ST 1.2.1 SHIPO DRILLING

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Disclaimer

This manual is part of the main manual, named “ST 1 Wells”. Other manuals in this range are:

- ST 1.1 Geology and Site Selection;
- ST 1.2 Manual drilling;
- ST 1.4 Finalization of the borehole;
- ST 1.5 Hand dug wells;
- ST 1.6 Finalization of a hand dug well;
- ST 1.7 Training of Care takers;
- ST 1.8 Training of Drilling companies.

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Baptist 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 supplied by Connect International. Please feel free and contact Connect International.

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1 Introduction

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

The SHIPO drilling combines sludging, percussion and jetting. It is based on the Baptist drilling technique named after the Baptist Missionary, Mr Terry Waller who invented this technique. See also www.waterforallinternational.org. Like the Rota sludge: this technique uses sharp drill bits to loosen the soil and drilling liquid to lift the particles.

This method is limited to non cemented, sedimentary deposits of sand and clay, and will not drill through solid bed rock. Some soft rock can be drilled slowly. For gravel or stones from 1 to 3 cm an open bit can be used combined with sludging. A mayor difference compared to other techniques as the Rota Sludge is that this technique uses 1 ¼” PVC pipes on top of the lower steel drill pipe. Therefore this option is very light and can drill down to 80 meters deep. With the Baptist method, world wide more than 2500 wells have been drilled.

Materials and tools needed for drilling. Spade, Hacksaw, Wrenches, Rope and pulley, Plastic Pipes, Steel drill pipe, Drill bits for different groundlayers, Reamer bits, Fish tools, Soil punch.
2 How it works

The lower drill pipe is a 1 ¼" heavy steel pipe. The weight of the lower drill pipe is increased by welding a 1 ½" pipe around it. At the bottom there is a dart drill bit which opens at the down stroke and closes at the upstroke. The borehole is made by percussion by moving the drill pipe up and down with a rope and a pulley. The borehole is kept full with drilling fluid, water mixed with bentonite, okra, fine clay or organic matter (for instance cow dung). This material increases the consistency of the water which is needed to lift the cuttings and to seal the bore wall from collapsing and to prevent water loss.

The drilling team consists of the following people:

- The driller: who controls the water flow and pipe stroke and coordinates the team;
- The pulling operators which are pulling the drill pipe up and down (minimal 4 people, more if available).

On the down stroke the valve will open, the dart bit valve hits the bottom and loosens the soil, which mixes with the drilling liquid and passes the open valve. On the up stroke, a valve will close, drawing up the water through the pipe and transporting the cuttings to the surface where it is pumped into the left sink pit. In this pit, the first cuttings settle down, and more settling is in the right sink pit. During drilling the drill pipe is turned from left to right, 10 strokes in the left pit and 2 in the right pit. This to give the heavy parts time to settle. The “clean” drilling fluid overflows from the right pit back into the well. This results in a continuous removal of cuttings. As the drilling progresses, pipes of 1.5 and 3 meter are added.
3 The material and tools for drilling

- 9 Drill pipes of 3 meters (PVC);
- 1 Drill pipe of 1.5 meter (PVC);
- 1 Heavy drill pipe of 3 meters (steel);
- Connecting sockets.

- 2 Poles of 4.2 meters (pole support);
- 2 poles of 4 meter to support poles
- 1 Poles of 2.5 meters (derrick)

- Drill bits including reamer bit
- 2 Pipe wrenches, 2 inches
- 1 Outlet sprout
- 1 Pulley (3 – 5 inch)
• 40 Kg Bentonite or 80 kilogram of fine clay or 4 bags of cow dung;
• 2-3 buckets to mix the drilling fluid.

• 2-3 drums of 200 litres with water;
• A shovel to dig and clean the sink pits.

• A soil punch

• 20 - 50 meters of rope (12 mm)
  (Length is depth of borehole plus 10 meter)
• Rubber strips to attach pole support.
4  Drilling step by step

4.1  Setting up the drilling site and start drilling

1. Make holes for 2 poles with a (self made) soil punch. Each hole should be 1 meter deep. Distance between the holes is 2 meters.

2. Prepare two poles with notch, length 4.2 meters and place them in the holes. Height of notch should be 3.2 meters above ground level. Use support poles to increase the stability of the poles.

3. Place the derrick, pulley and rope. Make sure that the wind direction is behind the driller to avoid splash water coming into the face of the driller.

4. Make a start hole between the poles of 2 meters deep, with the soil punch. The start hole should be 30 cm in front of the centreline of the poles (see step 5). If you are pulling the rope should be exactly above the starting hole to ensure a straight drilling hole.
Prepare drilling fluid by filling a bucket for 1/3 rd with clay or other drilling material, and 1/3 rd of water. Stir well. Make sure clay is dissolved well!

Make 2 sink pits of 30 cm deep in front of start hole. Make the sides with an 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

Pour concentrated fluid in the settling pits. Add water until the right mixture is reached and the pits and bore hole are filled.

Mount the 2” drill bit and sprout to the steel drill pipe and place them in the starting hole.
In hard soils the hole should be first drilled with the 2 inch bit. For softer soils the reamer bit can be mounted after the first 3 meters and a borehole of 4 to 6 inch can be drilled depending diameter of the reamer bit. In case of clogging close the outlet sprout with your hand on the up stroke to create vacuum. (Sludge method)

If you stop drilling for a break or to exchange the drilling pipes, always lift the drilling pipes and hang them with the sprout at the horizontal beam. Otherwise the particles will settle around the drill bit which than may get stuck.

To know the different ground layers, keep a drilling log by collecting a sample every meter. (Put bucket in left pit and pump 10 strokes.). More information on ground layers and sampling soil, in the manual ST 1.1 Geology and Site Selection.

Start drilling by pulling the pipe up and down with the rope, 1 stroke per 1.5 second. 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.
4.2 Connecting and disconnecting the drill pipes

Lift the pipes and hold with hands or a pipe wrench just beneath socket. Connect or disconnect the top pipe. **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 a wrench and someone who holds the pipe for extra safety!

To hold the pipe with a wrench, put a piece of wood and let the pipe. When removing a pipe, be careful since the top pipe is 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 “Baptisted”.

Each time .1.5 meter pipe length is added.
First mount a 1.5 m pipe. After drilling 1.5 meter, take of the 1.5 meter pipe and replace by a 3 meter pipe. Etc.
Continue drilling until you at the right depth.
See also manual ST 1.1 Well criteria

When the borehole is deep enough:
1. Start washing the borehole by adding clean water
2. Make sure borehole stays full with water all the time to avoid collapsing
3. Remove the drill pipes and directly install filter screen and casing.
For more details see the manual "ST 1.6 Finalization of borehole".
4.3 Flushing the well for temporary stops

Before stopping with drilling the pipes have to be cleaned by flushing. This should take place every time the drilling is interrupted. An interruption is considered to be a pause of longer than 10 minutes. Thus certainly at the end of the working day, but also for example, when connecting a new drilling pipe. Flushing prevents the that the particles in the drilling liquid sink to the bottom and clog the pipe of valve. It may also be necessary to flush in between times. Flushing is also needed when the drill liquid becomes to thick or to heavy.

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 lever operators to “Wash” This is moving the drill pipes up and down without touching the bottom of the borehole.
5 Problem solving

“How do I know where to start drilling?”
See the Connect International-manual “ST 1.1” about site selection. Talk to the people in village and ask about their experiences with bore holes, wells and water tables. Look for open wells to determine the depth of water and type of soil. It can give you an indication about the water- and ground layers (although this can change within a few meters). Look for specific vegetation and slopes of the land. If you are comfortable, use the divining technique.

“How do I know my drilling fluid is all right?”
There is no general rule for the best solution. If the soils has clay, only little other clay or dung is needed. In loam and sandy soils in general one bucket of cow dung for each three meter of drilling. Do a finger test. Some liquid should stick to your finger. If the fluid is to thick, there is no time for the particles to settle in the sink pit. If it is to thin, the drilling fluid has not the capacity of lifting the heavy particles. To test this, fill up a bucket with the outflow of 3 strokes, leave for 20 seconds to see amount and type of settlings. If there are no settlings, add clay or cow dung.

“No sludge comes out of the pipe!”
Possibly your drilling pipes are clogged. Try washing and 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 drill bit. After cleaning dilute the drilling fluid a bit and flush (wash) frequently during drilling. Makes sure the drill is not broken. Another cause maybe that the bottom valve is not closing, (a new drill bit has to settle).

“I don’t make progress during drilling!”
There maybe several causes. In hard compact ground such as tuff stone and sandstone, it may be necessary to connect a second heavy drill pipe (you always start with the steel pipe that is connect to the drill bit). This will give more pressure on the drill bit. It is also possible that the drill bit is blunt so check the drill bit. Other causes maybe hitting a gravel or stone layer. In that case install open drill bit and drill by sludging. It is also possible that your drilling fluid is to thin.

“I find stones and boulders during drilling!”
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. Add a heavy steel drill pipe. (A 1 ½” pipe welded around the 1 ¼” 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 to use the stone hammer (see manual ….). Use a stone drill bit.
“My bore hole collapsed!”

In most cases this can be avoided by adding clay or cow dung as soon as the water level goes down in the borehole. Therefore always mix 2 buckets and keep them ready for immediate use. In sandy layers there is an extra danger of collapsing of the well especially with a high drilling speed. To prevent this, extra cow dung is added increasing volumes for instance one bucket of dung per 3 metre to one bucket per metre. In case of the big leakage, such as an ant hole, mix the liquid with grass or other material of 1 to 2 cm. Make sure the hole is always full of water, also during the night! Clay or cow dung must be added as soon as water loss is observed. If your bore hole collapses during drilling, make sure that you get your drilling equipment out of the well as soon as possible and remove the collapse soil with the normal drilling method afterwards.

Avoid problems!

Keep the equipment in shape, have the drilling site organized, know what you are doing, be up to date

Loosing tools/ breaking of pipes

If this happens, use the fishing tools for fishing them. Waiting too long will give the sediments time to settle our the drilling bit at the bottom of the bore hole and it will be much more difficult to remove the parts. See the paragraph about the fishing tools in this manual.

“How do I know I reached water?”

Also this is really experience. In general water is found in sandy layers. See also the manual..... Normally you want to make the filter screen as long as possible. This means you continue drilling after you enter in the water bearing layer (sand) until you hit the next clay, or stone layer)

“There is no water coming out of my bore hole!”

Try to continue drilling as much as possible to make the borehole in the aquifer as deep as possible. It depends on the type of soil if water will enter in the bore hole. In clay layers there is no water. Normally sand or gravel is the best soil type for water. For water- and ground layer, see also manual ...

How do I maintain my drilling equipment

The maintenance of the equipment mainly consists of cleaning the thread ends after every movement with a bottle cleaner( 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..
6  How to construct drilling tools

These are basic drawings and drill bits depend on type of soil.

6.1  Drilling equipment assembled
6.2 Drill bit 2 Inch
6.3 Drill bit with reamer
6.4 Sockets

preparing all the steel sockets

- Cut 4 slots on both pipes
- Mount the socket on a threaded steel pipe and open a bit at the end
- In this way the thread on the plastic pipe will enter completely

6.4 Material list for Baptist drilling equipment

<table>
<thead>
<tr>
<th>Material list Baptist Drill Shipto model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials based on borehole of 36 m deep</td>
</tr>
<tr>
<td>Part</td>
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<tr>
<td>no.</td>
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</tbody>
</table>

* number of pipes and sockets depend on depth of borehole
6.5 Workshop equipment for making drilling equipment and tools

The Baptist drill can be made with standard workshop tools as Welder 150 Amps, with mask welding rods 2.5 mm, steelbrusch, Angle grinder with eye and ear protection, Bench or handrill with drill set, Squares, Measuring tapes, Thread cutter 1 ½”. (Cutter for PVC pipe can be made from a coupling). Hack saw, bench or hand drill, sturdy work bench, strong vice, hammer, files etc.

6.6 Construction sinks pits, bird view
### Drilling, Tools, Drill bits

<table>
<thead>
<tr>
<th>Soil Punch made of 2 m ¾&quot; pipe and 2 inch pipe</th>
<th>Point reinforced with a piece of old file or spring blade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread tool made of a 1 ¼&quot; socket</td>
<td>Piece of 1 ½&quot; pipe welded as guide to make sure the thread is straight</td>
</tr>
<tr>
<td>Fish tools top for the drill bit</td>
<td>Hook made of round bar 6 mm. It should fit with a bit resistance in the PVC Pipe</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lower for the PVC pipe</td>
<td></td>
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</tbody>
</table>

2 Inch drill bit
- Dart bit made of Truck spring blade
- Reducer 1/1/2"-1"
- Valve made of a Bolt 5/8 or M14-70 and a Ring made of Round bar 10 mm
  - Ring is welded to the bolt and than a valve seat is grinded
  - Piece of 2 inch pipe
  - Socket 1 ¼" (not cast iron!! Welding)

Note
Make point of the bit as sharp as possible
If well made the point will sharpen itself in sand, clay and compact clay

Note": inside the reducer an extra ring is welded to make the rim stronger
<table>
<thead>
<tr>
<th>Reamer bit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>This is made with a 2 inch bit and additional teeth of spring blade and a ring of round bar 10 mm or Strip 25 x 3 mm.</td>
<td>The reamer ring is partly open on the top Needed to allow flow of drill fluid.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit for gravel and hard layers. Open bit without valve. The sludge can be pumped up by closing the outlet by hand. (Sludging)</th>
<th>Coupling. Note the 8 cuts on both sides to open the coupling. This to make sure the whole thread is used.</th>
</tr>
</thead>
</table>