Hand Dug Wells, ODRINO, Northwest Haiti

The purpose of this document is to show how the Organization for Integrated Rural Development in Northwest Haiti (ODRINO) digs shallow wells using local technicians and labor for drinking water and irrigation.



The first step is to dig a hole the same depth as the form but several inches larger than the form diameter. Put the form in the hole and make sure it is fairly level.



The next thing to do is to pour concrete around the outside of the form. Most people who do this pour the concrete without any reinforcement. We drive the first rebars into the soil below the hole so that when they dig out underneath there are the ends of the rebars to splice onto for the next concrete pour. And we put rebar hoops around the cylinder in the concrete as seen here. It doesn't take a lot of rebar but it keeps the line of concrete tube from separating down the hole. And the rebar sticking out the top are used by the diggers to hook their ladder to as seen in a subsequent picture.



As soon as the concrete is poured you can start digging out in the middle of the hole below the form. The next day you dig out underneath the form to the same diameter as the first hole. The next step is to move the form(s) down lined up with the concrete cylinder above it. The diggers leave four to six inches between the form and the concrete already poured to have room to pour concrete behind the form.



Here the diggers are pouring the concrete behind the second form down. Notice the space between the already poured concrete above. They have a piece of 16 gauge metal 12”x12” or 12”x16” that they use to help get the concrete into the space behind the form. When they finish filling behind the second form down, they pack the space between the form and the upper concrete cylinder with stiff concrete to make the concrete tube continuous.

Notice on this form set made at Camp Perrin in Haiti they have guides that stick up to keep the form centered on the concrete above. These forms made at Camp Perrin are one meter (40”) in diameter. Because this only allowed us to use one iteration of HDPE pipe on the inside, we now have a multiple piece set of forms that make a 54” diameter hole that you will see in pictures below.



Lather, rinse, repeat. Keep doing the same thing going down pouring concrete rings as long as you can. When the well reaches water is when things get interesting. The best procedure is to put a pump down the hole and pump the water out so the diggers can continue with concrete work below the undisturbed water table. If the water is coming in from the side as opposed to the bottom, they often leave small PVC pipes through the concrete between the forms to allow the water to get into the well.

When the sides start caving in is when it is important to have the rebar in the concrete walls to keep a section from falling. It all depends on the soil type.

At some point in digging some holes like when rock is reached or depending on the soil type, there are times when the diggers stop using concrete to support the sides. This is an experience and judgement call. When you have concrete rings in the hole all the way down, it is really hard for the sides of the well to cave in on the diggers or fill in the hole.

When the water is coming in too fast to pump out you have to stop digging. But at that point you usually have enough water for whatever you had in mind.



In this picture you can see that they started the well too low and had to lay some block around the top to make the top of the well even with the soil. The rebar sticking out are used to anchor the rope ladder. When we first starting working with this team of well diggers, they did not have the ladders. They went in and out of the hole on a single rope or two ropes close to each other so they go down with a rope in each hand. These men are in very top physical condition and incredible athletes. The spoil from digging is removed from the hole with a rope and a bucket.

One piece of the three piece form from Camp Perrin is seen in the picture behind the men.



ODRINO added several important tools and techniques to the repertoire of the well diggers who were already digging hand dug wells when we met them and first started working together. The first is the rope ladder which for us is a safety feature.

The second addition was the use of HDPE pipe seen above. The well diggers often reach a depth where water is coming in, they are in gravel or caving soil, or other problems where they can't go farther and have to stop digging.

The first well we had the men dig started caving in. We thought we were done going deeper from the previous experience of the well diggers. But we had some of the HDPE storm drain pipe shown in the picture. We found that a piece of 30" HDPE would go inside the concrete that has been poured all the way down enabling the well diggers to keep digging inside the HDPE pipe. They dig inside and under the end of the pipe and then wiggle it down with them as they go.

This works really well except you only get one chance with the HDPE pipe. When you can't keep moving it down with you as you dig, you are done. The well can't be dug any deeper, even if you needed to go deeper. We have 24" HDPE pipe but there is not room in the hole for the well digger to work and for the pump at the same time.

More recently we solved this problem but starting to use a 54" set of forms to make a larger hole that you will see in pictures below. The larger hole allows us to use a first iteration of 36" HDPE pipe. When the diggers get to where they can't go any deeper, they can do one more iteration using a piece of 30" HDPE pipe like we originally used.



Here you see the technician slotting the HDPE pipe with a normal carpenters handsaw. For a 36” pipe they will put 6”-8” slots in four places around the circumference in every one of the troughs. In 30” pipe you can make three slots instead of four or make the slots shorter. It is not very scientific. You need to create places for the water to come in but leave enough pipe material to be structurally sound.



Notice the way the technician is finishing the slots in the pipe. If you just do the slot with the saw horizontal you only get half of a slot or you weaken the pipe with the oversawing to make the full dimension. The way to do these slots is to saw horizontally until the saw breaks through and then use the saw like the technician is doing in this picture in both directions to finish the slot.



If you are using the full 20’ section of pipe (recommended) it takes a bunch of guys and sometimes a rope to put the pipe in the hole. Sometimes depending on the situation, we use 10’ of the HDPE to go deep enough and act as the well screen at the bottom of the hole.

Notice the yellow pump (center) and trailer mounted diesel hydraulic power unit (right) used to dewater the hole while digging. Up to 20’ it is possible to use a normal 2”, 3”, or 4” gasoline or diesel powered centrifugal pump. Most wells need to be deeper.

When we met the well diggers they would use a 1 hp electrical pump to dewater the hole while digging. This has three problems. The first is that these pumps don’t last very long pumping dirty water like what is in the bottom of a well with men digging in it. The second is we don’t like to have men working down the hole in water with electricity present. The third problem is that the electric pump will only pump 20gpm. We often need to pump much more, especially when trying to get deeper and create a reservoir in the ground under where the water is coming in or in looking for irrigation volumes of water.

The hydraulically powered pump in the picture is a Stanley 4” model which will pump up to 400gpm and work in a well up to about 42’ deep. After 42’ we used to have major problems until we recently had built two hydraulic power units to power a 2-1/2” hydraulically powered Stanley pump. This pump will pump up to 200gpm of dirty water and work at depths of at least 100’. So far we have not worked on anything deeper than 70’ although the well diggers claim to have gone much deeper.

The third innovation that ODRINO added to the repertoire of the well diggers is the use of a Bosch 60 pound electric jackhammer. Previously when the well diggers encountered rock or a boulder while digging, if they could not lift it to the surface they had to stop digging. One day after they had somehow hoisted a 100kg rock to the surface I am still not sure how, we told them next time to get the jackhammer. Now as long as they are in the dry part of the well, if they encounter a boulder type rock or a layer or rock, they use the electric jackhammer.

When the well diggers encounter a boulder type rock, or layered rock and they are in water, we send them a Stanley 65 or 85 pound class hydraulic jackhammer that is rated for underwater use. This way they can keep going in rock when they hit water. At Foison and Beauchamp the water was in a thin layer on top of the rock where the soil met the rock. At Beauchamp the water was only three feet deep in the bottom of the well. It worked fine for a highly modified India Mark II or Afridev pump. The problem started when we put a 12gpm pump on this well making 6gpm. The pump would pump out the hole, cycle off, and then restart when the water level rose again. It would cycle all day long.

The hole was 13' deep and 5'x10' in size. It was dug before we had the forms when we built a concrete box to chase a spring that was not quite reaching the surface except when it rained a lot. 13' deep was where the soil ended and the rock started. We asked the well diggers to make the hole deeper. We asked for 30' if possible.

Three weeks later I came back to find two 10 wheel dumptrucks of broken rock out in front of the well house and a 5'x10' hole that was 30'4" deep. Now when the sun hits the solar panels first thing in the morning, the well has been filling all night. There are 7,000 gallons of water in the hole. Pumping at 12gpm never lowers the water level in the hole enough to shut the pump off. More often the reservoirs they pump into are overflowing or they turn the solar pump off.

At Foison there was only 6" of water on top of the rock layer. Digging the 40" diameter hole another 20' means plenty of depth to install the submersible pump in, and storage when the well yield drops during droughts.

Amazingly, there seems to be enough air naturally circulating in the hole for the diggers to breath as long as the hole is in the open. When it is inside a building or enclosure they start to have trouble breathing. After trying several different ideas we gave the diggers a modest $100 shopvac, some 2" PVC pipe and fittings, and a roll of duct tape and told them to see what they could come up with. They claim it is like having air conditioning down there.

The last item is like all the rest. It seems intuitive but like the others has taken us several years of experience and running into problems to figure out. They would normally work

down the hole with ambient light, and somehow they managed most of the time. Inside a building they ran into a problem, so we gave them a headlight that works off of three AAA batteries. They usually go through three or four changes of batteries doing one well, and working down in the water and mud is hard on the ten dollar lights. But it greatly improves production and probably safety.



This well was done with the more recently acquired 54” set of forms. This makes a larger diameter well that enables use of two iterations of HDPE pipe starting with a larger 36” diameter pipe. We have noticed that this form set makes a much straighter and cleaner

looking well than than using the forms from Cap Perrin (although it should be noted that our original Camp Perrin forms are salvaged and patched and have been damaged by vandals once, so a new set of these forms might also enable a straighter hole).

In the well pictured above, the diggers went 54' during an extended drought period. At this depth with pumps pumping 240gpm they could only lower the water level to waist deep as the water was coming in so fast. The purpose of this well was to replace a 70' deep irrigation well nearby that provided 500gpm of water. Unfortunately by the time ODRINO arrived with a hydraulically powered pump that can pump 600gpm at 70', there had been an extended period of rain and the well currently has 20' of water in the bottom of it. Pumping at 600gpm only lowers the water level in the well inches. So the well is fine for now, but at some future point in a drought, it will probably have to be dug deeper. As with all well drilling or digging, working during drought periods is the best way to ensure that you have the water you need when it is most needed.

Several advantages of large diameter hand dug wells:

-Can be done with local labor on shallow wells instead of high technology difficult to maintain well drilling equipment. Money stays local and doesn't require outside technicians.

-Large diameter acts like an infiltration gallery allowing plenty of area for large volume of water to enter well.

-Large volume of the hole acts as a reservoir on low yield wells filling during off peak hours including overnight for solar powered systems

- If there is a problem down the hole, or if something drops down the hole by mistake, the diggers can go down on a rope or the ladder and deal with it

-Not limited to slim well pump designs

-Can put multiple pumps in the same well

-If the well turns out to not be deep enough during a drought, the well diggers can come back and dig the well deeper under most conditions

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