



## Manual SHIPO Drilling



Simple,  
Market based,  
Affordable,  
Repairable  
Technologies

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SHIPO drilling has many details which can be best learned with practical training. Therefore it is highly recommended to use this manual in combination with practical hands on training that can be provided by a SMART Centre in Tanzania, Malawi, Mozambique, Zambia and in the future in other countries.

Please feel free to contact us via [www.smartcentregroup.com](http://www.smartcentregroup.com)

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### 3 Introduction

The techniques for drilling a tube well (borehole) can be divided in two categories i.e. drilling with a machine or drilling manually. In general manual drilling is cheaper and less complex than machine drilling but is slower and limited to softer ground layers. Compared to digging wells by hand, the drilling of tube wells is less dangerous, can penetrate deeper into the aquifer and wells are more hygienic.

The SHIPO drilling combines sludging, percussion and jetting (see below). It includes aspects of Rotary jetting and of the Baptist drilling technique named after the Baptist Missionary, Mr Terry Waller who invented the Baptist technique. See also [www.waterforallinternational.org](http://www.waterforallinternational.org). With the Baptist method, worldwide more than 3800 wells have been drilled with depths to 60 meters or more. A first version of this manual was made with support of John de Wolf of Connect International for the SHIPO SMART Centre in Tanzania.

The SHIPO drill method can drill in non consolidated deposits of sand and clay, small gravel and weathered rock. Also hard layers can now be drilled with new drill bits with tungsten tips. For gravel or stones from 1 to 3 cm an open bit can be used combined with sludging by hand.

This manual is part of a range of manuals that include:

Wells & drilling

- Geology and site selection
- Well digging
- SHIPO drilling
- Making of SHIPO drilling set
- Mzuzu drilling
- Making of Mzuzu drilling set
- Rota sludge drilling

Pumps:

- Rope pump model 1 Standard model
- Rope pump model 2 Economy model
- Rope pump model 3 2 Pole model
- Rope pump model 4 1 Pole model
- Pump care taker training
- EMAS pump

Storage, recharge

Water treatment

Workshop skills

Business skills:

- Training of Drilling companies.
- Business, financial and marketing planning



Pictures



Drums to store water



Jetting hose connection



New drill bits with Tungsten tips



Drill bits with and without valve. The tips made of Spring blades of a truck.



Hooks to remove drill pipes in case of breakage



Support for drill pipes

## 4.1 List of parts , tools and materials

Item	Number	Observations
Soil punch and/or auger	1	See manual
Tripod	1	See manual
Pulley, 4 or 5 Inch	1	
Rope (Nylon or PE),10 or 12 mm	20 meter	
Drill bits (open and with a valve)	3 to 6	For well diam. up to 10 cm, 3 bits. For well diam. up to 20 cm, 6 bits Spare bits recommended
Drill weight pipe 1 ¼", 3 meter	1	
Drill connection pipe. PVC 1 ¼", wall thickness 4 mm. Length 1,5 metre	1	If combined with jetting use thin walled metal pipe. See Manual Also other drill pipes can be 1.5 m
Drill connection pipe PVC 1 ¼", Length 3 meter	5 to 10	Depending on required depth See note above
Bottom support	1	For drill pipes
Bend and malleable coupling 1 ¼",	1	
Fish tool	1	
Threading tool	1	
Hacksaw	1	
Suction hose, 40 mm or 50 mm	2m	Reinforced hose
Pressure hose, 40 mm or 50 mm	3m	Reinforced hose
Hose clamps 1.5"	2	
Engine petrol pump. 5 HP, 2 inch	1	With connections
Jerry can for petrol/ gasoline. 5 liter	1	
Oil 10W40 1 liter can	2	
Bags of 25 kg of Fine clay or Polymer	5 bags	For polymer no of bags is 5 times less.
Spanners (17 fix and ring)	2	
Spade	1	
Hoe	1	
Screw driver	1	
Pipe wrench, 12 or 14 inch	2	
Drums. 200 liter	2	
Buckets. 20 litres	6	Steel or strong plastic
Rubber strips	2 kg	
Spray bottle	3	
Drill log form and pen	1	
Safety helmets	2	Or more
First aid kit	1	

## 5 Site selection

To select the best site for the tube well see manual: Geology and site selection. Suggestions include:

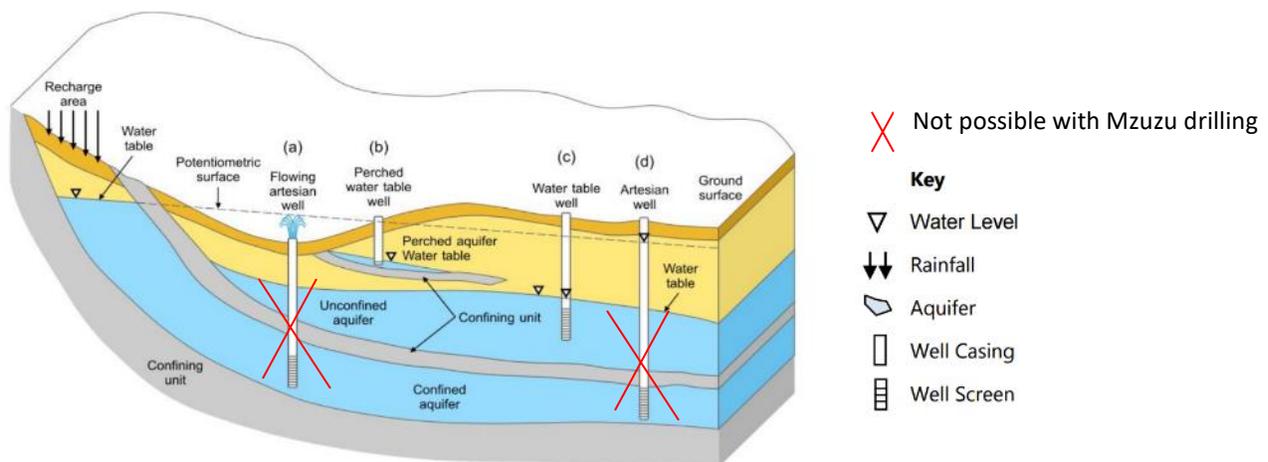
- 1 Find drilling logs of boreholes that have been drilled in the area. (Can be obtained from a SMART Centre, local authorities or NGOs.)
- 2 Look at existing drilled and hand dug wells in the area and see soil structure.
- 3 Ask villagers or owner of the new tube well for the best location. This may NOT necessarily be the best location to find shallow water layers!
- 4 Look at landscape, vegetation, anthills.

In general water flows from high to low so examine the landscape.

In flat areas a good indicator can be a gully, a stream or a river.

Rivers flow through the lowest-lying area and groundwater generally flows to rivers. Be careful: this only counts for natural rivers, not for manmade channels.

As a professional driller you are responsible to inform your clients about hygiene and the preferred distance between a well and a latrine or other sources of contamination.



Just as water in a river, also groundwater flows (although much slower) through sand layers or pores and cracks in the underground. Groundwater in general does not stand still. It is not always easy to determine the flow direction of groundwater and groundwater layers can go up and down with the shape of surface. Sunlight with its UV rays will disinfect the apron so drill, where possible, in a sunny place.

### 5.1 Sources of pollution

Be careful, when a latrine is located on the slope of a hill, the groundwater (contaminated with bacteria) is likely to flow in the same direction as the slope of the hill so it is preferable to construct the well up-stream of a latrine.

Most national guidelines indicate that a well should be at least 30 meter away from a latrine or other sources of contamination like waste pits, fuel or oil spills, pesticides or animal waste on farms. In general water from Shallow wells should be treated at the household level with boiling, chlorine or filters.

## 6 Preparation for drilling

1. Make a start hole with auger and or Soil punch of 2.5 to 3 meters deep
2. Install three poles length 4.5 meter or metal tripod. Height of pulley should be 3.5 meters above ground level. Place tripod in such way that the drill pipe is in the middle of the start hole. Make sure that the wind direction is behind the driller to avoid splash water coming into the face of the driller (so the pullers will be facing the wind).



3. Make 2 sink pits of 30 cm deep in front of start hole. Make the sides with a 45 degrees inclination. Use the soil to make a dike around the pits with a diameter of approximately 3 meter. Connect the two pits with a canal 15 cm deep and connect right settling pit with borehole with a canal of 10 cm deep (see chapter "8.2.1 Installing the casing" for sizes). Pour concentrated drill liquid in the settlings pits. Add water until the right mixture is reached and the pits and bore hole are filled.



4. Prepare drilling fluid by filling a bucket for 1/3rd with clay or other material, and 1/3rd of water. Stir well. Make sure clay is dissolved well. Need for complete well is 10 Kg Polymer or 80 kilogram of fine clay or organic material. Drilling liquid can be made with Polymer, bentonite, fine clay or organic material. The reason to use drill liquid are:

- 1 To lift material (clay, sand, stones, gravel)
- 2 To avoid the liquid is lost in sandy layers
- 3 To avoid collapsing of the borehole



5. Choose which method and drill bit to start with.  
If the soil is very hard, compact clay, weathered rock) start with drill bit no 1 (Drill bit diameter 2.5 inch).  
If the soil is softer, start with drill bit of desired diameter (4 inch, 5 inch or 6 inch).  
If there is large gravel that will not lift with jetting, use open drill bit. Study the material from the starter hole.  
The soil structure and material will change during drilling so keep a record of the soil type and adjust drill method and bit accordingly.
6. Arrange your materials and tools in a way they can never fall in to the borehole and instruct your helpers to put them in place after use.
7. Fill the sink pits with drill fluid until the bore hole is full and start drilling.

## 7 Drilling

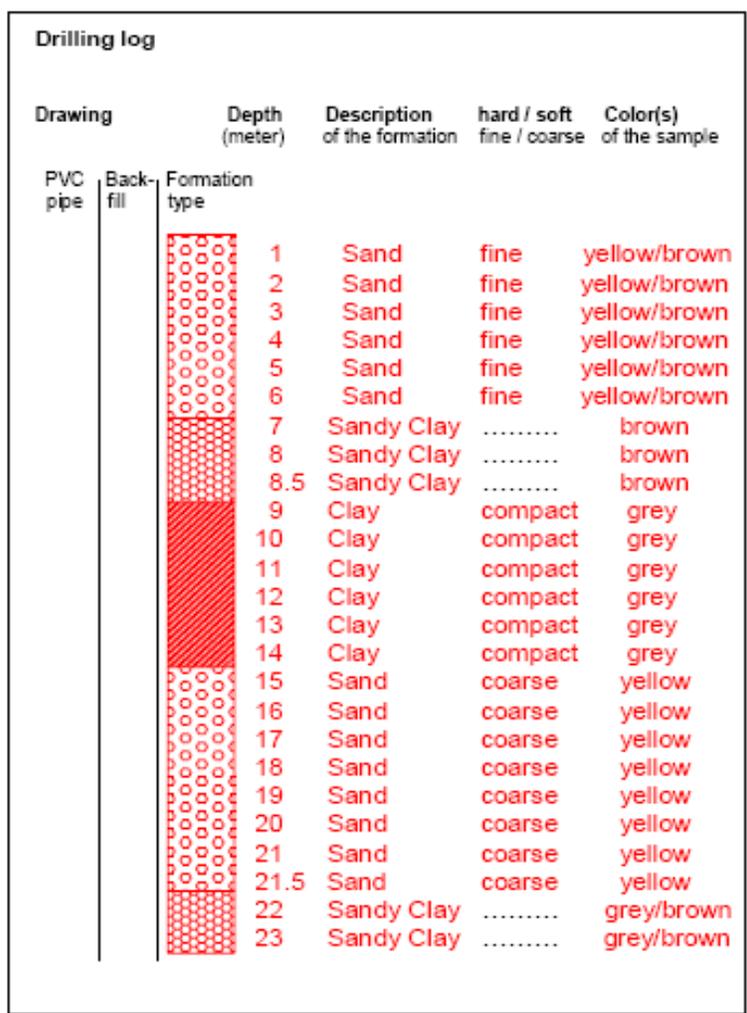
### 7.1 Drill log

To know the different ground layers, keep a drilling log by collecting a sample as soon as the soil changes. (Put bucket in left pit and pump 10 strokes). More information on ground layers and sampling soil, in the manual Geology and Site Selection.

Also keep drill logs of dry boreholes. This information is important for your client, the SMART Centre, local authorities and also yourself when you want to drill in future in the area. Keep the records organised.

Fill "Formation type" as you are drilling.  
For example:





## 7.2 Drilling with a foot valve (valve sludging)

The basic SHIPO drill method does not include an engine pump and has 2 types of drill bits:

1. Open bits for small stones or to be used for sludging.
2. Valve bits. These have a valve inside (a foot valve).

Normally drilling starts with a valve bit and pulling the drill pipe up and down with the rope, 1 stroke per 2 seconds. 10 Strokes in the left pit, 2 strokes in the right pit, (seen from driller side). At all times, keep the hole filled with liquid. Add liquid as soon as the level in the hole goes down.

The drilling liquid with soil from the bottom of the borehole splashes out on top of the drilling pipe each time the pipe with drill bit is released.



## 7.3 Drilling with a hand valve (hand sludging)

Gravel of 2 to 3 cm will not pass the foot valve, in that case use an open drill bit. Use your hand is used to close the drill pipe at the top which functions as a valve. It closes the drilling pipe when the pipe is lifted and opens when the pipe is dropped down. The hand must direct the splashing drill fluid into the sink pits.

With hand sludging the driller feels if the fluid contains only clay, sand or gravel.



## 7.4 Jetting

The SHIPO drill method can also be combined with an engine pumps for jetting.

With jetting open drill bits are needed. The drill pipe is connected to the engine pump with the pressure hose. The suction side of the pump sucks drilling liquid through the suction hose from the second sink pit.



## 7.5 Connecting and disconnecting the drill pipes

To connect or disconnect drill pipes, lift the pipes by hand or pipe wrench and let the coupling rest on the drill pipe support. Connect or disconnect the top pipe with two pipe wrenches. **Make sure that the pipe is straight when connecting a new pipe!** This to avoid damage on the thread.

Always ensure that the lower drilling pipe is secured by the Drill pipe support and someone who holds the pipe for extra safety!



### Special attention when using a foot valve

When removing a pipe be careful since the drill pipes are filled with liquid due to the valve at the bottom. So remove the pipe very slowly and cover the connection if you do not want to be “Baptised”. In case drill pipes of 3 meter length are used the drill pipe of 1.5 meter length and the pipes with 3 m length are changed each time. After drilling 1.5 meter: take of the 1.5 meter pipe and replace by a 3 meter pipe. When all drill pipes have a length of 1.5 meters drill pipes just can be added. Drill pipes of 1.5 meters are a bit more costly but will reduce the time of changing drill pipes. Continue drilling until you at the right depth (see chapter 8 Finalizing a borehole).

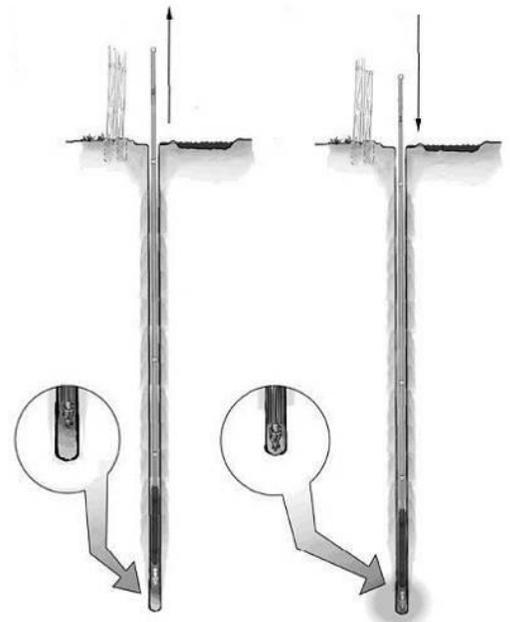
## 7.6 Flushing. Pause or stop drilling

When you want to stop drilling the pipes and borehole have to be “cleaned” by flushing, this to avoid that clay, sand will settle in the drill pipe and the borehole. Do this every time the drilling is interrupted for more than 5 minutes and certainly at the end of the working day.

Flushing is also needed in heavy clay when the drill liquid becomes too thick, in this case pump some drill fluid away and add water.

A good driller feels when the liquid becomes too heavy. It can be determined by the volume of water squirting out, which decreases with heavier sludge. The driller instructs the pullers to “flush”. This is moving the drill pipes up and down without touching the bottom of the borehole.

When you stop drilling and flushing; lift the drill pipes and hang them on the tripod.



**Attention!! The borehole should always remain full with drilling liquid otherwise it might collapse.**

## 8 Finalizing a borehole

Finalizing a borehole makes the difference between a good and a bad borehole.

Watch the video: <https://vimeo.com/channels/921629>



This chapter describes:

- 1 How deep should we drill?
- 2 How to make the casing and filter screen?
- 3 Backwashing the borehole.
- 4 Testing the borehole.
- 5 Installing the gravel pack and sanitary seal.

There are so many details in the finalization of a borehole that it is not possible to describe them all in this manual. Therefore we highly recommend to get trained by a SMART Centre to avoid errors and to learn the best way of finalizing the borehole. Training is an essential part of having a hygienic, user friendly and proper working borehole.

**Make sure the borehole is always full of water until the casing pipe is installed and backwashed!**

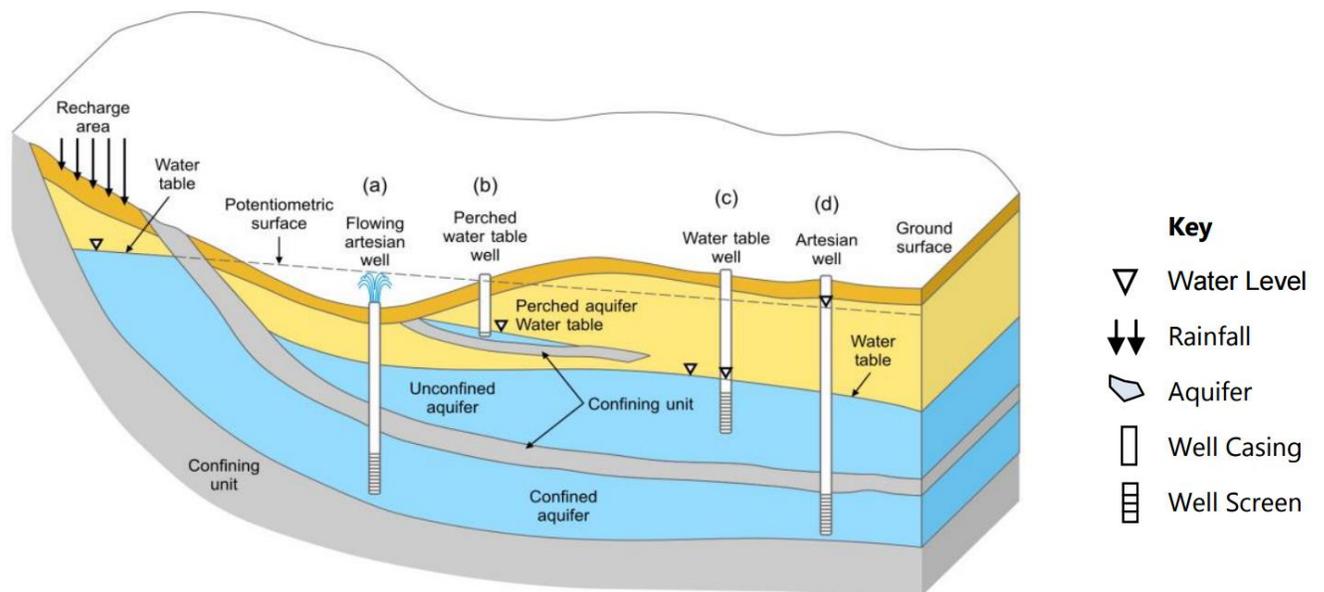
## 8.1 How deep should you drill?

The final drilling depth is reached when you think you are deep enough in a water bearing ground layer (aquifer). In general this is 4-6 meter in a water layer but more is better. There might be more than one water layer on top of each other. Deeper water layers usually provide better water quality so if possible; try to reach a second water layer. Indicators of reaching water layer can be:

- the level of drill liquid in the borehole suddenly drops fast (a sign of reaching a sand layer),
- the drilling liquid suddenly becomes more fluid (less thick),
- the drilling liquid suddenly becomes cooler,
- sand or small gravel comes up (these materials are "permeable" meaning they allow water storage).

With these indicators you know where a water layer starts. Note this in your drill log.

Drill deeper until you hit the next clay or loam or rock layer. Go as deep as possible but try at least to drill 3 to 6 meters.



*a = borehole in second water layer. Sometimes this is water under pressure (a confined aquifer) so water rises in the borehole. Sometimes the pressure is so high that water comes out itself (a spring).*

*b, c = well or borehole in first water layer.*

*d = borehole in a first or second water layer needs a good hygienic seal. With a second water layer the seal is between the 1st and 2nd water layer.*

**Attention:** if you reach a second or deeper water layer you need to make a hygienic seal (see below) to prevent that water from the first water layer, that may be contaminated, can leak along the casing pipe into the second water layer and so contaminate this water layer!

## 8.2 Casing pipe

Make sure that before you finish the drilling: have a filter screen ready!

### Making the filter screen

When the borehole is ready a casing should be installed. The casing is necessary to prevent dirt coming into the borehole and prevent the borehole from collapsing. The lower part of the casing (PVC-pipe) is a filter screen with slots to let water in but prevent soil particles to enter the borehole. With a drilling log we know where and how deep the aquifer is and therefore we know how many metres of filter screen are necessary and where to place it.

*In the example the water layer we want to tap water from starts at 15 meter down to 21.5 meter.*

Although carefully taken, the exact depth of soil samples might not always be accurate. To avoid material from entering, it is wise to make a gravel pack until 1 meter above the level of a water layer. In the situation as described in the drilling log here, the filter screen was placed from 21.5 to 16 meters, leaving a 1 meter margin of gravel pack.

Often it is possible to buy a pre-fabricated filter screen of 4 inch. You can also make a filter screen yourself by cutting slots every 12 mm in an angle of 45° on 3 sides of the casing pipe. Watch out not to cut the slots to long (60 mm for a 4 inch casing) because this will weaken the casing. Make slots as small as possible, using a used hacksaw blade and carefully hammering the teeth a bit flat.

Drawing	Depth (meter)	Description of the formation	hard / soft fine / coarse	Color(s) of the sample
PVC pipe Back-fill Formation type	1	Sand	fine	yellow/brown
	2	Sand	fine	yellow/brown
	3	Sand	fine	yellow/brown
	4	Sand	fine	yellow/brown
	5	Sand	fine	yellow/brown
	6	Sand	fine	yellow/brown
	7	Sandy Clay	.....	brown
	8	Sandy Clay	.....	brown
	8.5	Sandy Clay	.....	brown
	9	Clay	compact	grey
	10	Clay	compact	grey
	11	Clay	compact	grey
	12	Clay	compact	grey
	13	Clay	compact	grey
	14	Clay	compact	grey
	15	Sand	coarse	yellow
	16	Sand	coarse	yellow
	17	Sand	coarse	yellow
	18	Sand	coarse	yellow
	19	Sand	coarse	yellow
	20	Sand	coarse	yellow
	21	Sand	coarse	yellow
	21.5	Sand	coarse	yellow
22	Sandy Clay	.....	grey/brown	
23	Sandy Clay	.....	grey/brown	



*A pre-fabricated filter screen*

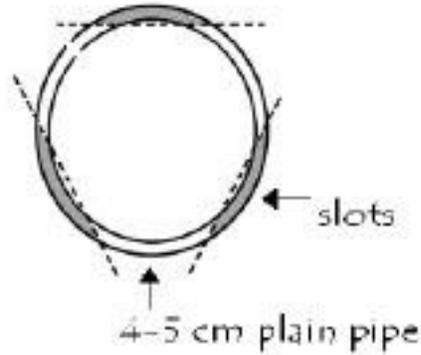


*Making slots with a hack saw under 45 degrees*

In case of very fine sand in the aquifer, mount a filter cloth around filter screen (e.g. fine woven wheat bag).



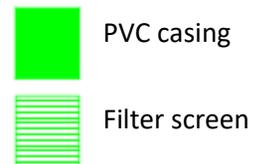
A folded bottom end of the casing



The bottom end of the filter screen pipe should be closed by making 4 - 6 cuts in the bottom part of the pipe and heat the pipe end. Fold the parts together and allow the parts to cool.

Fill the log-form with the casing pipe details:

Drilling log					
Drawing		Depth (meter)	Description of the formation	hard / soft fine / coarse	Color(s) of the sample
PVC pipe	Back-fill	Formation type			
		1	Sand	fine	yellow/brown
		2	Sand	fine	yellow/brown
		3	Sand	fine	yellow/brown
		4	Sand	fine	yellow/brown
		5	Sand	fine	yellow/brown
		6	Sand	fine	yellow/brown
		7	Sandy Clay	.....	brown
		8	Sandy Clay	.....	brown
		8.5	Sandy Clay	.....	brown
		9	Clay	compact	grey
		10	Clay	compact	grey
		11	Clay	compact	grey
		12	Clay	compact	grey
		13	Clay	compact	grey
		14	Clay	compact	grey
		15	Sand	coarse	yellow
		16	Sand	coarse	yellow
		17	Sand	coarse	yellow
		18	Sand	coarse	yellow
		19	Sand	coarse	yellow
		20	Sand	coarse	yellow
		21	Sand	coarse	yellow
		21.5	Sand	coarse	yellow
22	Sandy Clay	.....	grey/brown		
23	Sandy Clay	.....	grey/brown		



## 8.2.1 Installing the casing

The diameter of the PVC-casing depends on the type of pump your customer wants:

- If your customer wants to install a submersible pump (later) then the casing should be 110 mm (4").
- If you customer wants an EMAS pump the casing can be even 50mm (1 ½").
- If the customer wants a rope pump then the diameter of the casing pipe depends on the pump pipe diameter and therefore depends on the water table:
  - 0-10 meters: pump pipe 1 inch, casing = 110mm (4"), wall thickness 3 mm or more.
  - 10-20 metres: pump pipe ¾ inch, casing = 75mm (2.5"), wall thickness 2.5 mm.
  - 20- 40 meters: pump pipe ½ inch, casing = 60mm (2"), wall thickness 2 mm or more, inside diameter of 55 mm).

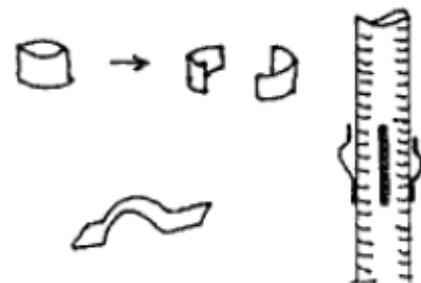
Some thick-walled PVC-casings have a thread, others have a socket that fit around the next pipe. If it doesn't fit exactly or if the tube has no socket, a new socket should be made.



Lengths of casing (normally 6 meter) are glued together until the casing reaches the bottom. Use PVC-glue that dries up fast so you can lower the casing directly if you have glued a length on top of the other. Eventually you can lower the PVC pipes into the borehole with using a rope (see picture) with a self closing loop. The rope is used to prevent the casing slipping into the borehole while adding a new length of pipe. Take notice of having 0.5 - 1 meter of casing above ground level.



To prevent the slots of the filter screen from becoming blocked with clay due to scraping against the borehole shaft, the filter screen and casing should be centralized. Centralizing the casing in the borehole will also allow the gravel pack to settle equally around the screen, leaving at least 1 inch of gravel all around the filter screen. Centralization can be reached by attaching spacer parts made of PVC strips, which can be attached on 4 sides around the filter screen (see picture).



## 8.3 Backwashing the borehole

After the casing is installed, the borehole should be backwashed to remove the drilling mud.

You can use the engine pump to pump clean water into the casing pipe and wash the borehole under pressure. Seal the hose and the pipe as good as possible.

The backwashing can also be done by hand by putting an extra pipe of one meter on the installed casing to create some extra pressure during backwashing. Backwash by pouring water into the casing pipe until the water coming up besides the casing is relatively clean. If the added water does not go down, it could indicate blockage of the filter screen slots. The filter screen can be unclogged by using a 'swabbing tool' which is moved up and down in the casing (up = fast, down = slow). This will create a shock wave in the water. Repeat swabbing until the water directly flows away when added. Continue backwashing until the water coming out of the borehole is relatively clean. Only then the gravel pack can be installed.

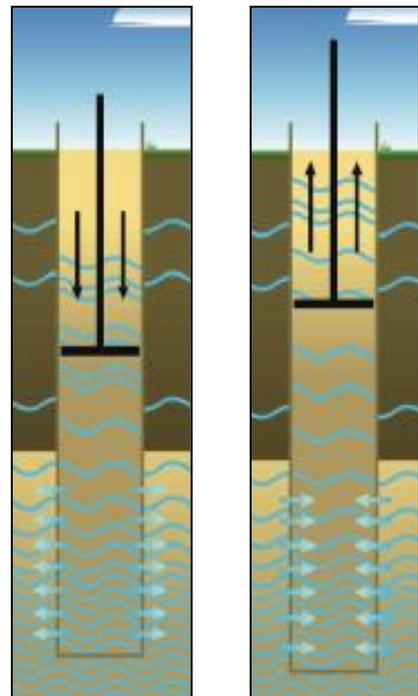
The swabbing tool exists of plastic ring and a rubber flap connected to a rod or pipe. The tool fits exactly in the casing and acts like a plunger. It can also be combined with the rope pump, with the advantage that dirty water can directly be pumped out. In that case, attach the disc and flap to the guide box. Install the it and pump a while. Loosen the rope on the wheel, move the pump pipe up and down, connect the rope and pump again. Repeat this as often as needed to get a good and clean water flow.



*The swabbing tool attached to a guide*



*Water goes in and comes out*



*The up stroke and down stroke*

## 8.4 Testing the borehole

After installation and backwashing we need to test if the borehole gives enough water. For a hand pump the yield should be at least 360 litres per hour but depends on the expected use and purpose. In general ask the customer before making the borehole what pumps he wants to install. If for instance it is a submersible pump the casing diameter should be big enough and the capacity of the well should be more than the capacity of the submersible pump. It is important to test if the borehole can meet the demands before finishing the borehole with a concrete slab, soak pit, etc.

Testing the yield (the well capacity) can be done by installing a rope pump temporary for instance by using a prefabricated well slab or using planks and bags of sand as a weight to stabilize the pump during pumping.



*First testing before final installation*



*Using planks to stabilize the pump during testing*

During drilling, the pressure of the drill fluid will avoid that the borehole will collapse. But during testing the water is pumped out so there is no more pressure and there is a danger of collapsing. In sandy layers it is therefore important to install the gravel pack around the filter screen before testing in order to avoid collapsing (no sanitary seal yet).

Sometimes there is not a clear sandy layer but the water layer is sandy clay (loam) layer. This in general is not a good aquifer. If there is not a clear sandy or stony layer and you still want to test the well capacity, do a pump test without installing the gravel pack first. In case the borehole does not give any or not enough water, you than can take out the casing, so the casing is not lost.

## 8.5 Gravel pack

The functions of a gravel pack are:

1. Filling the space between the borehole wall and the filter screen and so prevent collapsing.
2. Avoid clogging of the filter screen by dirt and avoid that fine clay/ sand particles enter the borehole.
3. Create some storage.

The gravel consists of a small stones (1- 5 mm) but in general just larger than the slot size of the filter screen. Gravel can often be found in river beds or lake shores. Use a sieve to select the right size of the gravel. Move the casing during filling from side to side to guarantee an easy passage for the gravel down to the filter screen.

Pour in the gravel slowly to avoid that the gravel gets stuck at the wrong level. Measure continuously the level of the gravel pack and stop according to the drilling log (to 1-2 meter above the top of the filter screen).



Sieve river sand for gravel pack



Pouring the gravel pack around the casing

Drilling log					
Drawing	Depth (meter)	Description of the formation	hard / soft fine / coarse	Color(s) of the sample	
PVC pipe	Back-fill	Formation type			
	1	Sand	fine	yellow/brown	
	2	Sand	fine	yellow/brown	
	3	Sand	fine	yellow/brown	
	4	Sand	fine	yellow/brown	
	5	Sand	fine	yellow/brown	
	6	Sand	fine	yellow/brown	
	7	Sandy Clay	.....	brown	
	8	Sandy Clay	.....	brown	
	8.5	Sandy Clay	.....	brown	
	9	Clay	compact	grey	
	10	Clay	compact	grey	
	11	Clay	compact	grey	
	12	Clay	compact	grey	
	13	Clay	compact	grey	
	14	Clay	compact	grey	
	15	Sand	coarse	yellow	
	16	Sand	coarse	yellow	
	17	Sand	coarse	yellow	
	18	Sand	coarse	yellow	
	19	Sand	coarse	yellow	
	20	Sand	coarse	yellow	
	21	Sand	coarse	yellow	
	21.5	Sand	coarse	yellow	
22	Sandy Clay	.....	grey/brown		
23	Sandy Clay	.....	grey/brown		

### Gravel pack length

The gravel pack will shrink when the borehole is in use so make sure it covers 1 or 2 extra meters above the filter screen. Check your log-form.

The gravel or coarse sand used in a gravel pack should **not** contain powder or very fine sand that can pass the slots.

## 8.6 Hygienic seal

It is essential to install a hygienic (sanitary) seal to make sure there is no contamination from either the surface or from an above laying (first) aquifer.

The hygienic seal consist of:

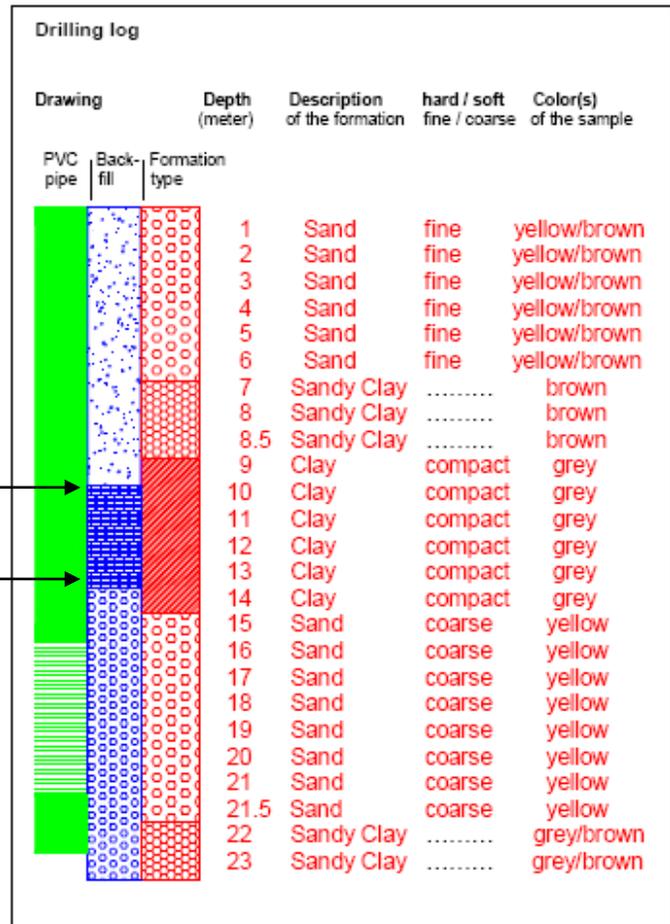
- 1 Two metres or more clay on top of the gravel pack to prevent any contamination of material from penetrating the gravel pack.
- 2 Then sand or loam or clay whatever is available.
- 3 The last meter at the top fill up with concrete or clay the drilling log.

Always pour in the material slowly, while moving the casing to prevent bridging of the material. If the borehole is into the first water layer (shallow) then the hygienic seal can be part of the apron (see manual pump installation).

*In this example the borehole is using water from the second water layer (in this case under 15 meters).*

*The first water layer (7 to 8.5 meters) has to be sealed off by a hygienic seal.*

Don't forget to complete the drill log with back filling data.



*Filled to the top with soil*

## 9 Problem solving

### **“How do I know where to start drilling?”**

See above and the manual “Site selection”. Talk to the people in village and ask their experiences with boreholes, wells and water tables. Look for open wells to determine the depth of water and type of soil. Look for specific vegetation and slopes of the land. If you are comfortable, use the divining technique yourselves or ask people experienced in this.

### **“How do I know my drilling fluid is right?”**

There is no one best solution. When the soil has clay, you only need to add a little bit of clay. In loam and sandy soils in general one bucket of clay for each three meter of drilling is needed. Do a test with your finger. Some liquid/mud should stick to your finger. If the fluid is too thick, there is no time for small clay particles to settle in the sink pit so in thick clay layers you may have to dilute the drill fluid. If the drill fluid is too thin, (too much water) it will not lift sand or gravel. In this case add clay or material. If you are drilling in sandy soil but no sand comes up add clay or other material.

### **“The soil is too hard.”**

In hard soils start drilling with a small drill bit of 2.5 inch. For softer soils the larger drill bits can be used of 4 to 6 inch.

### **“No drill fluid comes out of the outlet”**

Possibly your foot valve or drilling pipes are clogged. Try hand sludging by closing the outlet sprout with your hand with the up going stroke.

If this does not work take out the pipes and clean the pipes and drill bit. After cleaning dilute the drilling fluid a bit and flush (wash) frequently during drilling. Make sure the drill is not broken. Another cause may be that the bottom valve is not closing, so mount another drill bit.



### **“I don’t make progress the drill pipe does not go deeper”**

There may be several causes like:

- 1 Hard soils such as tuff stone and sandstone. You may connect a second heavy drill pipe to give more force on the drill bit.
- 2 A blunt drill bit. If so, mount another and sharp drill bit. With new tungsten tips, the drill bits hardly wear out anymore.
- 3 A compact sand layer and the hole is caving so sand comes out but the drill does not go deeper. In this case, add clay and make the fluid as thick as possible.
- 4 A gravel layer. Use an open drill bit and drill by sludging.

### **“There are stones and boulders in the borehole”**

Bouncing of the drill pipe and practically no drilling material coming out often indicates to the presence of stones or boulders. Experienced drillers can hear this from the sound made by the falling pipe. In such cases, a smaller drill bit can be tried or a heavy pipe with a few teeth to crush the stones. If it is a real hard layer and you did not reach your aquifer yet, try another site.

### **“My bore hole is caving!”**

This should be avoided at all times. Add thick drill fluid as soon as you see the water level in the borehole going down fast. Therefore always have 3 buckets with thick drill liquid ready for immediate use. In sandy layers there is an extra danger of caving of the well especially with jetting. To prevent this, add extra clay. In case of leakage, e.g. an ant hole, mix the fluid with grass or other material of 1 cm.

### **“The borehole is collapsing”**

Avoid this. Make sure the hole is always full of water, also during the night! If the borehole collapses during drilling, make sure that you get your drilling equipment out of the bore hole as soon as possible and remove the collapsed soil with the normal drilling method afterwards.

**Avoid problems:** prepare, keep the equipment in shape, have the drilling site organized, know what you are doing.

### **“The drill pipe is stuck”**

This can be caused by.

- 1 Blunt drill bits. Always use sharp drill bits with the sharp points outside.
- 2 Collapsing of the well. See above.
- 3 Drill pipe stuck because it stayed in the well too long so the drill mud has settled. Put maximum tension to pull up the drill pipe and hammer on the pipe with a hammer. The vibration may loosen the drill pipe. If there is an open drill bit you can try to connect an engine pump to inject water with pressure. In all case try to get out the drill pipe as soon as possible.

### **Breaking of drill pipes**

If this happens, use the fishing tool immediately and lift the pipe. Waiting will give the sediments time to settle at the bottom of the bore hole and it will difficult to remove the parts.

### **“How do I know I reached water?”**

Also this is experience. In general water is found in sandy layers and indications of a water layer is much sand in liquid, fast drilling, lower temperature of the liquid. If the sand layer is short (1 -2 meters) in general the aquifer is not enough so continue drilling until you hit a next water layer. See above.

### **What should be the length of the filter screen?**

Normally you want to make the filter screen as long as possible and ranges between 3 and 9 meters.

### **“There is no water coming out of the bore hole!”**

If after a first pump test there is no or not enough water coming out, try to drill deeper. It depends on the type of soil if water will enter in the bore hole. In clay layers is no water. Normally sand or gravel is the best soil type for water. For water- and ground layers, see also manual on site selection

### **How do I maintain my drilling equipment?**

The maintenance of the equipment mainly consists of cleaning the thread ends after every movement with a spray bottle (a PET bottle with a small hole in the cap). Always mount a protection socket. If you store pipes for a longer time put some oil on steels sockets and metal threads. Weld and/or sharpen the drill bits after each drilling.

- Cleaning of the metal threads is done with a steel brush. After cleaning the threads are oiled.
- All teeth from the drill bits are sharpened with an angle grinder.
- Inspect pulley, rope, fish tools, wrenches and other tools needed.