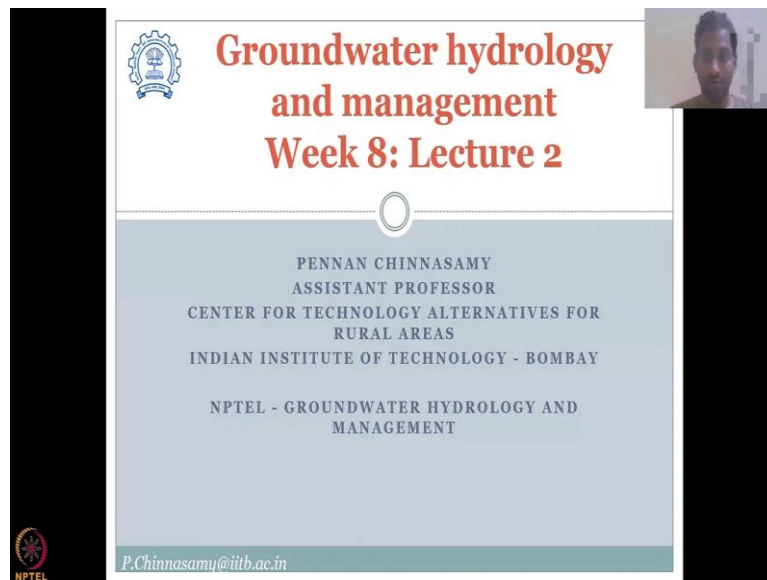


Groundwater Hydrology and Management
Professor Pennan Chinnasamy
Centre for Technology Alternatives for Rural Areas
Indian Institute of Technology, Bombay
Week - 8
Lecture 2
Groundwater wells construction

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The slide thumbnail displays the following information:

- Groundwater hydrology and management**
- Week 8: Lecture 2**
- PENNAN CHINNASAMY**
ASSISTANT PROFESSOR
CENTER FOR TECHNOLOGY ALTERNATIVES FOR RURAL AREAS
INDIAN INSTITUTE OF TECHNOLOGY - BOMBAY
- NPTEL - GROUNDWATER HYDROLOGY AND MANAGEMENT**
- Contact email: P.Chinnasamy@iitb.ac.in

Hello everyone, welcome to NPTEL course on Groundwater Hydrology and Management. This is week 8, lecture 2. In this week's lecture, we are looking at the wells, types of wells in India and how are they made and why are they categorized in different way. This is important because in the last week we looked at groundwater recharge, but then at the end of the day you want to use the water. So, you need to know what is groundwater discharge.

So, with this let us get into this second lecture. In the first lecture, we looked at the different types of uses of wells like agriculture, domestic and industry. And we found that there are three major types of construction of wells which is dug wells, driven wells and drilled wells. The driven wells are used in a different fashion but nowadays, it is morely dug and drill wells because in the driven not much use is there because everyone does not do manual labor for it, they just bring the drilled bore well loggers.

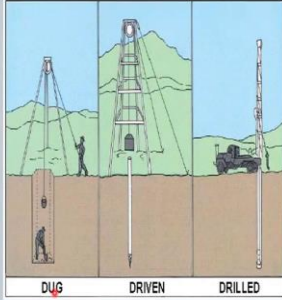
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Well constructions

2

Based on

- Use
- Manual vs Machinery
- Type of materials used
- Funds available



Source: aquapump

So, the well constructions we looked at the dug well it is mostly manual labor, they dig deep using tools, picks and other things. The dug wells are also based on the location where it is available, if you look at the background of these images very carefully, you could see that these dug wells can be anywhere straight horizontal terrain or some undulating terrain whereas driven is mostly in terrains of hilly terrains and stuff. And one of the reasons you cannot take the truck up and then drill is also that. So, that is why they use driven methods.

And then in the drill it is almost everywhere they can use as long as your truck or the load which goes up can do it. Nowadays, you also have smaller size bore loggers, we call them or borehole diggers. 5 years ago, it was a big lorry and nowadays it is such a small machine that you can put on top of a pickup truck and then that can do the job depending on the depth for sure. So, let us see how these are based on.

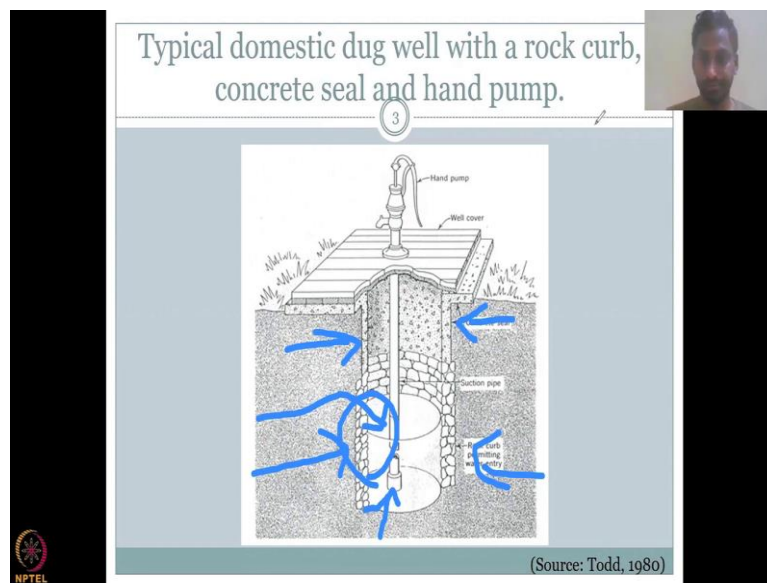
The well constructions is also based on the use as I clearly said how much water you need, is it for agriculture, domestic or industry and based on that the well construction type also differs. There is also difference between the manual versus machinery, please understand that when it is used with machinery there is lot of money you have to spend to take the water out and to make the well however manual methods are much cheaper. It is only you are putting your time so it is your labor cost is not accounted for.

And this can also impact the type of well or construction which is going to be made. The type of material use is also very important. How do you want to case the well, what casing you want to put around the wells so that the material does not fall on. So, all these also play a vital

role in the well construction. And most importantly, if not, it is the funds. How much funds do you have for constructing these wells. If you do not have much funds, mostly they go for dug wells. And based on the dug wells, your construction is also changed.

You do not take much water out of the ground. You just make sure you tackle only the shallow aquifers whereas driven can go to shallow and then also deeper aquifers, and drilled is mostly at the deep aquifers.

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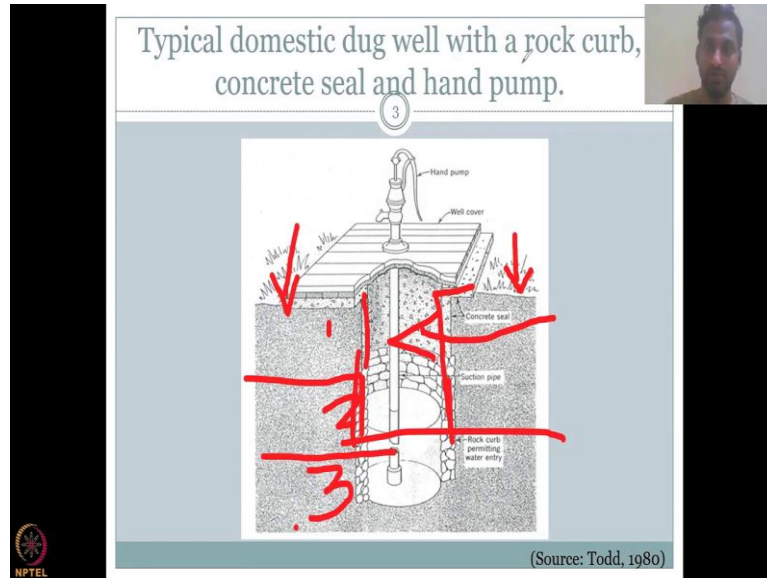
Let us look at the first type of well which is your dug well. In the dug well itself you have a smaller well which is mostly for your hand pumps, typical domestic dug well with a rock curb and the concrete seal and hand pump. So, there is a concrete seal as given in this diagram on the top which is seals the entire well and on top of the well they put this hand pump where you operate it by hand and the water comes up through the suction pipe, rock curb permitting water is kept along the perimeter of the well.

Please understand here that the rock is put to also like a casing however, if they put too much rock then the water will not come. So, it should be given that the rock has some gravel, porosity high porous space, so water can move. So, what I am trying to say is here there is no water movement because it is concrete which is there it prevents water movement.

However, water movement can happen through here and from the bottom, all the size and the bottom and the rocks are kept in a fashion, just zoom in and see here there are space. So, that space is how water can trickle through these material and then get into the well. The soil

particles are kind of stopped from moving into the well using this rock curb. Normally a curb is placed on the round on the turnings you call it as a curb.

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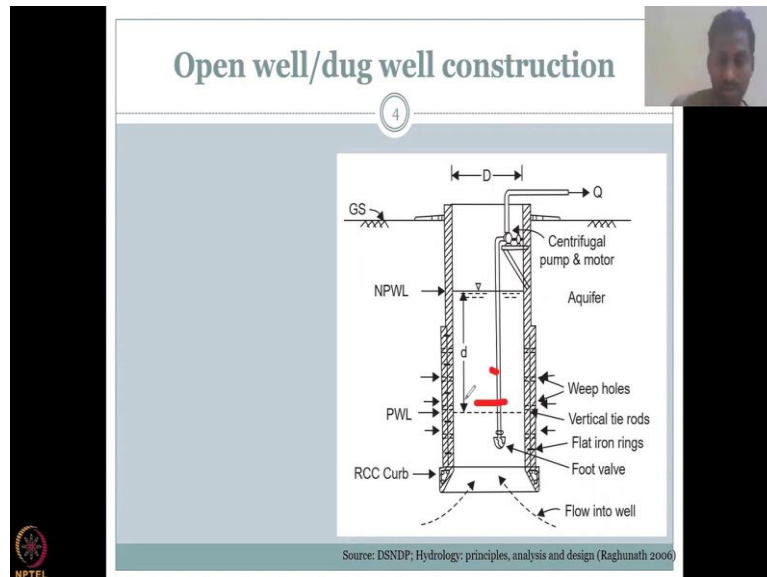
Moving on, we have another aspect which I wanted to tell you about these construction of hand pumps is how do you prevent pollution because on the top you have different pollutants that can come. I will do it in red. For example, you can have fertilizers, if it is in the urban centers, you do have hand pumps in urban centers. It could be a car engine oils and other pollutants that can leak in. And also for example, I said if it is a Ganges near the Ganges, you see a lot of hand pumps. And if the Ganges is polluted, then what can happen is water can come through like this.

So, to prevent that they have kept a concrete seal or wall and water does not flow through, so there is seepage, very, very little. And once it is old, the concrete can break. But for newly constructed wells, well maintained wells, you do not have water movement through the concrete. And it can go as deep as needed depending on the taste and quality of the water. If you want to take only the water from the third aquifer, which is this one, let us say, let us divide into 1, 2 and 3.

So, what you see here is they want only water from the third aquifer, so we should just make sure that all the other walls are sealed except the depth to the third aquifer. I will come back to show you how these different layers are set. And how do you know that this water is the best of the three. You can also pick in between, you can pick in between but in between is kind of hard. Because still there is some seepage you can either isolate the well. If you do not

need number 3, then you could just stop the well at number 2, you do not have to dig deep. But that has been a clear violation and issue in the recent times. I will also get through that the following slides.

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The next one we want to see is open well, dug well construction. So, the first one is kind of a dug well or an open well but with a hand pump. I am coming into the agricultural arena, now the previous well was for domestic use, mostly drinking water and domestic water for washing, bathing, etcetera. Whereas the well that we are going to see now is a open well dug well for agriculture. What you see is there is a ground surface and the well has been done so I said it has been dug using manual labor and the debris has been pulled using a pulley or something hooked.

And the whole well is not lined or no rocks are present. So, mostly the water can come in, what we have is two water tables. One is the non-pumping water table, which means the water level before pumping and after the pump is operated the water level falls down. There could be a meter placed outside the well, inside the well or inside the water. Outside is a just normal pump diesel, electric pump and then the centrifugal pump which they put on a stand in the well is also okay.

But nowadays you also have submersible pumps which go into the water. All the other things are technical terms in well construction which is not much discussion we will have. All we need to see is how does water move? Water moves laterally and also from the bottom of the well, it just comes from the bottom up depending on the pressure difference. So, make sure

you understand that there are multiple pathways through water which come and when the pump is turned on the most of the time the valve foot valve is open at the bottom or it can be screened like your well panel.

You can have a screen in the pumping tube and water can come through. Make sure they put a foot valve, a valve to protect not pulling the sand and silt because if that comes into the pipe then the pipe gets choked and you lose the water. You have to replace it, it is pretty expensive. Think about this if sediments get into the pump, the pump gets wasted. So, they have to maintain a filter kind of thing throughout the tube or in most important junctions and they have the well cleaned along the side so that no sediments are much inside or even the bottom now and now and then they to clean the water.

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Open well/dug well construction

Requires

- Manual digging
- Removal of debris
- Shallow aquifer
- Maintenance

Source: DSNDP: Hydrology: principles, analysis and design (Raghunath 2006)

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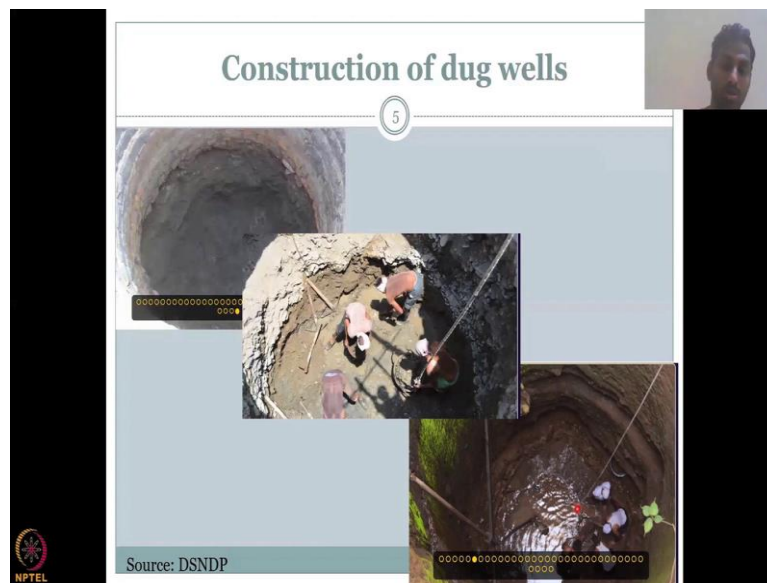
What does this open well require? It requires manual digging, lot of manual labor as the name suggests dug, it is dug using a manual interference. Removal of debris, you have first let us take the solid surface and then you start dig using your shovels and picks and then some people would put a small bomb to shake up a little bit and then loses the soil and then take it out. Mostly it is a village made small bombs not much dangerous but still it could be if you do not use it properly.

And what happens is they you start to remove the debris which is the small rocks and soil that are broken either by digging or by the small augers, etcetera. And it is mostly in the shallow aquifer, shallow also tells you the depth of the aquifer. Since you are going to dig, you are not going to dig manually to meters it is just couple of meters max that you can get into of digging because think about it you also need to get out of the well, so well means your digging well means it is good for digging and also for being out.

So, please make sure that is also understood because all the repairs everything you have to go down, you have to put the pump in, so you can see here, so it is not too deep. That is all I am trying to say. It is deep but it is for human swimming and other aspects but it is not too deep to get into the deep aquifers. Maintenance is key the wells are big. And as I said mostly they are not lined. So, there could be a lot of sediments and debris which fall into the well and also it is open on the top so there could be a lot of a return flow and pollutants that can come in.

Let us take an example if the dug well has plants near it, you apply fertilizers. If it is not protected well like a ditch around the well or something, then this water can actually get into the well and then pollute the groundwater. So, care has to be taken on how you use the water around the well also and mostly the other aspects like washing clothes, bikes, car, etcetera should not be done near the well because it can easily if you are doing it here it can easily seep back into the well, the pollutants, so very important that is done. Maintenance is key, like any other well, you will have to do a little bit higher maintenance here.

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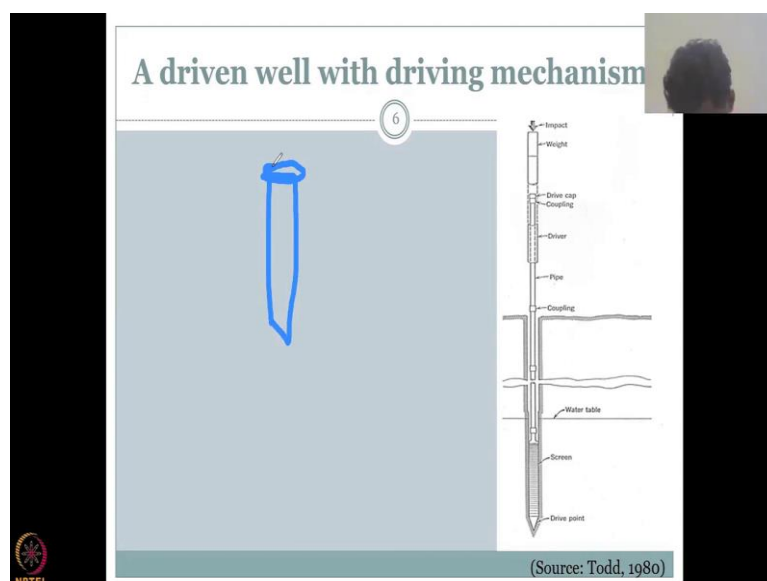
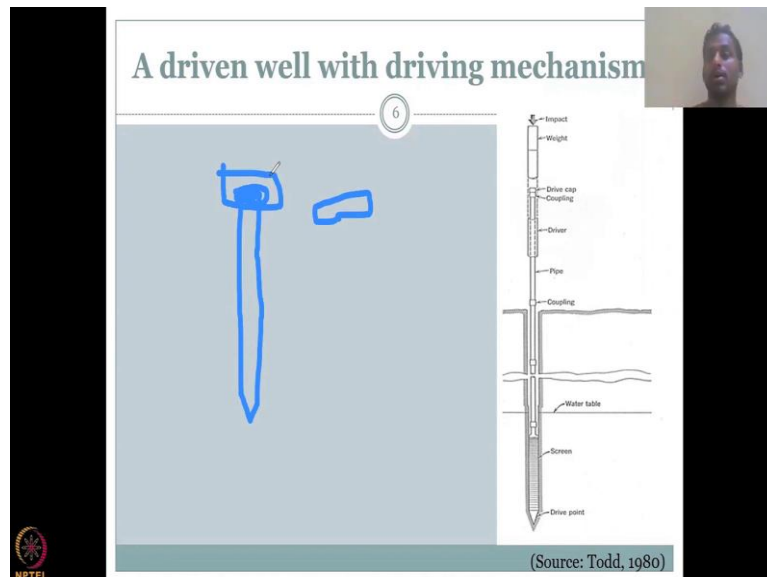
Let us look at how the dug well is constructed. As I show this is the first top view of the surface while digging they also make the rocks on the side, the rock curbs, it could be just bringing the rocks and keeping piling them on the sides. Also from the debris matter or it could be a stone massoned as a brick and a wall around it, or cement, the circular rings that they put inside the well. All this you would have visualized. Now you know why they put it, they put it so that this the surrounding sediment and loose soil does not fall into the well. But why does not this part of the well have that lining, think about it.

Once you go deeper and deeper, the soil is more intact, it is consolidated. And the pore space is less. Once the pore space is more and it is unconsolidated, it can move and then fallen through water also. But here, as you go deeper and deeper, you have less water, and also less pore space to make that movement. So, after a particular amount of depth has been achieved, then people get into the deeper parts of the well to use picks and shovels. And then there is a pulley system which sends the trays down to take the debris out.

So, if you see here, three men are working on digging the wells of the sides and on the bottom. Whereas one person might be just a shoveling all the debris, the sand, the rocks, all the solid materials into the tray. And then when he puts a tray it just goes up. There is also maintenance, as I said, people can throw in stuff unknowingly, we can wash into the wells, all these are maintenance is still there and deepening of the wells. So, once the well is done, and the groundwater table is achieved, it is okay then you can access the water. But sooner or later the water level does come down and which needs more digging.

So, the maintenance also includes digging, but most importantly, the maintenance is taking out the soil which has fallen back into the wells from the sides, mostly from the sides. So, that can be done during the lean season where the water table is low. So, that people can get in and do it, otherwise it is going to be very hard to pull out the debris.

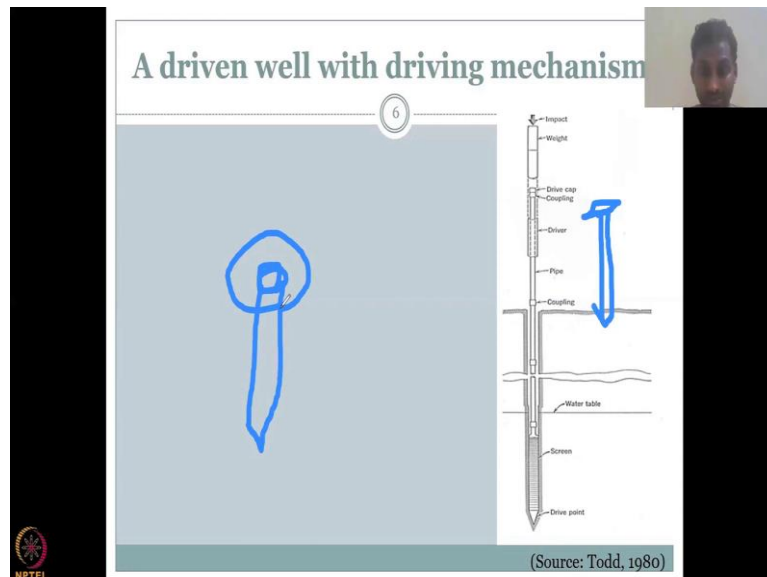
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The next well we are going to see is the driven type, a driven well with driving mechanism. Let me go through how it is done. So, you have a ground layer, this is your ground layer. And then this is your drive point, a drive point is something like a big nail, a big nail with a coupling on this side. Initially there is a cup that goes or a stopper that goes on top. So, this when you place it on the top, like it screws on the top, then now you can hit on the top to get the drive into it.

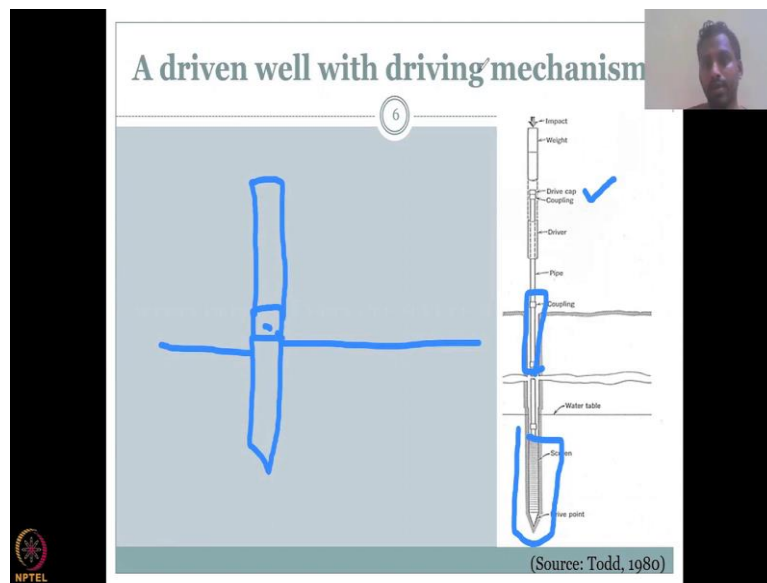
So, you are driving a nail kind of, think about driving a nail in your wall or your wood, you are hammering it, it goes in and if you look at the nail on the bottom, it is sharp. It is sharp at the bottom and on the top, it has a small head where you hit and it goes in it is called the head of the nail.

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Here you do not have the head because it is a coupling kind of arrangement. So, it is a circle screw type. On top of the screw you can put a head and then you hit hit until this drive point goes in. So, the drive point is going in and once the drive point, so, initially you started here, you put the drive point and then you started a hit, once you hit this has moved down here. While it moves down, you need to open, unscrew the top and then connect a connector or elongated for your drive point and that is why it is a coupling. So, there is always a coupling. So, there is always a coupling.

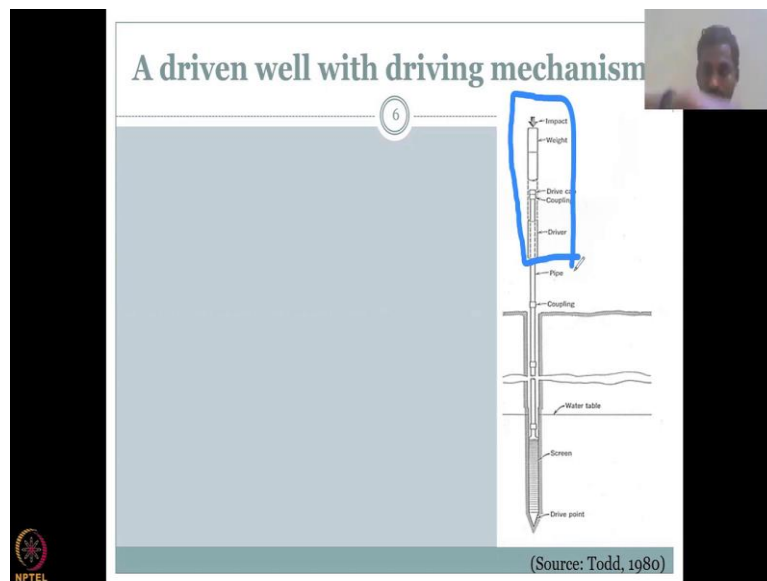
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So, first is your drive point which you take. And then you have your drive cap. You can see here the drive cap, which you take for putting on the top and hitting. Once it goes into a particular depth. Then you take a connector, a coupling connector you can see here, which you just screw on and then again put the head and hit, hit, hit. So, this can go on until the depth you want to be reached out. I will just give an example, I have one drive point and then the head I am hitting it goes in.

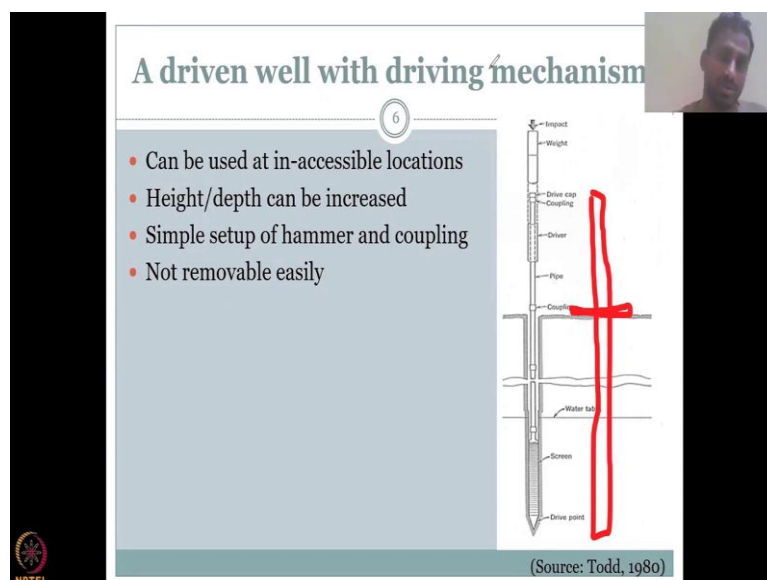
Once it goes into the ground level like this then I want it to go more down. So, and then I remove the first I remove this top part, so let me remove it. I remove the top part. Now I connect another elongated tube and then I hit, I start hit again and once this goes in another one, another one until your depth is reached.

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Now, how can you hit it? You can hit by a hammer mechanism but you have to be careful not to put weight on one side because the cap will go given or the drive point will turn. So, this has to be straight as much as possible for which there is a hitting mechanism, proceed here, it is just a weight you pull and then drop. You pull the weight on and then drop it will just hit, hit, hit and then it goes very very slow.

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So, it depends on how you holding the drive point and then putting the weight on top. If you do it well then it goes vertically down otherwise it can slant. Remember you do not want it to slant because you are losing the height or the depth of the well. So, you have to keep it as straight as possible to go down. Let us see what this is based on. Can be used at in accessible

locations if you remember the previous diagram, we did show that background had lot of hilly regions and hilly terrains, it is mostly for those kinds of terrains where you cannot take a machinery or you cannot take a lot of load out.

So, example, the spring's drinking water supply for people around mountainous regions, so these are kind of done using drive point wells. The height and depth can be increased as much as needed. But again, as the depth increases, it is hard to get the tube to go in, you can go technically, technically you can go to as many because your all you need is more connectors and then a connector. So, think like this, it is like this, and then you add one connector, add one connector, add one connector, so it goes on, the depth of the tube goes on.

But as the depth increases, you cannot hit it that easily. It is very, very hard, it is because the porosity is not there. And the material is going to be hard rock. Simple setup of hammer and coupling. So, you see a weight on the top and a coupled drive point at the bottom. That is a very simple setting, not much expensive. And not much debris and other maintenance. Not removal easily. So, that is another point. The other wells you can close and then so for example, dug well, if it is not working, closing or putting a fence around, it is fine.

Here the all the tube that you put in is going to be there, it is not easy to remove a well. So, what normally people do is if they done with the study or the well is no longer in use, they would just cut the well for example, the well is here and this is the depth of the well, all they lose, they cut this part, remove the top and then close the, close it with sand, so because if we leave it open, people can get trapped, animals and another living organisms can get trapped.


So, it is very very interesting to know that these things people fall in like small small kids, I am saying, a ball and toys whatever they used to play. It depends on how big you want, but most probably it is within 5 centimeters of diameter. People do not fall into those it is small. So, however, as I said small very very small things can get in. It can pollute, so it is better if you are not using the well, cut it and then put on the top your soil. If someone's going to build something on top of that they are at the top of it or while they are removing the soil they will find a tube well inside.

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A driven well with driving mechanism

6

- Can be used at in-accessible locations
- Height/depth can be increased
- Simple setup of hammer and coupling
- Not removable easily
- Screen can become clogged



(Source: Todd, 1980)

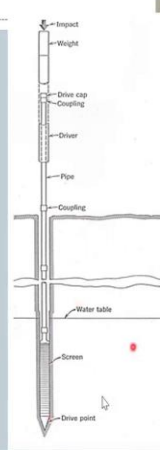
Screen can be clogged. As I said while hitting again this is not when the water is moving while you are hitting the screen can be clogged or damaged. If you look here, the screen is here. And you are hitting from the top and this is also having some stress. So, sometimes your screen which is just a perforated hold tube might get squished. So, it gets damaged, the other part is this small rocks and soil can get clogged or can clog your tube the screening part. This happens in locations especially, where there is a lot of small small debris that can get into the wells.

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A driven well with driving mechanism

6

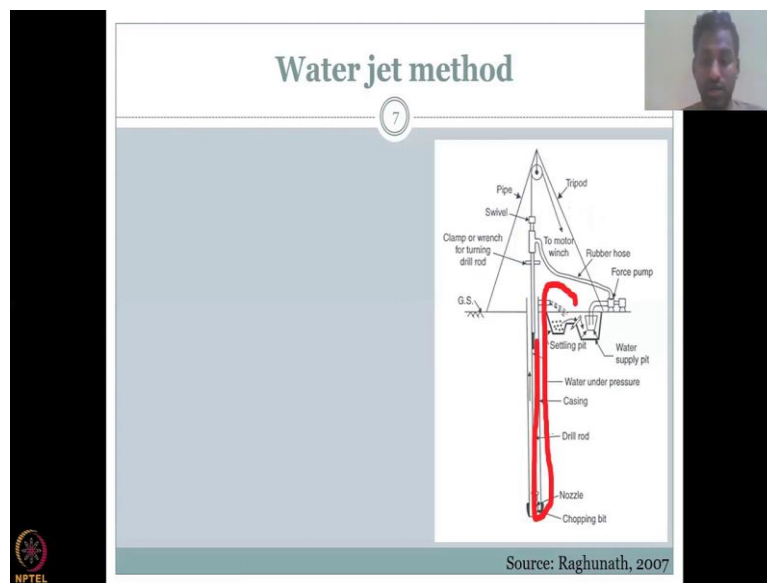
- Can be used at in-accessible locations
- Height/depth can be increased
- Simple setup of hammer and coupling
- Not removable easily
- Screen can become clogged
- Drive point



(Source: Todd, 1980)

The drive point is the most important part of this exercise as sharp and as sturdy the drive point is it can go down. If it is weak material then it will break and if this becomes blunt, the drive point become blunt then nothing even if you hit, hit, hit, the tube will not go down, so be very careful about using it. Then the most other important thing is the screen as I said, the screen tells you where you want water. You can drive the point down and can get water here. But most importantly, you open the screen so that at the bottom near the drive point, so that water can come.

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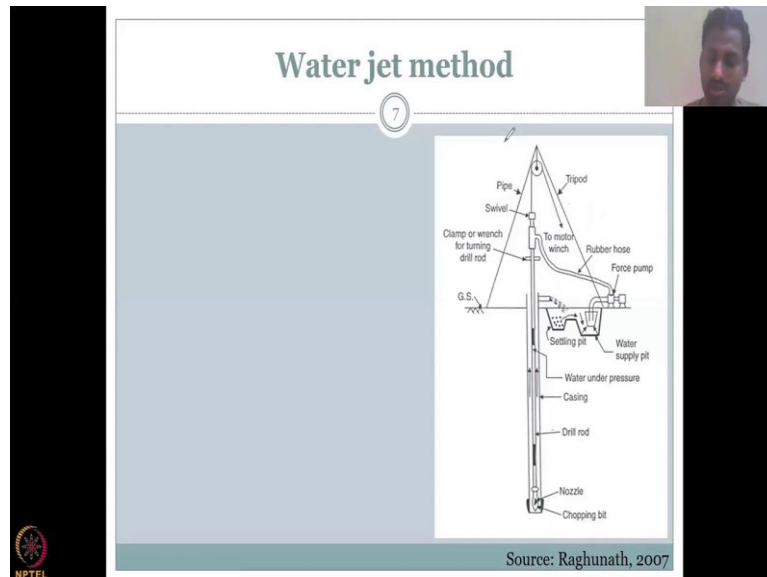


The water jet method, I will introduce it but I will start again in the next lecture. The water jet method is part of your drill method where you drill down, you drive down the tube, but sometimes you need to remove the debris out. In the previous example, you cannot remove the debris. In this example, you could remove the debris using a water supply. You flush water in and that flushed water actually prevents the debris from moving inside or it flushes out your debris.

So, this kind of model can be used in regions where there is less stability along the wells and you do not have enough manpower or funds to get a digger to dig it in. For example, the motor is there which gives in the water at a high pressure and the pressure comes down on the nozzle. So, instead of pulling water, you are supplying water. It is kind of your well discharge, but please understand this is not to recharge your ground level it is mostly to push the sand and silt coming out from the sides.

So, when a water is pushed, then what happens it just starts to rise in the well and then come out while it comes out it is flushing all the debris, the small sand, silt, the particles out which can clog your well or which can prevent more digging and deepening of the well.

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So, with this I will stop and then I will continue with this what is the water jet method for pumping? I have just explained what is it for accessing the debris out. But in the next class I will look into what are they using this for, how are they using these water jet methods for water supply? With this I will see you in the next class. Thank you.