

SMART Centres



Simple,
Market based,
Affordable,
Repairable
Technologies

Mzuzu drilling



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This manual is about the use and construction of the Mzuzu drill. This drilling technology is for low cost and shallow wells to be used for small scale irrigation, animal watering and / or domestic uses. If water is used for drinking, make sure that water is treated with a point of use treatment like boiling, chlorine or a good quality household water filter.

Mzuzu drilling has 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. You can contact us at; www.smartcentregroup.com

Videos on the Mzuzu drill at;
<https://youtu.be/PxySOopYwKI>
<https://www.smartcentrezambia.com/highlights/online-training-making-a-mzuzu-drill-set-aug-2016/>

If you have observations or suggestions on this technology please contact us at info@smartcentregroup.com
We intend to update this manual every year.

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2. Introduction

Techniques for drilling wells can be divided into Machine drilling and Manual drilling. Machine drilled wells are called boreholes and are 30 to 100 meters deep or more and in Africa mechanical drilling rigs are imported. Manual drilled wells often are called 'Tube wells'. Manual drilling is less complex than machine drilling but takes more time and is limited to softer ground layers. Manual drilling of which the drilling tools can be produced locally include; Mzuzu drill (drills to 25 meters deep), SHIPO drill (to 50 metres deep), EMAS and Baptist drill (to 80 meters deep). These options can be produced in any African country. They can be made (after proper training) with local materials in metal shops with basic tools like a welding machine and an angle grinder. Compared to digging, the drilling of a well is less dangerous (no danger of collapsing) and can penetrate deeper into the aquifer (water bearing ground layer) so there is less risk of dry wells. Making a hygienic seal for a tube well is also easier and can be cheaper especially if the hand dug well needs a lining and is more than 10 m deep.

In aquifers with a low permeability, hand dug wells maybe more appropriate because of the large storage capacity. (Water can seep in at night and be taken out in the daytime)

The Mzuzu drill was developed by the SMART centre in Mzuzu (Malawi) and combines Augers, a Stone punch and a Tube bailer. The Tube bailer is lightweight and uses a tube (poly pipe) whereas conventional bailers are heavy and use a rope. A Mzuzu drill set cost \$100 to \$300 depending on the depth and number of drill bits. Compared to other technologies, Mzuzu drilling is simple. There is no tripod, drilling mud, sink pit or gravel pack needed so with a short training families themselves can drill a well. It can drill to 25 m deep and penetrate 2 to 6 meters into an aquifer. It can drill in sand, compacted clay and gravel and can crush stones but will not drill through very hard stone layers. This manual is part of a range of SMART Centre manuals. The complete range has manuals like:

Wells&Drilling

- Geology and site selection
- Well digging
- SHIPO drilling
- Mzuzu drilling

Pumps:

- Rope pump model 1 Standard model
- Rope pump model 2 Economy model
- Rope pump model 3 With wood poles
- Rope pump model 4 With 1 pole of Gi pipe
- Pump care-taker training
- EMAS pump
- Solar pumps

Water storage tanks

Groundwater recharge

Irrigation

Water treatment

Workshop skills

Business skills:

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

3. Tools and materials

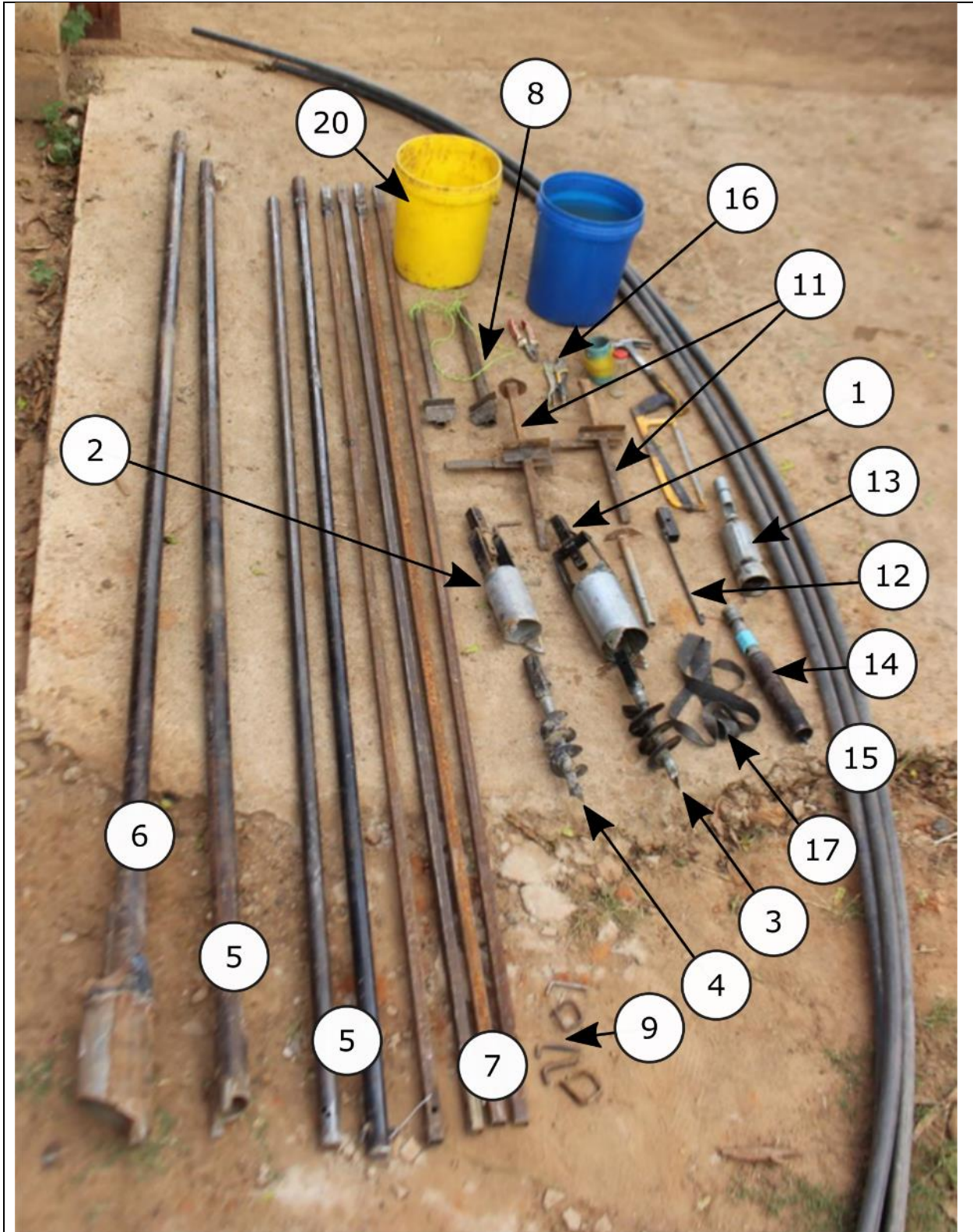


Photo 1. A Mzuzu drill set for 12 m deep wells. A table of parts is listed below.

Table of parts

No	Item	Ot.	Observations
1	Core auger 4 Inch to make holes for 4 inch casings	1	Optional: Eventually spare augers
2	Core auger 3 Inch to make holes for 2 +3 inch casings	1	3 inch can also be written as 3"
3	Spiral auger 4" to make holes for 4" casing	1	
4	Spiral auger 3" to make holes for 2" or 3" casings	1	
5	Stone punch 2" with 2 round extension pipes	1	Or use drill pipes for extension
6	Stone punch 4"		For 4" casings
7	Drill pipes Length 3 meters	6	Number depends on depth
8	Handles	2	
9	Fast fix pins	6	Number depend on depth
10	Foot step (Not in this photo)	1	See photo 5 & construction manual
11	Cleaning pins. No 1 with a pin, No 2 with a plate	2	
12	Fishing tool	1	
13	Tube bailer 3" for a 4" casing	1	
14	Tube bailer 2" for a 3" casing	1	For 2" casing, use bailer of 1.5 "
15	1" or 3/4" Poly pipe (connected to bailer) in metres	15	Or longer for deeper wells
16	Hand tools (Hacksaw, round file, knife, lighter, Vice grip (for foot step) .	1	1 each
17	Rubber strips in kg	1	Made of inner car tube
18	Clay 10 kg	1	Only needed in sandy soils
19	Spade, hoe	1	
20	Buckets of 20 litres. (strong plastic or metal)	3	
21	Drill log, Marker pens (permanent), Duct tape	2	
22	PVC pipe for casing 2" or 3" or 4" plus end cap		Number depend on depth
23	Pump to be installed, 1 bag of cement		

4. Site selection

To select the best site for a tube well see the manual, "Geology and site selection"; in short, criteria are:

- 1 Where the client wants the well. (This may NOT be the best location to find shallow water layers!)
- 2 Use knowledge of people in the area. Look for existing wells and see soil structure, depth of aquifer.
- 3 Find drilling logs of existing boreholes in the area. (Maybe available at a SMART Centre, local authorities, NGOs or drilling companies.)
- 4 Look at landscape, vegetation, anthills, a good indicator can be a gully, a stream or a river.
- 5 Divining. (an ancient method using bended metal wire, wood twigs or other tools to indicate water layers. It is not a scientific technology but is applied in many countries by skilled people)
- 6 VES method. See also website of Jacana SMART centre. www.smartcentrezambia.com
- 7 Where possible, install the well in a sunny place. Sunlight with its UV rays will disinfect the apron.
- 8 Keep distance from latrines or other sources of contamination like waste pits, fuel or oil spills, pesticides or animal waste. Professionals, drillers are responsible to inform clients about this.
- 9 In areas with a slope it is likely that the flow of the groundwater is the same as the slope so it is preferable to construct a well "up-stream" of a latrine.

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. Groundwater in general does not stand still but flows (very slowly) through sand layers or pores and cracks in the underground.

Household water treatment

In general for all shallow wells it is recommended that the **water used for drinking is treated** at the household level by boiling, chlorine or a good quality household water filter. Studies indicate that filters in general are most efficient because of the consistent use.

5. Drilling

Mzuzu drilling starts with a **Core auger** in softer layers or the **Stone punch** in hard / stony layers. If the Core auger does not lift materials or there are loose stones, use the **Spiral auger**. Once the aquifer is reached and the Spiral auger does not lift soil anymore, a casing (PVC pipe with filter screen) is placed in the hole and the well is further deepened with a Tube bailer. The diameter of the auger depends on the casing but in general is 15 to 20 mm more than the diameter of the casing. Note that all Galvanised pipes and most PVC pipes are indicated in inches but a 2 inch PVC pipe is not 50 but 62 mm outside. So:

- For a 2" casing (60mm) use an auger that makes a hole of ca 75 mm
- For a 3" casing (90mm) use an auger that makes a hole of ca 105mm
- For a 4" casing (110mm) use an auger that makes a hole of ca 125 mm

If soil layers are hard, start with a small diameter. Spiral augers can eventually also be used inside the casing pipe. If so, the Spiral augers is at least 10 mm smaller than the inside diameter of the casing pipe.



Photo 2. Left; **Core auger**, 4 inch (4") pipe with inclined teeth to make holes for casings of 4" Middle; **Handles**, to turn the square drill pipes. **Fast fix pin** to connect the drill pipes. Right; **Spiral augers**. A 3" auger to drill a hole for 2 and 3" casings, 4" auger for a 4" casing

5.1 Steps of drilling

Core auger.

- In softer ground layers start with a **Core Auger**. In hard layers start with the **Stone punch**.
- Turn the Core auger **slowly (1 turn per 15 seconds)** to **reduce** wear. Push down while turning.
- In sandy or loose soils add clay and /or 2 cups of water so the material sticks in the auger.
- When the auger has gone down 20 to 30 cm, lift it and empty it, first with the **Cleaning pin 1**, later with **Cleaning pin 2** (photo 3 & 4). Keep on turning in the **same direction** while lifting.
- In case of hard ground layers mount the **Foot step (5)** so a person can step on it to add weight.
- The Footstep can be fixed with a Vice grip or rubber strip underneath the foot step

- When the hole is 2.5 meter deep, connect the 2nd drill pipe, after 5.5 mtr a 3rd pipe etc.
- Connect drill pipes with **Fast fix pins** and secure with a strip of rubber.



Photo 2. Choose the diameter of the auger. In this case a 4 inch auger for a 4 inch casing.



Photo 3. Turn, **very slow and push down**, to the right until the auger is filled up.



Photo 4. Lift the auger with the handles. **Keep on turning to the right while lifting**



Photo 3. Position of cleaning pins, Left pin 1. On the right pin 2 which has a plate



Photo 4. Empty the Auger with pin no 1. If needed with pin no 2



Photo 5. Use Footstep for hard ground layers. Stay close to the drill pipe

- If you go deeper than 6 meters, disconnect the top drill pipe when you lift to empty the auger.
- Don't have more than 6 meter drill pipes in the air, it is dangerous and will bend the pipe.
- Use Core auger as far/deep as possible, until it does not bring up soil, normally when you reach the water layer. Than start with the Spiral auger.



Photo 6. Connecting a new pipe with Fast fix pin. Secure the pin with a rubber strip



Photo 7. To remove the fast fix pin pull the rubber strip.



Photo 8. If the drill pipes are longer than 6 meters, take off the pipes exceeding 6 meters.

Stone punch

For very hard layers, the **Stone punch** can be used. The teeth of this punch should be strong to crush stones, for instance Tungsten tips or other hard material. 4 steps to use the Stone punch;

- Down (push/throw the punch down in the hole)
- Swing (make 2 large circles with the top end of the tool to keep the punch loose)
- Lift (bend knees while lifting to avoid back problems)
- Turn (turn about 90 degrees to keep the hole round. Repeat steps)



Photo 9. Using the Stone punch with the 4 steps. 1 Down, 2 Swing, 3 Lift, 4 Turn



Photo 10. Empty the stone punch with the 2 clean pins



Photo 11. Stone punch with a tungsten tip

- If the soil is dry and falls out of the punch, pour 1 or 2 cups of water in the hole.
- If material does not stick, add water mixed with clay so the sand or stones will stick.
- After 4 to 8 times punching, empty the punch with the **Cleaning pins**.
- The Stone punch can be made longer with extension pipes. Use either the square drill pipes or use round pipes. Round pipes are easier to handle but is an extra investment.
- Go as deep as needed with the Stone punch until you can use the Core or Spiral auger again.

Spiral auger

- The diameter of the **Spiral auger** should be the same as the **Core auger**.
- This auger can have a strip or plates bent upwards to collect more sand/ gravel. See annex 2
- Turn the auger **slowly**, pushing it down or with someone on the Foot step
- Turn as far as possible, then lift the auger. If it can not be lifted, turn it back 0.5 or 1 turn.
- Clean a Spiral auger with the **Cleaning tool** by rotating it **counter-clockwise**.
- Use the Spiral auger until it does not lift material anymore, normally if there is much water. Then install the PVC casing with the filter screen and start bailing.

		
<p>Photo 13. The Cleaning tool for the Spiral auger.</p>	<p>Photo 14. To empty; keep the drill vertical, push the tool to the pipe, turn the drill around.</p>	<p>Photo 15. Stones that can be lifted with a Core auger or Spiral auger</p>

Installation of the filter screen/ casing

See Annex 1 for diameter of casing and how to make filter screen

- When the Spiral auger cannot bring up more soil install the filter screen, socket part down.
- Add, glue new Casing pipes (3 meters or longer) until the filter screen hits the bottom
- Push down the casing as far as possible and cut pipe 1 meter above ground level
- File the rims inside the PVC pipe to avoid that the bailer gets stuck
- Make sure you know the total length of the casing pipes in the ground.
- Mark this total length on the poly pipe of the Tube bailer. For instance use duct tape or rubber strip. In this way you know the position of the bailer when it is inside the casing pipe and you know when the bailer is below the casing pipe.
- Put a weight on the casing pipe and start bailing. Instead of a weight you can also push down.

Type of bailer

- If you use a **Combi bailer** (photos 19 & 20) you can make it a **Closed bailer** by pushing the PVC piece over the hole (and secure it with a rubber strip) or as an **Open bailer**, lifting the PVC piece.
- The Combi bailer has a poly pipe with a diameter (preferable) of 1 Inch
- In case you use a simple **Open bailer** (photo 23) the poly pipe can be ¾ or ½ inch
- The diameter of a bailer should be 10 to 20 mm smaller than the inside diameter of the casing pipe. For instance if the casing pipe is 75mm you can use a bailer of 60 mm.
- To see the progress of the bailer, look at the mark (duct tape) on the poly pipe which indicates the position of the bailer; so you know if it is below the lower end of the casing pipe.




Bailing with a closed bailer

- Move the bailer up and down with fast strokes, 20 cm. Water/sand comes out the poly pipe.
- If the pipe clogs up, try to open it by closing the pipe outlet with your hand when going up (Hand sludge), and open it on the down stroke.

Bailing with an open bailer

- If you use the combi bailer as an **open bailer** or you use a simple **Open bailer** move it up and down in fast strokes of 0.5 meter and push down the casing or hang a weight on the casing pipe. By doing this the sand may come into suspension with water, become fluid, and you may push down the casing pipe 0.5 meter in a few seconds.
- If long fast strokes do not function, move the bailer up and down with **small strokes** of 5 cm. Make 5 strokes, turn the bailer 45% degrees and repeat. Do this about 15 times, lift the bailer.
- Empty the bailer in a bucket with water by moving it up and down in with short strokes. After a few strokes, push up the bottom valve with your finger and water and sand flows out.
- The bailer should be clean before entering in the casing; ensure there is no stone in the valve.
- After removing sand 5 to 10 times from inside the casing, you will create a hole underneath the casing and the casing will go down by pushing it down or by the weight. (photo 24 a. b)

Attention. Do not hammer the PVC pipe, vibrations may compact the soil increasing friction.

		
<p>Photo 16. Install the casing with filter screen</p>	<p>Photo 17. Glue additional pipes. Socket down so the bailer does not get stuck at the rim.</p>	<p>Photo 18. When the casing hits the bottom, push down and cut 1 meter above ground level.</p>

		
<p>Photo 19. Combi bailer as open bailer. The blue piece is a 1"</p>	<p>Photo 20. Combi bailer as closed bailer</p>	<p>Photo 21. Closed bailer (without the PVC piece)</p>
		
<p>Photo 22. Bailing with a Closed bailer; pumping out water and mud. Uses a 1 inch poly pipe</p>	<p>Photo 23. Open bailer connected with a 1/2" poly pipe</p>	<p>Photo 24. Bailing with an Open bailer and pushing down the casing</p>

Casing. Adding casing pipes

- With bailing, the casing goes down. When the casing is at ground level, add a new piece of 1 metre. It should be a convenient height to bail. If you stand on a drum, the pipe can be 1.5 mtr.
- File sharp edges inside the PVC pipes to avoid that the bailer gets stuck
- Repeat these steps until the casing does not go down any deeper in the aquifer. In general this should be at least be 2 meters but more is better.
- Cut casing ca 20 cm above ground level

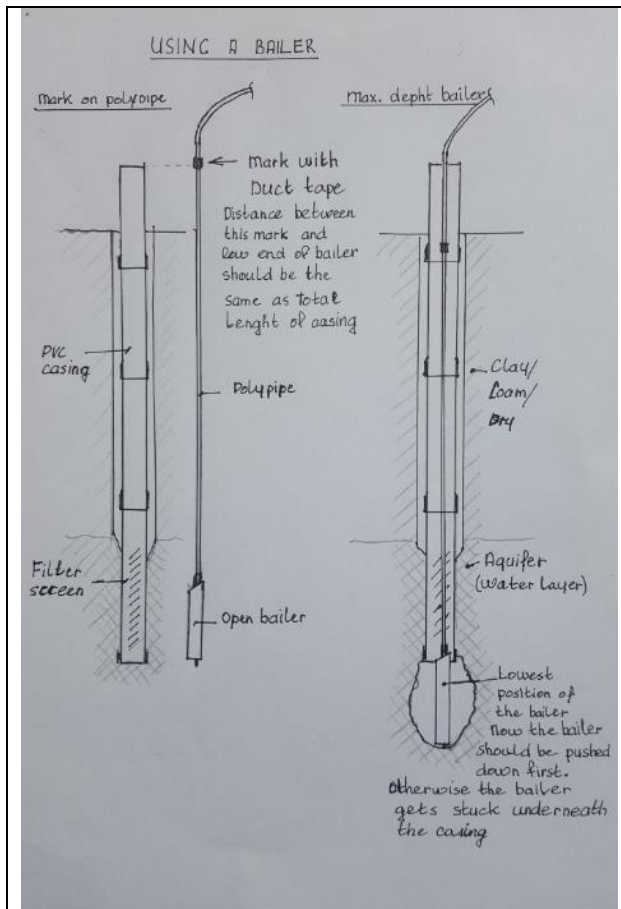


Photo 25. Mark the total length of the casing with duct tape on the poly pipe. Each time you add a PVC pipe, shift the position of the duct tape on the poly pipe

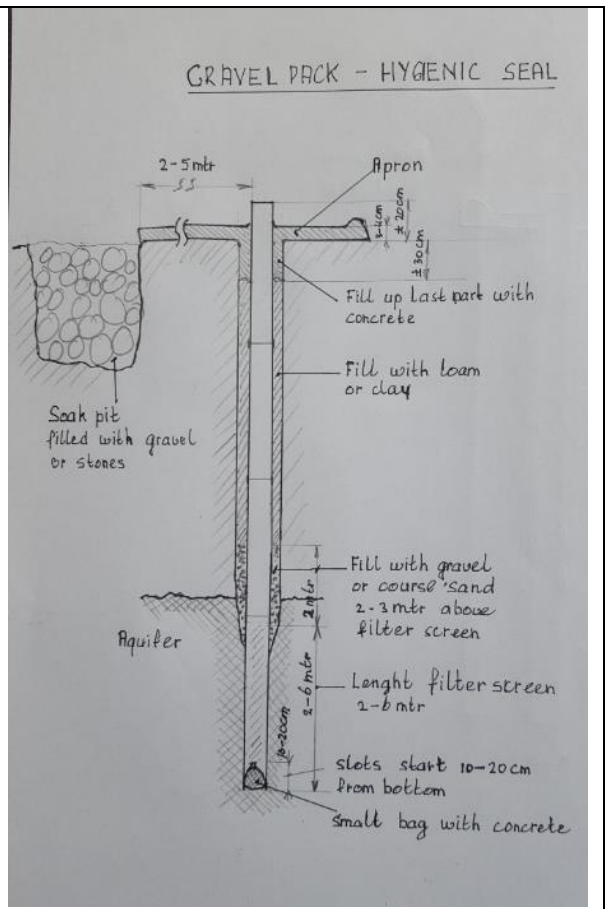


Photo 26. When the casing is as deep as possible, cut 20 cm above ground level. Fill up space around the casing. First gravel or sand, than loam or clay. Finish with concrete. Also make a soakaway and soak pit



Photo 24. Mark poly pipe



Photo 24 b. Weight with metal



Photo 24 C. Weight with sand bags

Gravel pack, Hygienic seal

When the filter screen enters the aquifer (mostly sand) it will collapse against the casing so leaving no or little space for a gravel pack. **This is different from other drilling technologies.** Particles smaller than 1

mm will pass the filter screen, enter in the casing and are pumped up. Particles bigger than 1 mm will stay around the filter screen. It is **important to prevent surface water from flowing** into the aquifer along the casing pipe so install a hygienic seal above the gravel pack. Steps include:

- Fill the space between casing and the hole with sand or small gravel (size 1 to 3 mm) to 2 a 3 meters above the filter screen.
- If the sand from the drilled well is >1mm, you can use that sand or use sand as used for construction, preferably with particles that are bigger than 1 mm (the slots of the filter screen).
- Fill up the remaining space around the casing with clay or loam until some 30 cm below ground level. (This is different from guidelines for boreholes for communal wells). For these guidelines see <https://www.unicef.org/wash/files/04.pdf>
- Fill up the last 30 cm with concrete (1 part cement, 3 parts sand) and make the apron, drain, and soak pit that is filled with gravel or stones (photo 26).

Note; The soakpit is important. It avoids that water stays around the pump; attracting insects etc.

Closing the casing pipe

When drilling is in the last stage, remove sand at the bottom of the casing by making very slow strokes with the bailer. This to avoid sand entering again in the Casing pipe. To avoid sand from entering the casing pipe, close the bottom of the pipe. Steps are.

- Fill a small plastic bag with concrete (1 part cement, 2 parts sand, very little water!!)
- Shape the bag as a “cigar”, make a knot to close the bag and let it drop into the casing.
- Push the bag down softly with the poly pipe of the tube bailer. Be careful not to damage the plastic bag (photo 27).
- Leave the bag with concrete 2 days (to harden). Now the casing bottom end should be closed



Photo 25. Prepare concrete (1 part cement, 2 parts sand) and very little water, so concrete is like clay



Photo 26. Put concrete in a small plastic bag and make a knot. Shape it like a cigar and drop in casing.



Photo 27. Push the bag down gently with the poly pipe. Avoid bag damage! Leave 2 days to cure before starting to pump

Finish the tube well

Make an apron and install a pump - for instance a rope pump model 4 (with 1 leg) or another pump according to the needs of the well owner. In general the hygienic seal, apron and soak away can be made with 1 bag (50Kg) of cement. See Photo 30

Developing the well. Swabbing

When the casing is installed, the well can be developed using a 'swabbing tool'. (See also manual Rope pump model 1 and Photo 32). This tool will open the holes in the filter screen that may have been clogged with clay. The swabbing tool consists of a plastic disc and a rubber flap connected to a pipe, for instance the extensions pipes of the Core auger.

The rubber flap has 1-2 mm clearance within the casing and acts like a plunger. When it is moved up (fast) it closes and creates a vacuum. When moved down (slow) it opens. In case of a rope pump the Swabbing tool can be connected to the guide block and the dirty water can be pumped out.

Swabbing with a rope pump.

- Install the pump with pipes and a swabbing tool mounted on the guide box
- Pump until the water is clear or the well is empty.
- Wait until water flows back into the well, disconnect the rope from the wheel and move the pump pipes up (fast) and down (slow).
- The most efficient stroke is to pull up quickly and push down slowly.
- Reconnect the rope, and again pump out the dirty water.
- Repeat this as often as needed to get a good and clean water flow.



Photo 28
Developing the well. Here a Rope pump model 4 (one leg) installed 15 cm besides the well



Photo 29
Putting concrete in hole and for apron



Photo 30
After pumping and swabbing the water becomes clean



Photo 31 . **Developing the well.** Here a Rope pump model 2 mounted on a prefabricated well cover



Photo 32. **Swabbing tool.** In this case attached to a guide box of a Rope pump

Pump test

When the water from the well is more or less clean you can test the well capacity.

The minimum yield of a well depends on the purpose of the well. An example. If the well is used by 50 people who need 40 litres per person per day, the well capacity should be 2000 litres per day.

Any yield is OK as long as the user is satisfied.

If you want to be sure of the well capacity before finishing the well, do a test before installing the hygienic seal. You can use an engine pump if water level is less than 7 metres, a rope pump model 2 or 4, a solar pump or an electric pump. If you use a hand pump like a rope pump, pump at a high speed to clean the tube well and do this as long as water is dirty. Eventually use a swabbing tool.

If the well does not have enough capacity you can decide to take out the casing and drill at a new location. A pump test with a hand pump goes as follows

- Pump as fast as possible in a bucket and count the liters per minute.
- Do this for 1 hour or more. This will give the information about the well capacity.

Disinfection of the well

It is recommended to disinfect wells before use. For wells with a 2 or 3 inch casing, pour in 1 small bottle of Chlorine. (100 ml). For a 4 inch casing use 2 bottles. Wait 1 day and pump out water until the taste of chlorine has disappeared.

8. Problem solving

“How do I know where to start drilling?”

- See above

The Core auger does not go down

- The drill tips are blunt, sharpen them with welding and grinding
- Soil is hard. Add some water, so the soil becomes softer.
- Soil maybe too hard for a Core auger (volcanic tuff, sandstone, etc.) Than use the Stone punch. If that does not work start another hole

How can I drill in a gravel layer?

- Use a spiral auger and eventually mix with clay

Soil is loose. Sand falls out of the Core auger or Stone punch

- Add some black soil or clay to make the soil sticky

Soil is very wet and can not be lifted by the Core auger

- Start using the Spiral auger

Spiral auger can not be lifted

- Turn back 0.5 turn, if you still can not lift it turn back another 0.5 turn

What to do if the poly pipe of the closed bailer is clogged ?

- Try hand sludging. Add water in the hole to dilute the mud. Close the outlet of the poly pipe with your hand during the up going stroke and opening with the down stroke. If this does not have effect, take out the pipe and clean the bailer and pipe.
- To avoid clogging, flush (wash) frequently during drilling.
- If the closed bailer does not function, use the open bailer

The bailer is empty when it is lifted.

- There may be a stone in the foot valve. Rinse in water and remove the stone

The PVC casing is not going down while the bailer is going down.

- You are digging a hole under the casing pipe. The casing pipe may have to much friction or hit a stone. Continue bailing, make the hole deeper. Eventually the sand will collapse or the stone will fall down. A hole around the filter screen can be positive since it can store water when the well is used.

Note; Do not hammer the pipe! If you do the soil will get between the casing pipe and the hole and create more friction

The Bailer is stuck in the casing pipe.

- Small stones between the bailer and the Casing pipe.
- Add water in the casing pipe. Try small movements up and down and try to push the bailer down.
- By cleaning the bailer more frequently and eventually add water while bailing, the bailer is less likely to get stuck.

The bailer is stuck underneath the Casing pipe

- Try to turn the bailer by turning the poly pipe and pull up
- Do not apply force, you might break the casing pipe or the bailer. Just try frequently moving it down and up again and it may get loose after some time.
- When you manage to get it out, check if the bailer has a tapered , inclined top (Pipe is cut on 30 degrees) If not first adjust the bailer top before using it again.

Auger or bailer stuck in the hole

- If this happens, use the fishing tool or a strong magnet immediately and lift the broken piece.
- Act as fast as possible to avoid that sediments settle on top of the auger or bailer which will make removing more difficult.

How do I know if I am deep enough in the water layer/ aquifer?

- This knowledge comes with experience. Water is found in cracks in stone layers or sandy layers.
- Indications of a water layer is that lifted soil has much water and so difficult to lift with an auger.
- If the sand layer is thin (1 -2 meters) the well capacity may not be enough so continue drilling , maybe you hit a next water layer.

What should be the length of the filter screen?

- This depends on the water layer but ranges from 1.5 to 6 meters.

The well does not provide (enough) water

- The well may not be in a good water layer. In clay layers there is no water, in loam there may be some water. The best water layers consist of sand, gravel or cracks in stony layers.
- Try if swabbing will increase the well capacity. Often after some days of pumping the well capacity increases.
- The filter screen may not be in the right position or not long enough. If you know the “length” of the water layer you can adjust the length of the filter screen. If you do not know make the filter screen 3 meters or more.
- One way to increase the water around a well or borehole is to install a Tube recharge near the well. See also manual on Tube recharge. www.smartcentregroup.com

If it is sure the well does not have water you can try to take out the casing with a lever or a tripod with a pulley and a car. Hammer the casing while lifting. The vibration may loosen the grip of the soil around the casing.

Maintenance the drilling equipment

- Clean the Augers with a spray bottle (PET bottle with a small hole in the cap)
- If you store the drill set for a long time put some oil on steel parts, pins
- Sharpen the drill bits after each drilling. Inspect fishing and other tools.

Annex 2. How to construct a Mzuzu drill set

This annex contains an overview of the part in a Mzuzu Drill set and how to construct them. There is a separate manual available on this topic with the title 'Making of Mzuzu Drill'. Download the manual from <https://smartcentregroup.com/index.php/resources/manuals/>

Material list for a drill set to 16 m deep

Material	Unit	Quant.	Observations
Square Black pipe. 25 mm. x 2mm	6 metres	3 to 5	Depending on well depth
Square Black pipe 32 mm. x 2 mm (event.1.6 mm)	6 metres	1	To connect drill pipes and augers. Pipe of 25x2 should fit inside 32x2
Round Black pipe 50 mm x 2 mm. Event 1.8mm	6 metres	1	For Stone punch
Round black pipe 32 mm Thickness 1.2 mm	6 metre	2	Eventually. For extention pipes of the Stone punch
Gi pipe ½". Thickn.1.8 mm	metres	1	For Spiral augers and Open bailer
Gi or black pipe 1" Thickn. 2.2 mm	metres	0.5	For Combi bailer
Gi or black pipe 2" Thickn. ca 2.5 mm	metres	1	For bailers , event. Stone punch
Gi or black pipe 3" Thickn. Ca2.2 mm	metres	0.2-0.4	For Core auger, eventually Bailer
Gi or black pipe 4" Thickn. ca2.5 mm	metres	0.4	For Core auger and Stone punch
Strip 40x4 mm	metres	2	For Core augers, Stone punch
Strip 25 x 3	metres	2	For drill pipes etc.
Angle iron 25x2.5	metres	2	For handles
Poly pipe, 3/4" (25mm)	metres	15	Or more depending depth. For bailer
Poly pipe, 1" (32mm)	metres	15 m	Or more depending depth. Only in case of a Combi bailer.
Sockets 1"		3 pcs	Only for Combi /closed bailers
Nipples 1"		3 pcs	Only for Combi/ closed bailers
Round bar 8 mm	metres	2	For bailer valves and security pins
Round bar 6 mm	Metres	2	For bailer valves
GI wire 2 mm	Kg	1	Optional. To secure the pins
Rubber strips	Kg	1	To fix step. Or use vice grips
Tungsten drill tips	Pcs	4	For Stone punch. Or bike crank axles
Bike axles (front wheel)	Pcs	2	For bailers
Used / old files. flat or half round	Pcs	1	For Core auger and Spiral auger
Tools for the field			
Safety helmet	Pcs	2	Depending # people
Hacksaw, half round file	Pcs	1	
Pipe wrenches, 12 Inch	Pcs	2	Or similar
Buckets 20 ltrs (Metal)	Pcs	3	
Clay.	Bags 25kg	1-3	Depends diam. casing and soil type. Or Polymer, 1-5 kg
Tools for production			Vice, Angle grinder, Welder and rods, Hand drill with drills 5, 6, 10 mm. Hacksaw, Round file

Drill pipes, Pins, Handles, Footstep, Clean pins

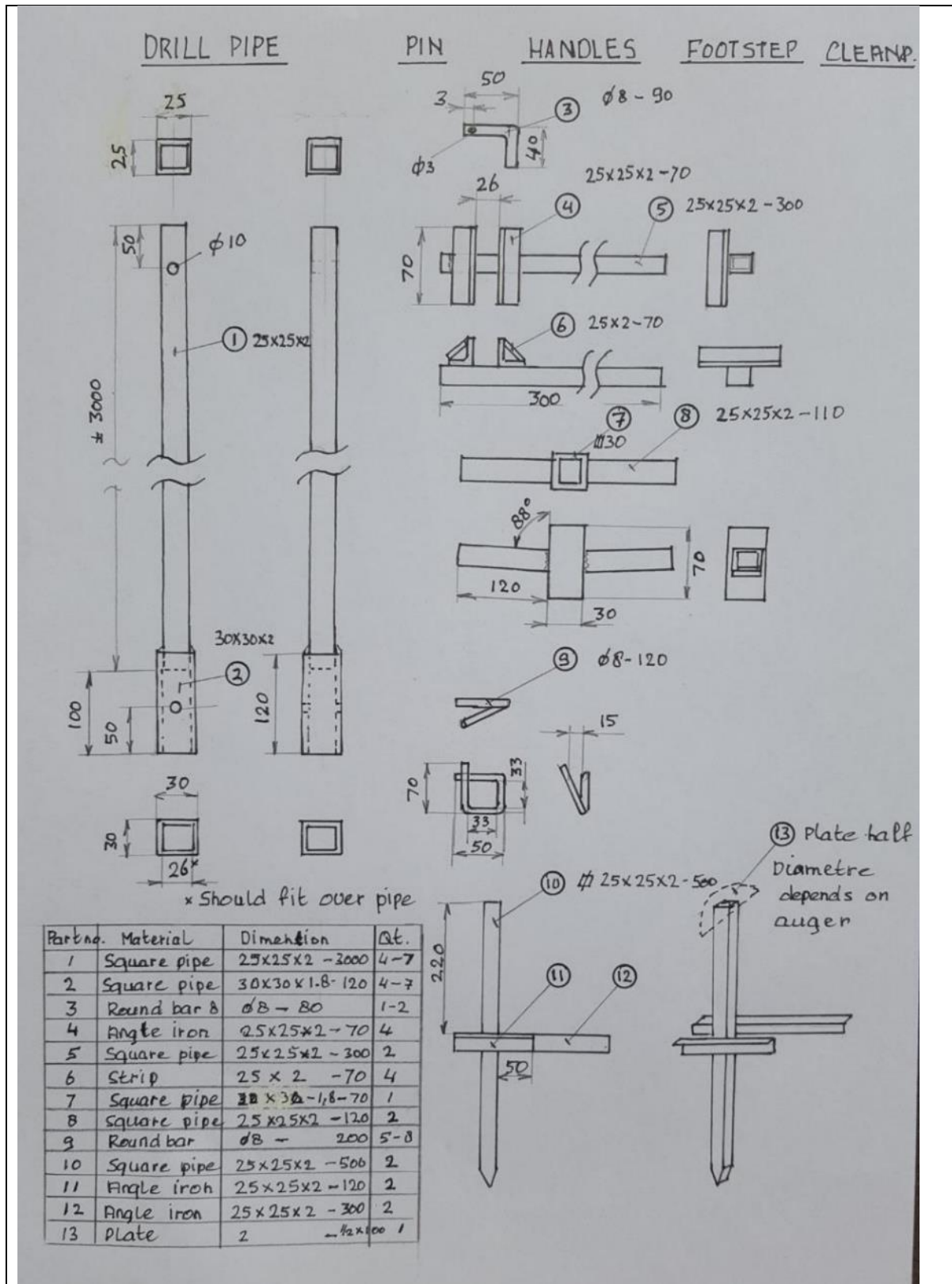




Photo 1. Mark the drill pipes with a hack saw or welding. In this way the pipes always fit



Photo 2. Fast fix pin. If too long there is danger of getting stuck

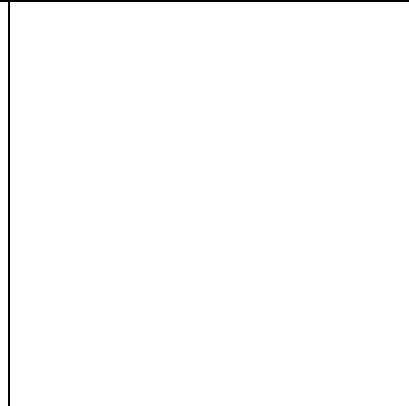


Photo 3.



Photo 4. Handle



Photo 5. Handle can also be made with square pipe



Photo 6. **Foot step.** Fix Foot step with a Vice grip (Photo) or a rubber strip



Photo 7. Clean pin 1



Photo 8. Clean pin 2

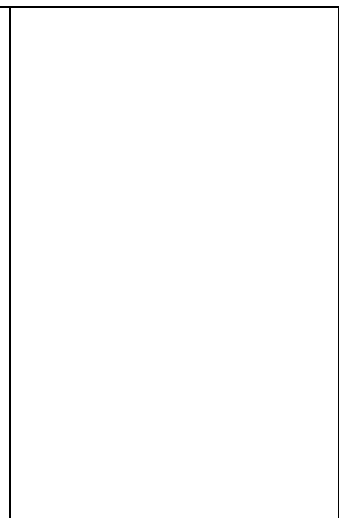
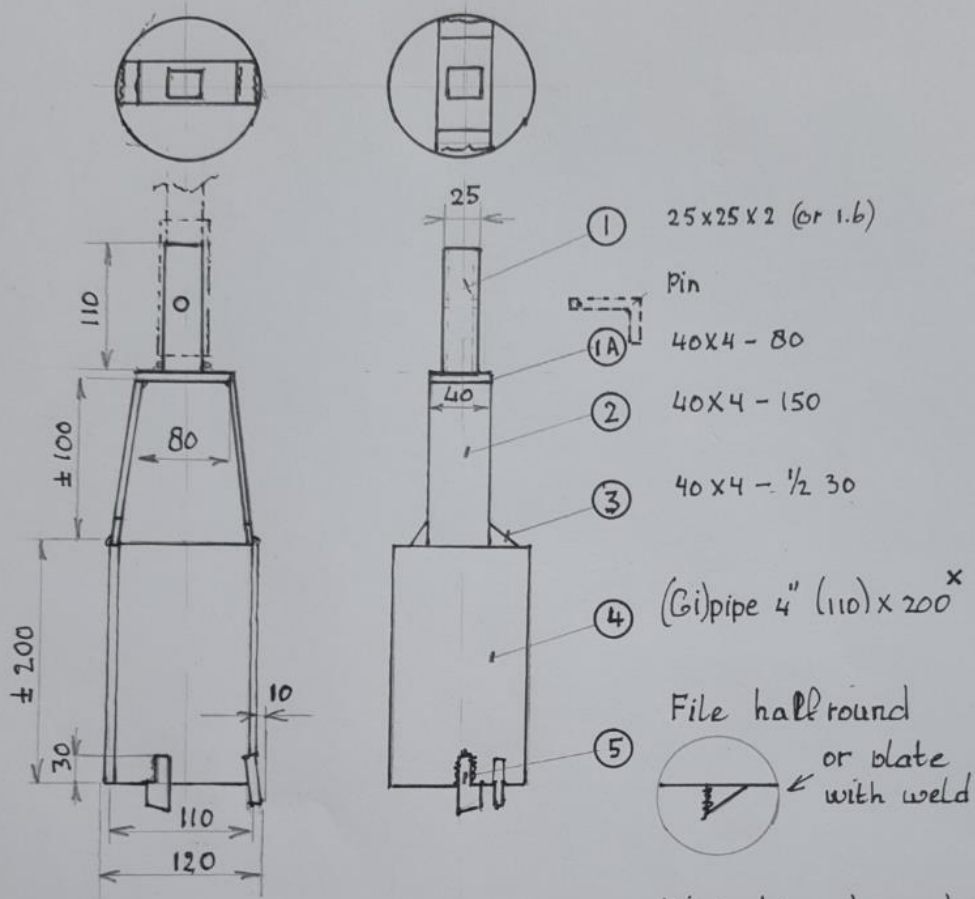


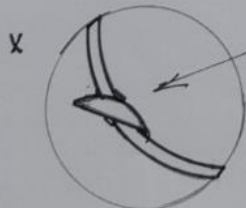
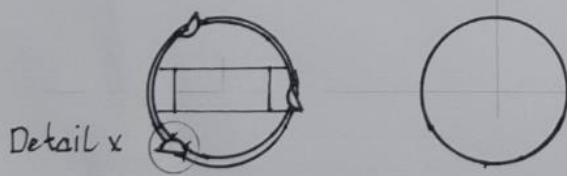
Photo 9.

Core auger

CORE AUGER 4" (110)



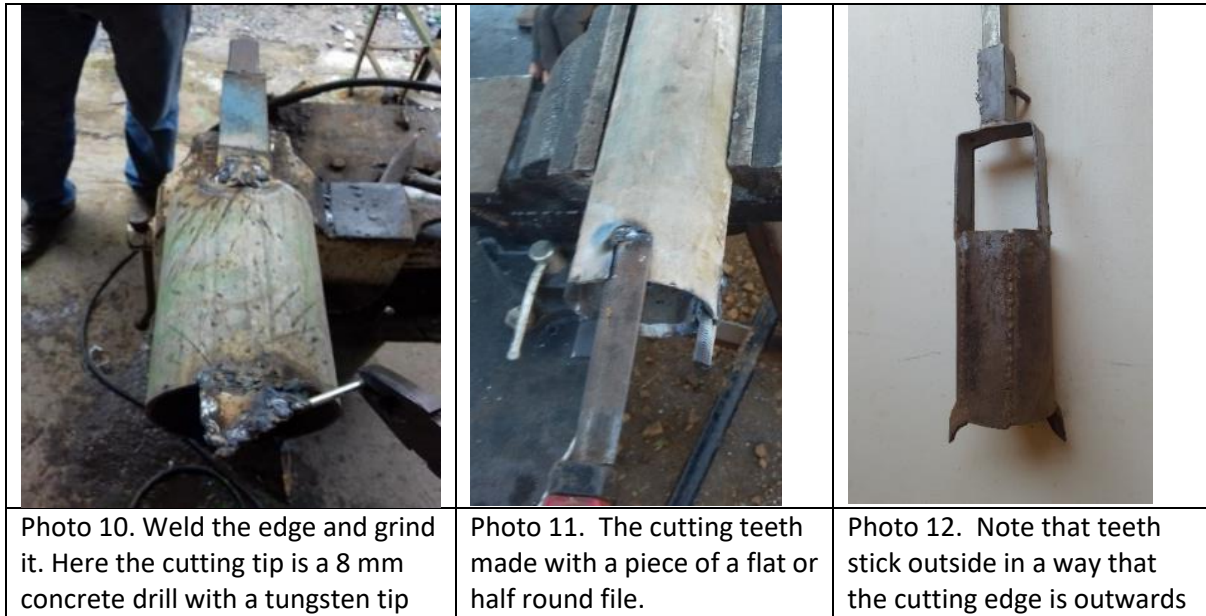
x Diameter depends on casing. Can also be 3" (90)



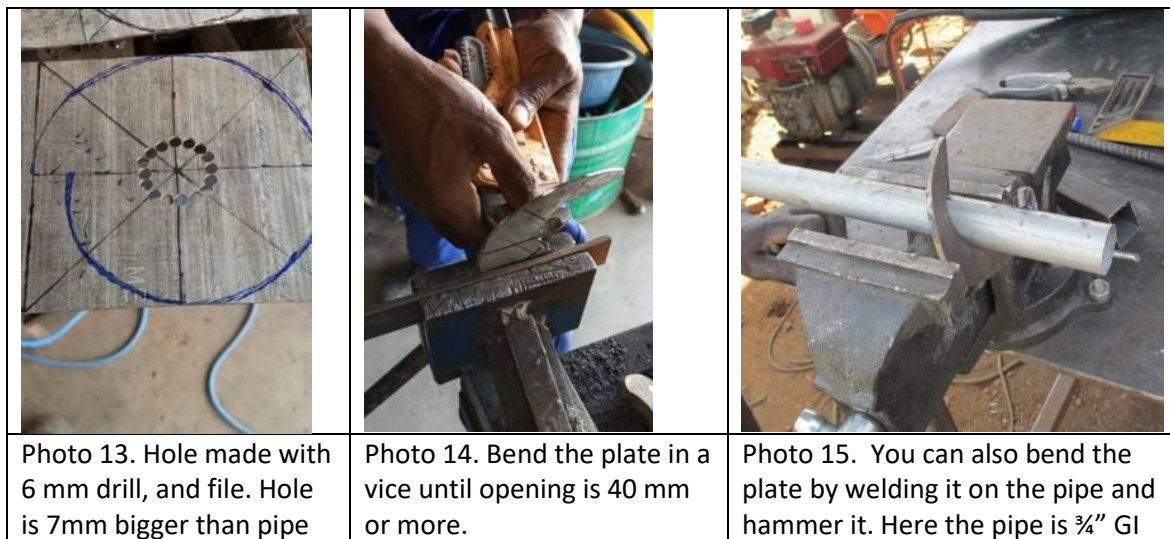
Teeth can be made of half round Pipe

Part no	Material	Dimension	Qty
1	Square pipe	25x -110	1
1A	Strip	40x4-80	1
2	Strip	40x4-180	2
3	Strip	40x4-30	4
4	Pipe	4" (110) -200	1
5	File half	-60	3
6			

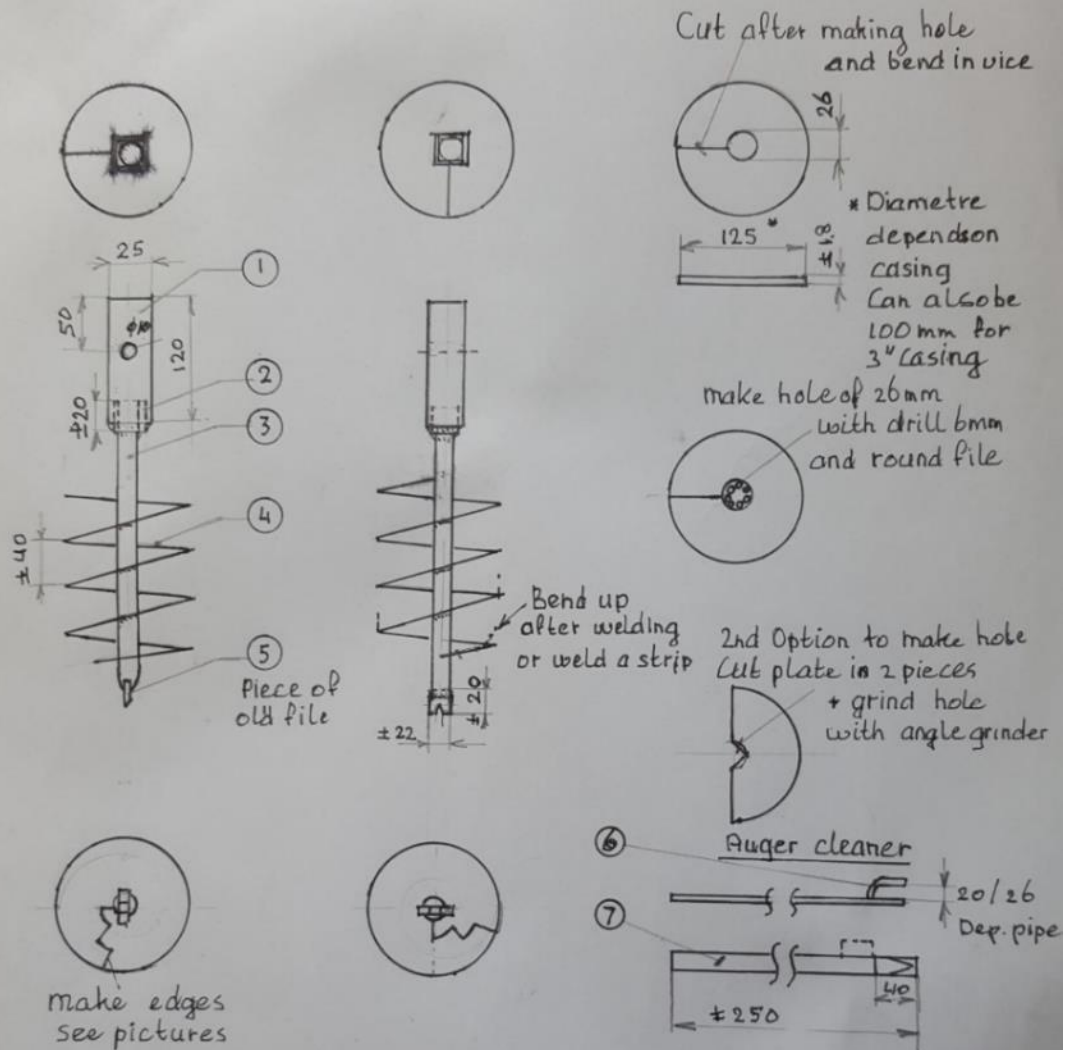
- The diameter of a Core auger depends on the diameter of the tube well. In the drawing the auger is for a 4 inch casing (diametre 110 mm).
- Make the cutting edge hard by welding or use a flat or half round file



Spiral Auger, Auger clean pin



SPIRAL AUGER 4"



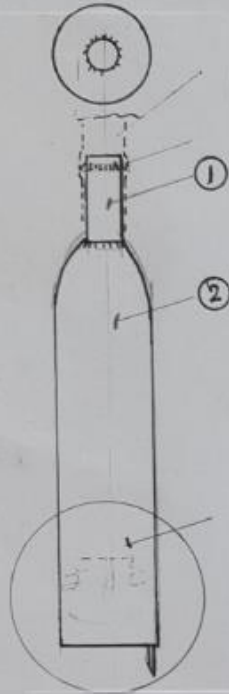
Part no.	Material	Dimension	Quant.	Observations
1	Square pipe	25x2 - 120	1	
2	GI pipe	3/4" x 2 - 20	1	
3	GI pipe	1/2" x 1.8 - 250	1	
4	Plate	φ125 x 1.5	4	
5	Tip	20 x 5 - 25	1	Eg. Piece of Pile
6	Strip	20 x 2 - 60	1	
7	Strip	20 x 3 - 250	1	

- The Spiral auger in this drawing is for 4 inch casing (110 mm) so plates of 125 mm
- For a Spiral auger for a 3 inch casing (90mm) make plates 105 mm
- The plates can be made of a 2 inch GI pipe cut open and made flat.
- The hole in the plate should be 7 mm more than the diameter of the Centre pipe so for a 1/2" pipe (20 mm) the hole should be ca 27 mm.

		
<p>Photo 16. Make cutting edge, weld a rim. (1/2" pipe)</p>	<p>Photo 17. Grind the cutting edge</p>	<p>Photo 18. To make a hard tip you can use an old flat file.</p>
		
<p>Photo 19. Open the tip in the middle and grind in the right way, like this</p>	<p>Photo 20. Eventually you can make the tip with a stone drill of 8 mm</p>	<p>Photo 21. To increase the capacity you can bend up the plates</p>
		
<p>Photo 22. To bend up the plates, cut a piece, hammer the plate and spotweld</p>	<p>Photo 23. You can increase the lift capacity by welding a 15 mm strip around the plates</p>	<p>Photo 24. Different diameters of Spiral auger.</p>

Bailers

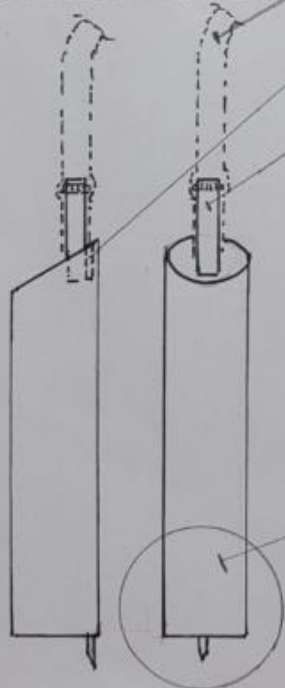
CLOSED BAILER 2"



Poly pipe 1" 5-10m or more
Weld rim to avoid the poly pipe from slipping off

The same valve assembly as the COMBI BAILER

OPEN BAILER 2 inch



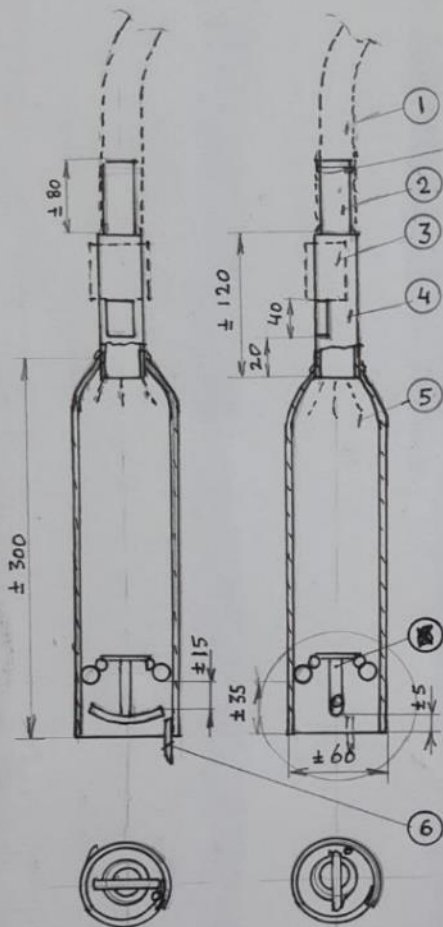
Poly pipe $\frac{3}{4}$ " or $\frac{1}{2}$ "
Height depends on well depth

- ③ Strip 20x2-40. To make some distance between $\frac{3}{4}$ " pipe and 2" pipe
- ④ GI pipe $\frac{3}{4}$ " - 100

Part no.	Material	Dimension	Qt.
	Poly pipe 1"	5-10m or ↑	1
1	GI Pipe 1"	100	1
2	GI Pipe 2"	300	1
3	Poly pipe $\frac{3}{4}$ "	10-15m or ↑	1
4	Strip 20x2	40	1
5	GI Pipe $\frac{3}{4}$ "	100	1

The same assembly as the COMBI BAILER

COMBI BAILER 2 INCH




Polypipe 1" x 5-10 m or more
Weld rim. To avoid the pipe gets loose

GI pipe 1" - 100

PVC pipe 1 1/4" Cut open

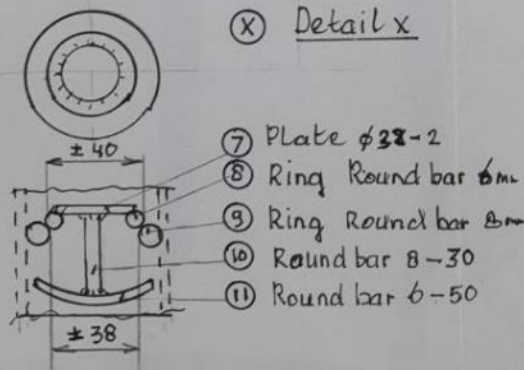
GI pipe 1 1/4" - 120 with opening

GI pipe 2" (60mm) - 300

 Cut slices + close + weld
to GI pipe 1 1/4"

Valve assembly. see detail x

Pin $\phi 6-30$



(X) Detail x

⑦ Plate $\phi 38-2$

⑧ Ring Round bar 6mm

⑨ Ring Round bar 8mm

⑩ Round bar 8-30

⑪ Round bar 6-50

Part no	Material	Dimension	Qt
1	Polu pipe 1"	5-10 m deb.	1
2	GI pipe 1"	100 mm	1
3	PVC pipe 1 1/4"	60 mm	1
4	GI pipe 1 1/4"	120 mm	1
5	GI pipe 2"	300 mm	1
6	Round bar 6	30 mm	1
7	Plate 2mm	$\phi 38$ mm	1
8	Round bar 6	$\phi 40$ outside	1
9	Roundbar 8	$\phi 56$ outside	1
10	Roundbar 8	30 mm	1
11	Round bar 6	50 mm	1

- The diameter of the bailer depends on the casing to be used
- These drawings show a 2 inch bailer to be used for 3 inch casings
- If you start drilling, start with the Simple **Open bailer**

		
<p>Photo 25. Making of a valve seat by bending round bar 8 mm around a 1.25 Inch pipe</p>	<p>Photo 26. Valve with round bar 6 mm. The outside diameter of the valve should be 2 a 3 mm more than inside valve seat</p>	<p>Photo 27. Valve assembly</p>
		
<p>Photo 28. Here valve assemble for a 3 inch bailer. Valve seat made with ring 8 mm and ring 6 mm.</p>	<p>Photo 29. Valve made with round bar 6 mm and a plate of 2 mm</p>	<p>Photo 30. Place valve assembly inside the pipe. Here it is kept straight with 2 wires welded in 2 slots made by angle grinder</p>
		
<p>Photo 31. Weld the valve seat on the bottom sides with tack welds</p>	<p>Photo 32. Weld 1 or 2 pins at the pipe bottom (ej axle of bike wheel).</p>	<p>Photo 33. Combi bailer. (for example part of an axle of a bike front wheel)</p>



Photo 34. Simple open bailer



Photo 35.

Stone punch



Photo 36. Stone punch

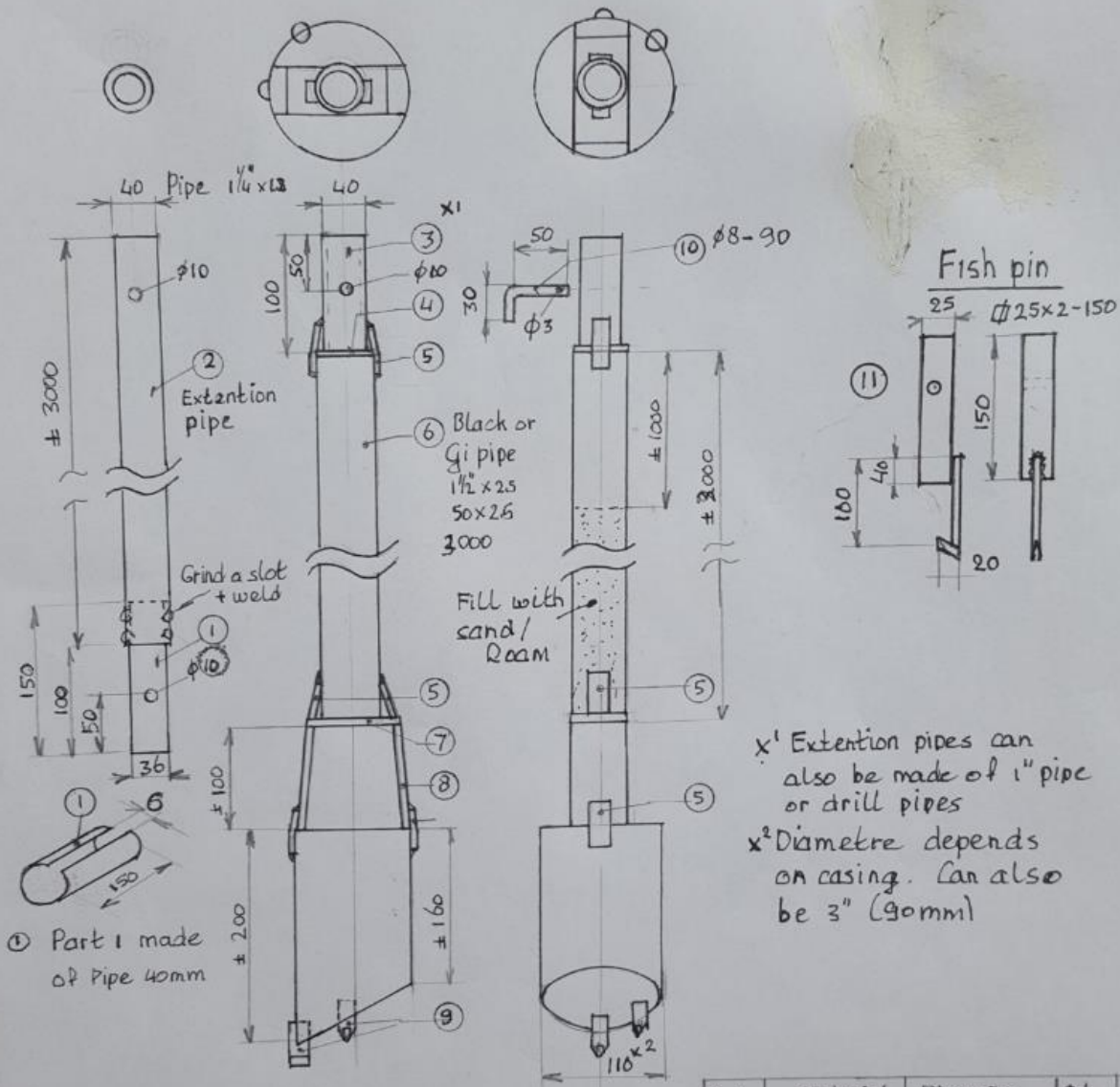


Photo 37. This model uses a tungsten tip



Photo 38. Clean the punch with the Clean pin so push up the soil

STONE PUNCH 4"



Part no	Material	Dimension	Qt.
1	Black pipe	1 1/2" (40x1.2)-150	0-4
2	Black pipe	1 1/4" (40x1.2)-3000	0-4
3	Black pipe	1 1/4" (40x1.2)-100	1-4
4	Strip	40x4 -40	1
5	Strip	25x2 -50	4
6	Black pipe	1 1/2" (50x1.2)-3m	
7	Strip	40x4 -70	1
8	Strip	40x4 -100	2
9	Tungsten	50x20	2
10	Round bar	φ8 -80	1-4
11	Fish pin		

- The pipe of the Stone punch needs to be of good quality preferable 3 mm thick
- If that is not available, weld a reinforcement plate at the side where the tip is

Annex 3. Steps of drilling. Short version

1. Start with a **Core auger**. The diameter depends on the casing to be used. Any time stone is encountered, use the stone punch.
2. Turn the Core auger with handles **slowly** to avoid excessive wear. Push down while turning.
3. In sandy or loose soils add some clay and 1 or 2 cups of water so the material sticks in the auger.
4. When the auger has gone down 20 to 30 cm, lift it and empty with the "**Cleaning pins**".
5. Keep on turning in the same direction while lifting.
6. In case of hard soils use the **Foot step** so weight of a person will push the auger down.
7. After 2.5 meter connect the 2nd drill pipe, after 5.5 meters connect a 3rd drill pipe etc.
8. If you go deeper than 6 meters, disconnect the top drill pipe when you lift to clean the auger. Do not have more than 6 meter drill pipes in the air since it will bend.
9. When the Core auger does not lift material anymore, use the **Spiral auger**.
10. If lifting the Spiral auger is too heavy, turn it back 0.5 turn.
11. Clean a Spiral auger by rotating it counter-clockwise and remove cuttings with the **Cleaning tool**.
12. Drill as deep as possible in the aquifer, until the Spiral auger does not lift material anymore because the cuttings are too wet / too loose to adhere to the auger.
13. When the Spiral auger does not lift soil anymore install the PVC casing with the filter screen. Length of screen 2 to 6 meters depending on the expected depth of the aquifer.
14. Take out sand inside the casing with bailing. If you use a **Combi bailer** start as a closed bailer.
15. If that does not work, open the bailer (lift the piece of PVC pipe). Fill it up by making small movements up and down. Lift the bailer and empty by washing it in a bucket of water.
16. The same no 15 applies if you use a **Simple open bailer**
17. With bailing, the PVC casing will go down by itself or with the weight or a bit of pushing.
Do not hammer the casing down!! That will compact the sand and increase friction
18. Go on with bailing and pushing the casing down as deep as possible (until you hit clay or rock) Install a temporary (rope) pump and clean and develop the Tube well. Eventually use a swabbing tool if the well capacity is limited. See Photo 32