**Ground Water Hydrology**
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**Module No # 04**
**Lecture No # 20**
**Induced Recharge (Contd.); Wastewater recharge for reuse; Water spreading**

Welcome to this lecture number 20 this is the lecture in which where the following topics will be covered that is we will start with and this induced which is basically spillover from previous lecture and we will move on to waste water recharge for reuse and followed by water spreading.

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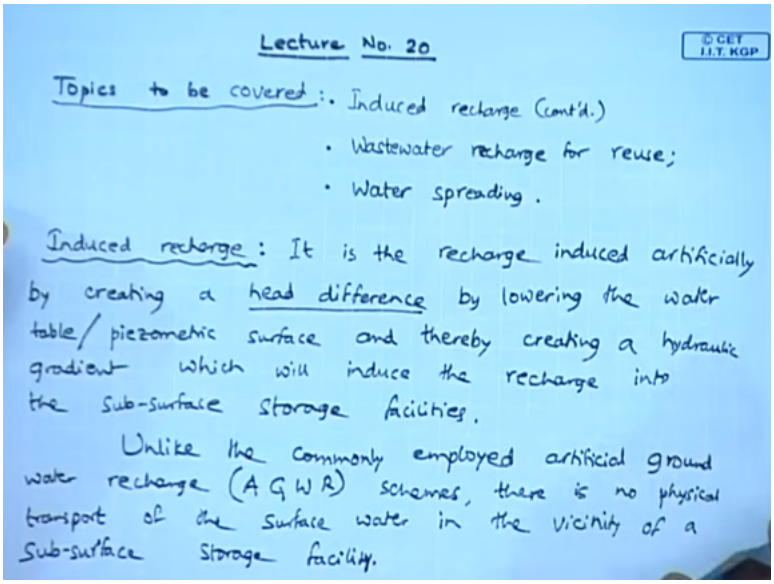


So now we will go to the first topic of the lecture that is induced recharge so basically this induced recharge basically this induced recharge which has been induced artificially due to creating a difference in the water level so unlike in most of the water artificial ground water recharge schemes were in the ground water is surface water is transported near to the well or other subsurface storage facility there by the water is met to infiltrate the surface water is made to infiltrate and get stored in sub surface storage facilities.

And here the same thing the purpose is same but this recharge is induced by say lowering of the water table. So thereby ahead is created and this creation of head will induce the hydraulic gradient and thereby the artificial ground water recharge attached. So here so it can if we write this one the meaning of this induced recharge we can write that that it is the recharge induced

artificially by creating a head difference by lowering the water table water table stroke peizometric surface.

And thereby creating a hydraulic gradient which will induce the recharge into the sub surface storage facilities. So unlike the common the commonly employed artificial ground water so which have been abbreviating as AGWR schemes. So there is no physically physical transport of the surface water in the vicinity of sub-surface storage facility. So this is a major difference between the induced recharged and the artificial ground water recharge so here it is induced because of head difference.

So this head difference it is a major cause which results in the establishment of hydraulic gradient which will induce the recharge into the this one and now we will see some of the typical induced schematic diagram of typically induced recharge schemes .

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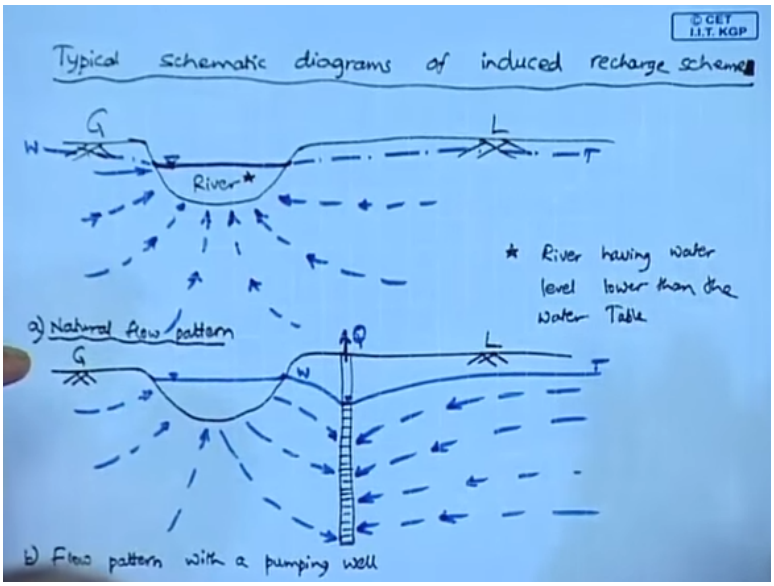


And so typical schematic diagrams of induced recharge schemes so firstly let us see there is a suppose this is a the ground surface and here let us say this is a this is a river and here so this is the water surface this one and here let us say this is the water surface and in this say that the river water surface is lower than the water table may be due to say excessive pumping of water from the so this is the water table.

So this is river and because of this lower water level in the river so what happens is so the water is the ground water enters the river through bed as well as banks. So basically here we can note down so this is a just to write this one so the river having water level lower than the water table.

So this river having the water table lower than the water table will establish a hydraulic gradient and then that hydraulic gradient brings about the induced recharge into this one and so that is the this one and so next so net we will so here we can say next we will and here in this say let us say suppose in this vicinity of this to the ground level and so and here in the vicinity of the river so there is a well and so this is a pumping well.

And this pumping well so here we can say this is the screen or the slaughtered casing and because of the screen in this is the water table or the water surface in the river and then so it is a so this is the original water table and here what happens is on the other side there is a recharge and here what happens so the because of the pumping water through the well and so here you can say so this is A that is natural flow pattern which is this top figure and B is the flow pattern with a pumping well.

So here what happens is when the pumping well is not there so then so everywhere so through this bed as well as banks so this recharge into the river and whereas this when the pumping well is drilled in the vicinity of the river. So what happens is the water surface in the pumping is slightly much below the water surface in the river.

So therefore what happens is towards the well so the flow gets reversed so initially it was the flow was into the river so on both sides that is on the left side as well as right side. So now after the verse pumping well has been drilled so what happens is towards the pumping well so the flow is from the river into the well whereas away from the pumping well the flow is into the river.

So therefore this is an example of this this is a typical schematic diagram for this induced recharge schemes sorry so this is just a scheme. And now we will see little bit about and of course so here what happens so the so this is on typical example so that could be various other reasons where in establishment of hydraulic and then so because of the establishment of the creation of hydraulic gradient so the recharge that is the induced recharge starts.

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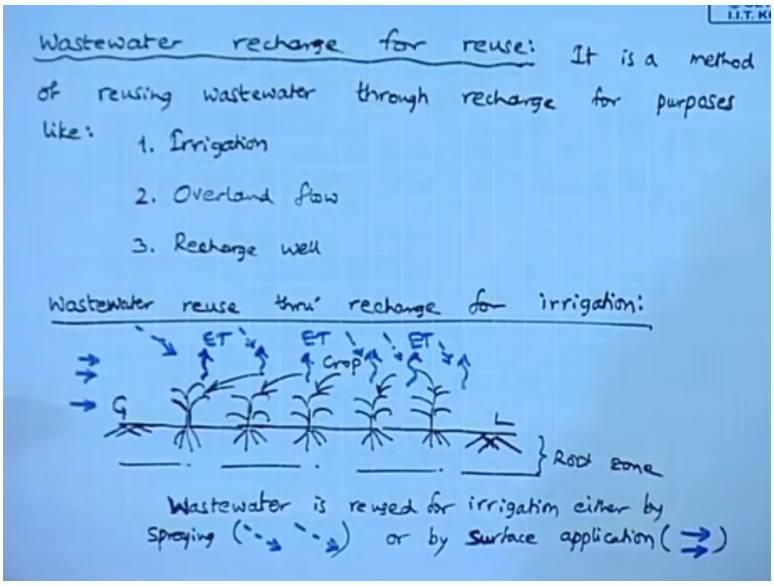


So with this we will go to the next topic that is on waste water recharge for reuse so here this is a so with the awareness about the water use efficiency so this there have been many schemes which have been come up in the recent past. Wherein the waste water I used for reused for various through this recharge. So basically here we can say so it a method of reusing waste water through recharge for a purposes like irrigation, two over land flow, recharge well.

So these are some of the purposed where in so this waste water is reused and here so this is a waste water irrigation. So this is a quite common and here so let me just so first let us consider that is the land application for waste water land application for waste water for reuse through irrigation. So that is a waste water reuse through recharge for irrigation so here this suppose this is the so these are the plants which need irrigation say these are the root zones of the plants and this is the general ground level with some slope here and so here so this is the root zone.

So these are all the crop and here through this so this is evapo-transporation and so this is so this waste water is so waste water is reused for irrigation either by that is spraying. So which has been indicating by this kind of arrow or by surface application so this surface application has been indicated by so this kinds of arrow. So by employing any of the methods either spraying from the top or by surface application so we can reuse the waste water.

And thereby reduce the water demand and on irrigation because we all know that this irrigation requires the highest amount of water this is highest water requirement for irrigation by using this waste water re-using this waste water we are slightly minimizing the water requirement for irrigation and here what happens is where we use whether you employ the that is spraying or the surface spreading of this waste water.

So it will infiltrate into the root zone of the crop and thereby it will provide the necessary irrigation for the plants and for which form the crop and thereby so this we make use rather we take care of two problems one is we will reduce the load on the of waste water in the civilized system or waste water system. And then secondly we will also reduce the irrigation water requirement of crops and in so doing this we make use of that is the storage which we can create the root zone of the plants which form the crop.

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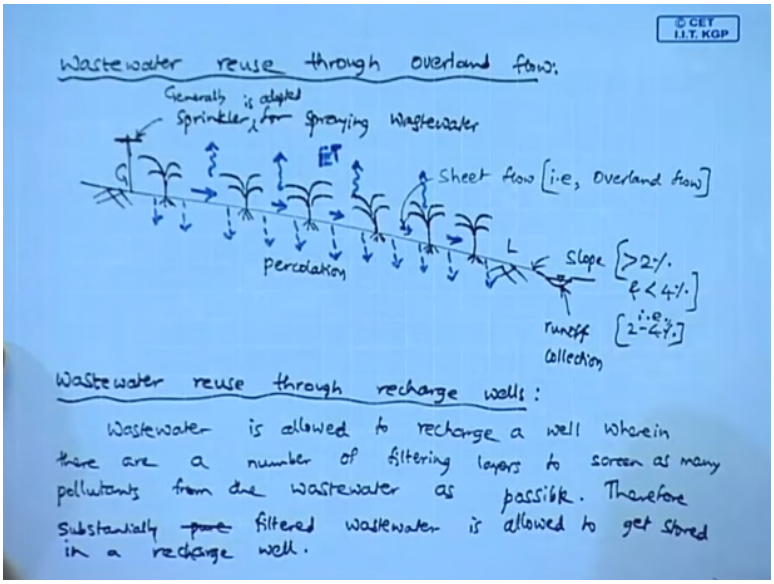


And so next we will go to that is the waste water reuse through over land flow so here so in this case suppose more sloping ground say this is a ground level slope greater than 2 % and less than 4% also. So that is say slope of 2 to 4% and here suppose this one there are the various say crops are there. So here what we do is so there is a percolation so there is a so this waste water is sprayed through a sprinkler.

So this is a sprinkler for spraying waste water and there by so here sheet flow or over land flow is created. So this is a obviously so this are the so this is the so this is sheet flow that is over land

flow and of course there is also so percolation of so this is a percolation and in this case so here we may also collect this so this is a for runoff collection so like this so this waste water can be reused in sloping lands.

So thereby what happens is by either applying generally this one and of course here they can also show so this is a so this is evapo-transporation so this ET. So this is a second method of waste water reuse and of course in this case also so what happens so once is waste water is generally here you can generally sprinkler is adopted for spraying waste water.

So in sloping lands so suppose we employ this sprinkler for spraying the waste water so then what happens is and larger this one is waste water is created and part of it percolates and part of it very small portion or some portion may also flow as a sheet flow and thereby the waste water is recharged and the same and the previously whatever was happening in case of irrigation that means reduction in the water demand for irrigation as well as the reduction in the load the civilized system.

So both purposes are achieved simultaneously and that is this one and then the third is let us say this is the waste water reuse through recharge wells. So in this case what happens is waste water is allowed to recharge wherein there are a number of filtering layers to screen as many pollutants from the waste water as possible. So therefore that is substantially filtered waste water is allowed to get stored in a recharge well.

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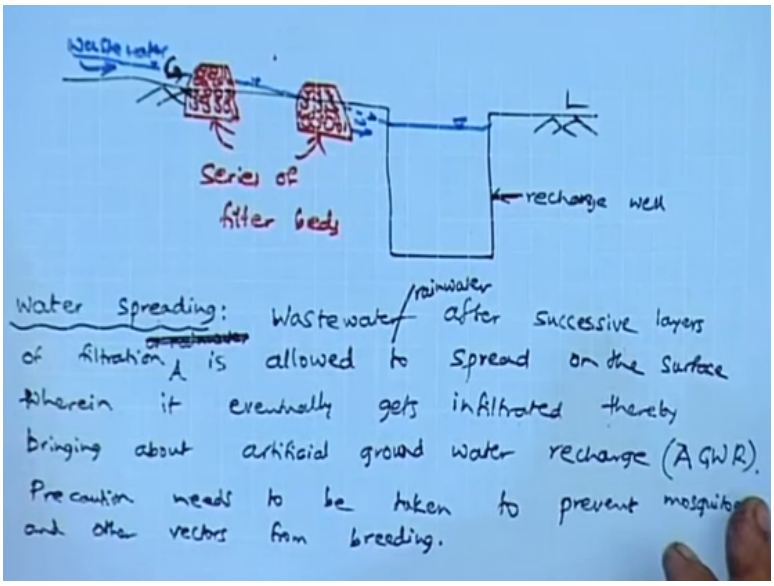


So here we can a typical diagram you can show say suppose this is a recharge well and of course here I am showing this as a an open well and so this is the waste water and so typically so different kinds of so this filter beds are employed and so here we can may be another and in this case so this is the recharge well so this is the this is the ground level so this is the waste water.

So this waste water gets filtered through this so these are the series of filter beds to substantially remove the most of the pollutants in the this waste water and then eventually what happens is so this is what happens is so this is so the waste water is allowed to recharge into this recharge well.

So like this we can ensure that this waste water is because what happens is generally this waste flow is very regular flow because of the municipal water us which is obviously the all human beings do need water on a regular basis irrespective of the season for carrying out the daily activities. So therefore waste water is generated and if this waste water is properly filtered and the allowed to recharge into recharge well.

So then of course and again so it will provide a constant supply of water for the recharge well and then again so it can further be purified and then in many cases it has been brought to the level of this even portable standards also of course if there is an attitude problem is a and if there and if there is an attitude problem is also this taken care of so then this waste water this treated waste water.

So it can be used significantly to meet the water requirements and so now we will go to the other this one that is this water spreading last topic today's lecture is on water spreading. So in this here what is done is so this waste water is allowed to spread and waste water after successive filtration layers of filtration is allowed to spread on the surface were in it eventually gets infiltrated there by bring about artificial ground water recharge that is AGWR.

So this is water spreading even though it is we call it water spreading so it can either waste water or even say that is rain water waste water here let me write this is rainwater. So after successive layers of filtration is allowed to spread on the surface and thereby so it is this artificial ground water recharge is achieved. So this is a regarding this one and obviously so this is but only thing is so the precaution to be taken.

So precaution needs to be taken to prevent is mosquitoes and other vectors from breading so it is a very important this one so that the precaution as to be taken so that so this water spreading does not increase or does not create the new menace of vector or mosquitoes and thereby it is it will cause more problems and so will also it is so with this we will come to the end of this chapter on artificial ground water recharge and of course of this artificial ground water recharge is very this one that it is especially in the scenario of climate change.

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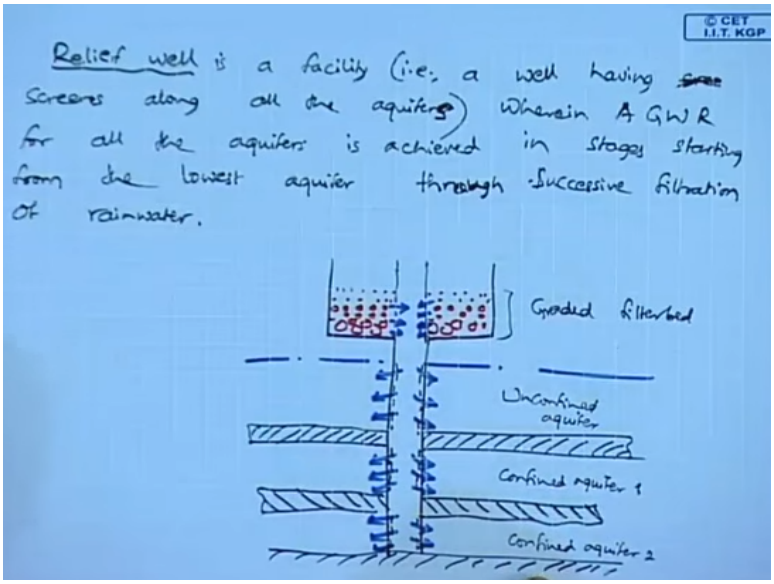


So this artificial groundwater recharge is very necessary in these as we all I would like to take this opportunity to bring it to the notice that the human dependence of water of course this was

dealt in one of the article of earlier lectures water so it is starts with rainwater then moves on to river water and then so this is a so rainwater so then this is the river water and the moves on to so this is a ground water.

Then moves on to ground water so therefore so here so this artificial this ground water recharge schemes so what they do is and here this is a either through rain water. So the water is allowed to filter and that is infiltrate and there by create a thereby fill the subsurface reservoirs and so this is an artificial ground water recharge brings about the necessary water security which is very important which is very important especially in the context of climate change.

Where in the frequency of floods and draughts is significantly increasing in a most of the places on earth as well as there is a gradual decrease in the number of rainy days at a place. In many locations so this rainy days so here a rainy is a day with a minimum daily precipitation of 2.5 MM. Both is one and of course so this so the so to design this any artificial ground water recharge scheme.

So various factors such as the amount of rainfall as well as the infiltration as well as the desired water table depth range of water table depth. So all this factors need to be considered and so and how much this and of course here why would it also this bring about bring to the notice of one very effective technique which can recharge the and that is the unconfined aquifer at the top as well as unconfined aquifer at the bottom and so that I could like to mention here so this is it is known as the relief well.

So basically so this relief well is a facility that is a well having screens prolong the all the aquifers it is a facility where in so this artificial ground water recharge for all the aquifers is achieved in stages starting from the lowest aquifer through successive filtration of rainwater. So here I would like to bring about this one so a relief well so basically here so this relief well is something like this.

So here this is the just let me consider and here so there is a filter bed and so here so here the water enters and there by the water enters so this is the impervious layer. So this s the unconfined aquifer so this confined aquifer one and this is confined aquifer two and so on and here so

wherever this is there so this is a strainer with perforations. So here what happens is so once the water enters through this one so next the flow is into the aquifers.

Similarly here also the flow is into the aquifers so this is also a very important facility for relief well and then here so this is the graded filter bed so with this we will come to this end of the chapter and so this completes our modules and remaining four modules will be dealt by my colleague professor Anirban Dhar thank you