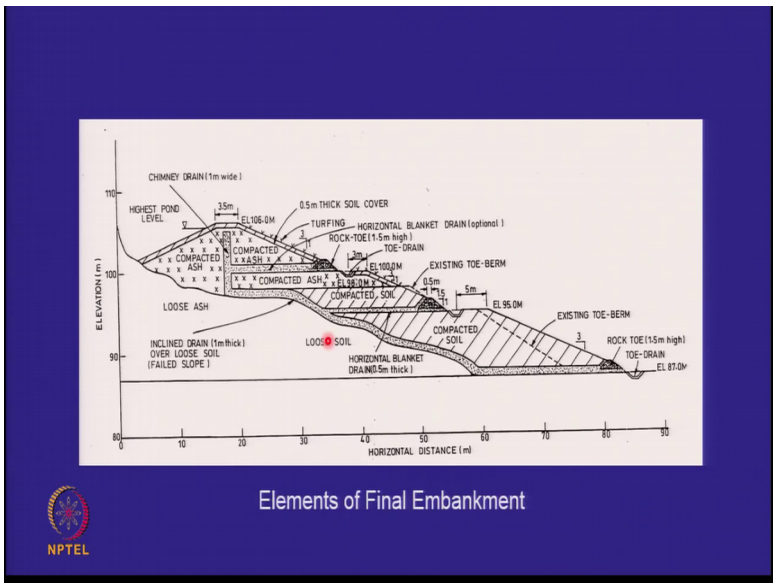

Which had been arrived at from stability analysis.

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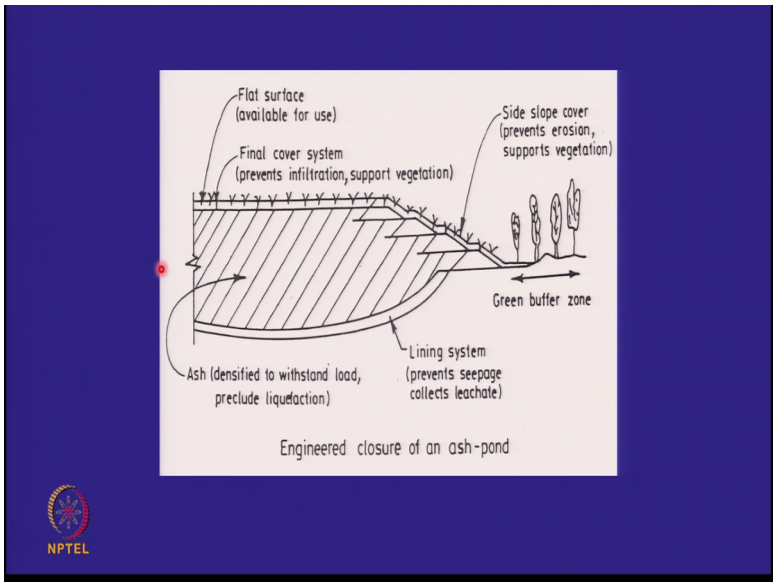

How in the end when the life of a thermal power station or a mining project is over say after 100 years, you cannot just leave a apart and walk away what kind of stabilization measures you need densification covers self supported vegetation greenbelts any one liners that are required. And how slurry ponds actually affect the groundwater table because they are very large in size and the groundwater table rises and how we have issues about.

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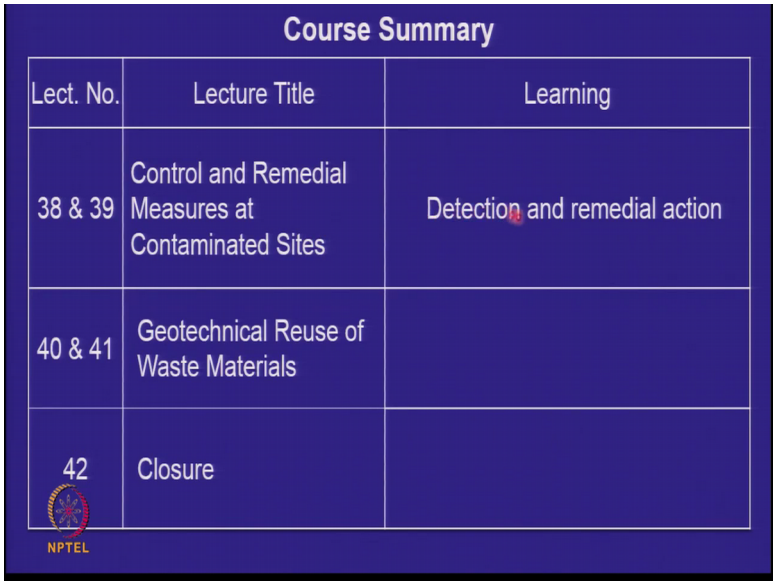

Water logging on the sides and rising of the groundwater table and how liners are now becoming increasingly being specified beneath these facilities. In the end we did a few lectures on contaminated sites we looked at the methods we looked at how you detect contamination. We looked at what kind of remedial measures or control measures we adopt for contaminated sites.

And that gave us a learning about how did how we do detection. And how we do remedial action.

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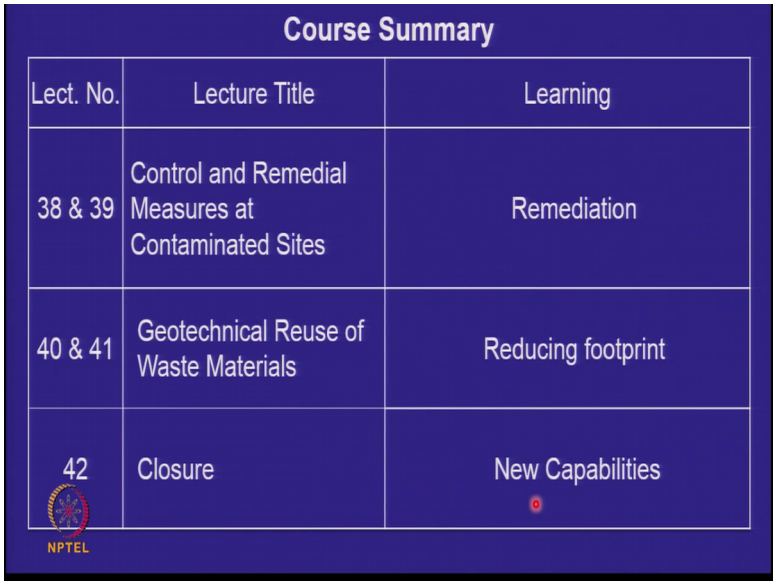

We spend 2 lectures on geotechnical reuse of waste materials and basically we had a learning about how if we can reuse waste materials, which are like soils in geotechnical applications be the construction of embankments back phase behind retaining structures filling of low lying areas that would reduce the footprint of the waste. And finally, today we are looking at the wrap up or the closure and trying to understand what are the new capabilities that have been built in us, what is it that we can do what we could not have done when we started this course.

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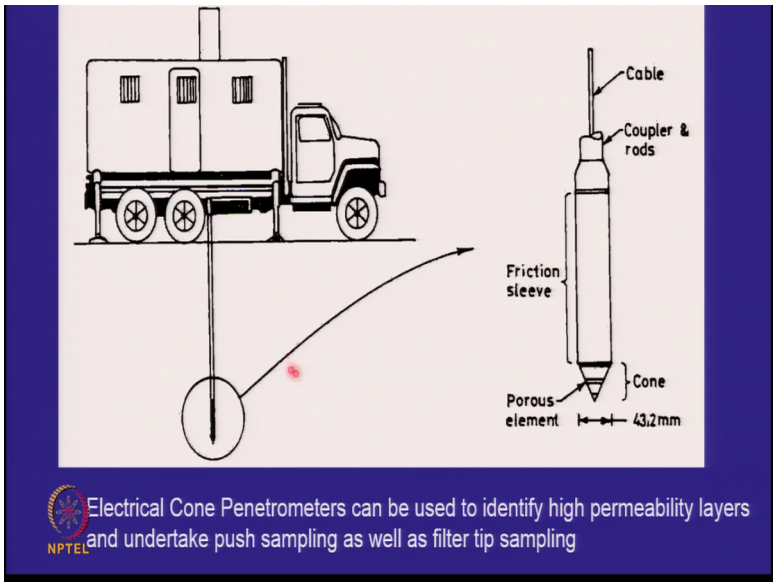

So, in contaminated sites we talked about high end equipment which can be pushed into the ground of the electrical cone with the filter tip.

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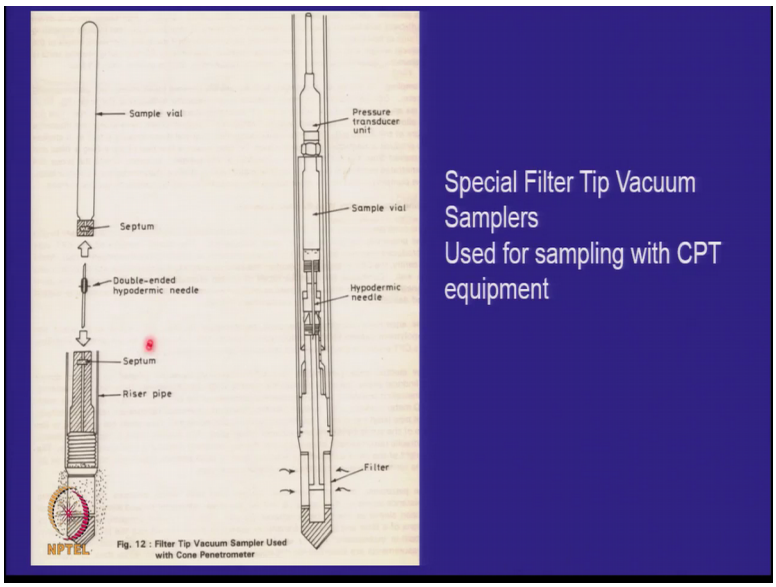

And how we can also use a special vacuum samplers to take out this and detect what is the contamination at various depths.

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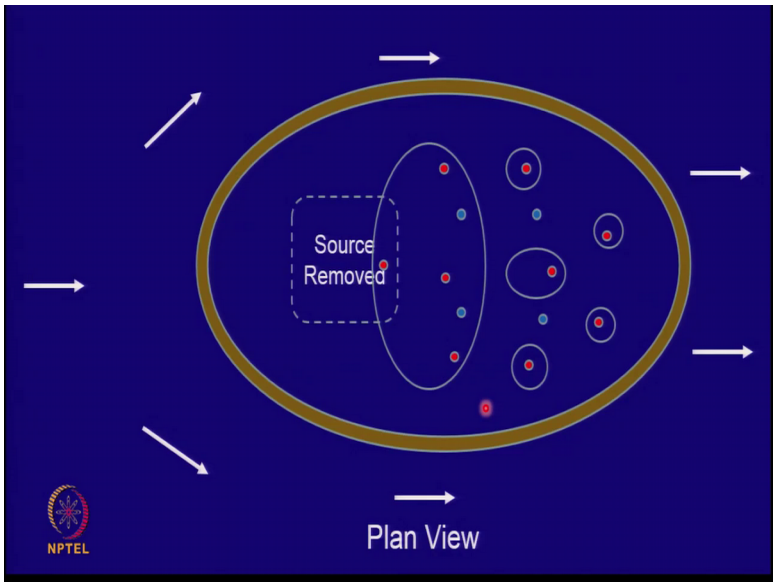

And how we can then look at remedial measures in terms of control through cutoff walls. And also in terms of bringing back to the original condition by pump and treat. By pumping out and injecting and removing the source.

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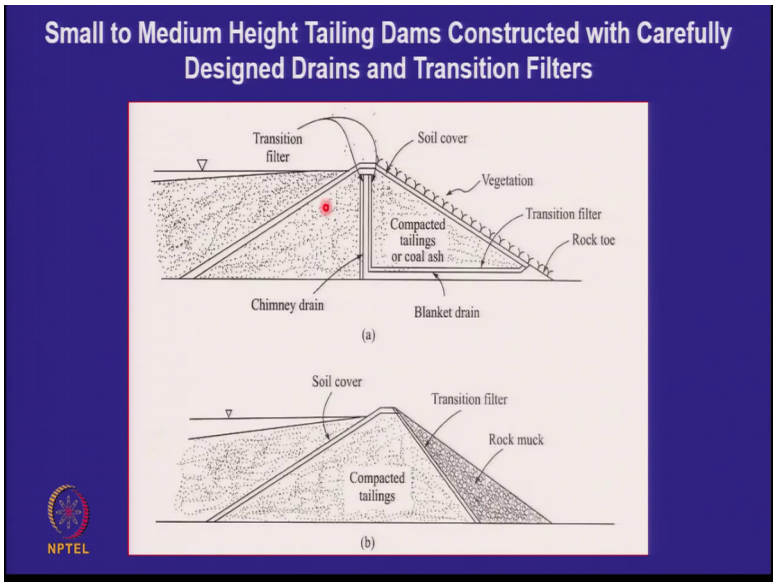

We also looked at reuse of waste either in the form of compacted ash or tailings in embankments with chimney drains. Or with rock mark or just for road embankments with layers of soil to prevent dust pollution. We also briefly touched on the kind of work which is now going on municipal garbage dumps to mine soil we are not.

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So, sure that the soil is of the quality which it can be used and whether what is coming out is soil or compost and that is something which will get sorted out probably in the coming year, but these are the kind of efforts that are going on and sometimes when you look at this material very closely it does seem to remember a zambia soil.

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And therefore, there is an opportunity to look at it is utilization, but we freezes this has any deleterious material that we should not adopt it as. So, I unless you of course, contain it in some kind of a lining system.

So, that brings us to the final set of slides or slide as to what is it that we have learnt which we can do what we could not have done earlier. So, any one of you wants to take a call on that? That I am I can now do this for example, you can make a statement that I can join give me the name of a good environmental consulting organization that we know. I can join erm consultants or golda consultants as a geoenvironmental design engineer do you think. So, I am I am just saying that is one statement which you could not have said in January this year because you did not know anything about this topic. And believe me there are a lot of work of contaminated sites in this country 1000s of contaminated sites 1000s of dumps and there is it is a segment which is generating a lot of work for the environmental consultants, but they cannot do it they have traditional environmental consultants our air and water consultants and getting into soil and making the difference is where the geotechnical person comes in.

So, anybody would like to say other than what the example that I have given you well, first you have to know each other top 6 global consulting companies which are in India. And I think you will do well you will do very well to learn about them because you are now at an advantage. And you should know which are the top 6 global geotechnical consultants which are in India. And you should know which are the top 6 national consultants in geotechnical engineering. And you should know which are the top 6 national environmental engineering consultants, this is basic general knowledge.

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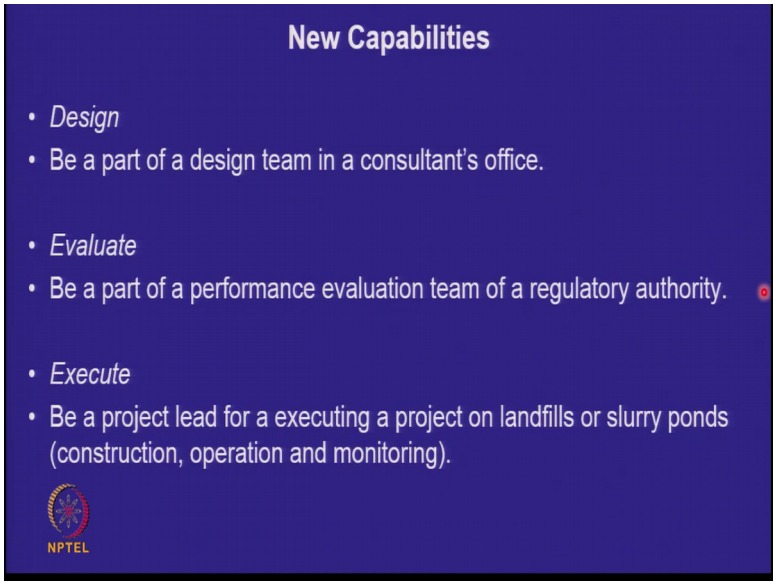

So, once you know that you can see where you can position yourself, but I do know that now built into you is a design capability and that design capability means that you can be a part of a design team in a consultants office.

So, you will learn from a senior consultant is personal mentor you, but you would be able to very confidently walk into an organization and say I can design I can do this design in landfills. Will ask you can you do design of leachate pipe diameter and spacing and you say no I do not, but I can do it in 5 days, because I can always read up about it I am not I am not it is not something which I am blind to have been the principles have been explained to me. And I can always go and do the mathematics in the formulae and come back to you. So, I think you are in a good position to do this. And you are not in the position to do this before you started the course. Another thing which you are in a good position to do is evaluate you see one of the things what happens when you work in the geoenvironmental domain or the environmental domain is, somebody has to always go and check whether something is harming or not harming the environment.

And it is very easy to go close your eyes look at the good places where no harm is being done, and say that it is not harming the environment and this is true for everything. To find the critical locations and to evaluate them and then come up is the important things. So, you do not go hunting for leachate in summer months. Like fundamentally you can not do that if you do that there is a problem, but you can go hunting for leachate in the post monsoon period. And if you do not see even then any leachate outside you can put a borehole in the center of the landfill. I could assure you or a waste dump I am talking about not a landfill you will find a lot of leachate absorbed by the waste inside it. So, you have the ability to evaluate a diamond again because this is under regulatory authority, we have a central pollution control board we have state pollution control boards, we have ministry of environment and forests, we have state ministries of environment and forests, we have ministries of urban development we have state ministries of urban development.

So, we have industrial development corporations, we have state industrial development corporations everybody is monitoring. So, you can also be a part of a performance evaluation team of a regulatory authority. You know more about subsurface sampling than anybody else, you have not done field experiments, but in terms of what type of sampler how to collect how to take out a whole sample that you know more about. So, you are I believe you now have the ability to do this. Better than most of the other

engineers who in the past have not done a course on geoenvironmental engineering. And that is a they will do very well air sampling they will do very well surface water sampling.

But to be able to do good groundwater sampling, it is not taking out water from a hand pump nearby. If it is if the hand pump is polluted very good god is kind to you it is telling you, but if the hand pump is not polluted it does not mean that the 360 degrees around the landfill is you can always come and give that report we went to the site we looked at 3 hand pumps there was no pollution.

And everything is fine, but then you should go and say that no did you take 2 sample at 10 meters depth 20 meter depth and there are 3 different depths one upstream 3 downstream that ability you have. I also believe you have ability to execute though you have not gone for any site was it have you gone for a site to that landfill, how many of you have seen a landfill? Raise your hand other than the PhD students you have which landfill have you seen.

Student: (Refer Time: 32:37).

You, from far and be smelted and he said let me run away from here. So, you can be a project lead I mean I am not saying, you can be just an engineer everybody else has to do the work there have to be waste collectors, there have to be other people who are doing other things, but you can actually be a project leader for executing a landfill product our slurry pond project if NTPC wants to build 2 new slurry ponds they did they do it in house, but they also give it out to their consultant. Now there are some consultants in the energy sector a few of them I can name, but none of them have had that good and expertise in ash pond design.

So, one can always be a project lead. So, see how much of learning has been imbibed in you my point is very simple even if everything you do not remember. At least I hope you will remember the philosophy of what we did and you can always go and look up a book do you think. So, so that is 3 new capabilities you have 3 more is not it amazing even you might think we did not know we had these capabilities. So, one of the things that you can do is bring best practices to the country to be able to bring best practice you must know have your fundamentals sound clear and crystal clear.

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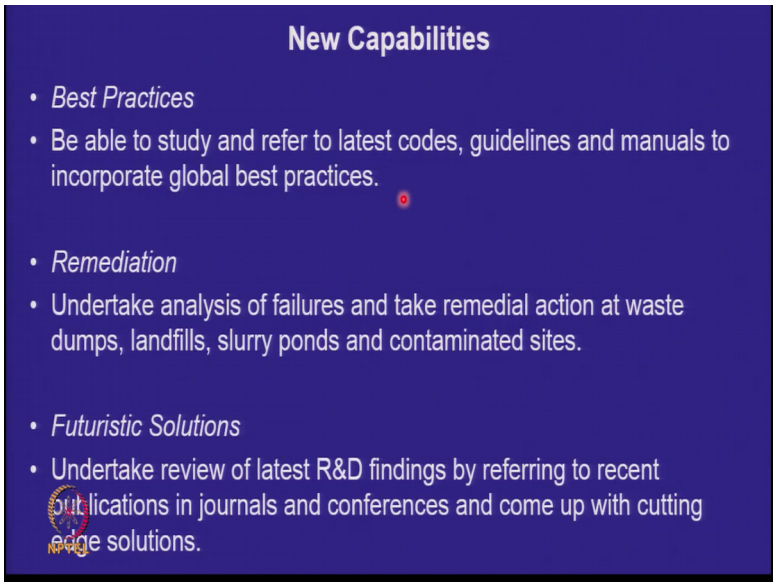

If you have if your fundamentals are not clear you do not know whether one technology is better than the other right one can always read up, but to be able to say that this is a good practice you need to have strong fundamentals which I believe this course would have given you.

So, you will you should be able to study and refer to the latest codes I mean for example, the issue about why has America in 2016 specified liners for ash ponds in the US and why? A full regulatory manual or a code has come out. And what is in it now that is something does not need to come to India. Because we keep on picking up usc pa United States environmental protection authority manuals for different things. So, you have the ability to study and refer to the latest codes. Without doubt without feeling uncomfortable not I can not understand terminology I cannot understand. So, why upstream method and not downstream method.

So, you have to study and refer the codes the guidelines which are bought out by the various countries the manuals so that you can incorporate the best global practices. I just finished conducting a PhD viva was the examination in Bangalore, and the student had worked on a new system for landfill site selection, but unless that new system is brought down to the field engineers level and put in a manual with the solved example step by step. It is not going to go any other which is going to remain buried in that PhD thesis, but he has per he has published papers.

So, one can also you know use that side of information, but at the moment what we are saying is that if some best practices have been adopted in some countries for example, there is this best practice now of adopting geosynthetic clay liners GCLs, but they can only be used under certain circumstances in India, what is happening? It is becoming rampant to use them not caring whether you are putting them on sand or there is a low permeability strata underneath it or not. So, they can be used in the part of a double liner system, but people are just using them as a part of a single liner system. So, they are good material and when you do not have impervious soil at a particular location they can definitely help, but to be able to recognize the best practices you should be able to read up all the manuals and say all right these are the practice this is the limitation and this limitation needs to be brought here.

Another thing is that a lot of failures are around us failures in the sense slurry pond embankment failures waste dump failures contaminated site failures means the dump is just contaminated the area. To take an analysis of these failures what has gone wrong or to do investigation or to quantify contamination the extent of contamination. And to arrive at a remedial action even if you are not doing the remedial action yourself, to be able to evaluate proposals of remedial action. You are in a good strong position to look at them again give. You an example I sat in a meeting in which sediments show being taken out from the base of a lake NMK lake in Hyderabad anybody from Hyderabad? Anyways.

So, the sediments were polluted as we said many of the sediments of in water bodies air polluted. And it was being proposed to place the sediments in geo tubes. As one of the solutions now everybody in the meeting thought that the geo tube is like some kind of for you know treatment system, in which the sediment of the leachate will be put and the leachate which will get treated like your permeable reactive barrier which you were think yesterday. And what will come out will be good clean water. I went there I was called leachate about the middle of the meetings I 6 had already taken when I said look this is just a blanket the geotube is just geotextile. It will dewater the sediment it would not treat it then if you are dewatering it you have to collect it and then send it to a treatment plant.

So, my thing is that with the information that you have is in the environmentally engineering and your course on geosynthetics. You would be in a much better position to analyze the problems and look at remedial action and adopt one which has very little

risk. And finally, in the end solutions are always being upgraded technology is always moving ahead of ahead with time. And innovation is the hallmark of improving technology. So, what I believe you can do with your background today is to be able to read a lot of research papers. And not be scared by the content once you are able to read a lot of research papers on the same topic you are able to put together a comparative table as to what is happening what was happening? In 2000 what was happening? In 2005 what is happening? In 2000 a lot of people are published in there I am doing this is the new innovation this is the new technology bring it together.

And then come out for yourself the state of the art report what you call as the state of the art report or a critic as to what is emerging. And once you have a finger on it then you can use that technology for futuristic solutions. You may not be the proposal of the futuristic solution, but you should know it is coming you should know it is coming. If composting by putting water is going to be overtaken by composting by putting a culture and no water you better know it is coming, because that is future technology.

So, this is important. And what I feel is that with your base you can read up any papers if you can not understand the paper you can go back to the book the book the research papers are little more ahead the books are a little back see the research papers are the furthest ahead then the manuals and guidelines then the books and the codes are the most behind because they come out and a lot of experience has been generated. So, you can look at you can do a PhD after looking at all the people will say oh yes this is a gap area, oh and if I make this I can make million dollar company go to Stanford start a PhD and leave the PhD after you have got your halfway through you are done the work just shift out in the innovation and just say or a by a Stanford thank you for the labs, and then make it start a startup and said my value I am Stanford not past. And it is my company in this concept and that is on a lighter note, but you can always go to our innovation hub in the system.

So, I think this is 6 new abilities come to you from this course. Of course, this is an area in which progress is slow in India because there is not So much money for geoenvironmental clean up, but it is something which is progressing with time, and you will have a lot of opportunities to work in this area. So, with this confidence building end of the course review and telling you how great you really are, I hope it will make a difference in the long run. So, if there is anything you would like to discuss about the full

course about the fact that you think none of the 6 capabilities are not there. Then we can have a little more discussion, otherwise we can stop here. So, no thoughts then all the best, prepare well and I will see you in the near future.