

AUGERING

Manual drilling series



TECHNICAL TRAINING
HANDBOOK ON
AFFORDABLE MANUAL
WELL DRILLING



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TECHNICAL TRAINING HANDBOOK ON AFFORDABLE MANUAL WELL DRILLING

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PRACTICA Foundation develops and disseminates low-cost appropriate technology in water and renewable energy in developing countries. We focus on technology that responds to local cultural contexts, can be locally produced and maintained, and supports existing markets.



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This instruction manual is available in English and in French and has been developed for use in **technical training courses** organised for the intended users. In case you want to organize such training, you may contact the PRACTICA Foundation for further information and support.

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The United Nations International Children's Fund (UNICEF), PRACTICA Foundation and Enterprise Works/Vita have developed a toolkit for African countries wishing to embark on the professionalization of manual drilling. This toolkit includes Technical Notes, Technical Manuals including this publication, Advocacy Materials, Mapping of suitable areas for manual drilling, Case Studies, and Implementation and Training Manuals. This initiative builds the capacity of the local private sector in order to respond to the ever increasing demand for safe water in rural areas.

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Foreword

The high cost of developing potable water sources prevents many rural people from gaining access to clean, safe water supplies. Increasing access to improved water supply for under-served people and communities while keeping up with growing populations will require serious consideration of lower cost alternatives to the existing expensive water supply options. The manual drilling sector has proven itself as a successful, lower-cost approach with great potential under suitable conditions. In numerous countries manual drilling techniques are used as an alternative or to complement machine drilling. Drilling 'shallow' water wells by hand using local enterprises, can reduce the cost of a well by a factor 4 - 10 compared to a machine-drilled borehole. This cost reduction not only enables NGOs and Governments to construct more water points, but also 'opens the door' to villagers, farmers, schools and small communities to finance well construction independently through the private sector. Strategies and programs should be adopted to professionalize the manual drilling sector in order to scale-up rural water supply for drinking and irrigation purposes.

Variations of four manual drilling technologies are being used, each with their own advantages, disadvantages and suitability for different geological conditions. This handbook describes the practical aspects of the drilling technique Augering and is part of a series of 5 handbooks providing the basis for local entrepreneurs to start practicing affordable well drilling.

We suggest that this drilling handbook is used in combination with the manual: **'Understanding Groundwater & Wells in manual drilling'**.

READERSHIP

This handbook can be used as a guide during training sessions for well drillers, local trainers and quality controllers. It also serves as a reference for drilling supervisors, NGOs, development agencies, manual drilling teams and enterprises during the entire drilling process. The handbook consists of three sections that can be read together, or used and printed separately for the various target groups.

NOTE

Technical terms and the way in which subjects are explained are based on the average expected educational level of the intended users. Sometimes, the use of complicated geological and technical terms has been avoided to create better understanding. Please keep in mind that the objective of the handbook is to create better understanding of well drilling in practice, aimed at technical workers of manual drilling teams who may have a limited educational background.

Colophon

AVAILABLE MANUALS IN THIS SERIES:

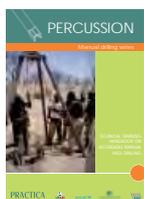
Technical training handbooks on affordable manual well drilling.

These practical handbooks create awareness of manual drilling for affordable water supply and a roadmap for implementation of manual drilling programs. The manuals provide an extensive and detailed guide for trainers and drilling teams in the use of various drilling techniques for making affordable boreholes. The techniques are explained in simple and understandable language, using clear illustrations and drawings.



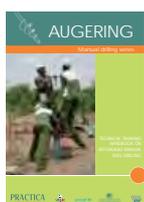
1. Manual drilling series: JETTING

This handbook describes in detail the various jetting techniques that can be used to drill wells in loose and soft soil formations. With this technique, wells are drilled in a number of hours rather than days.



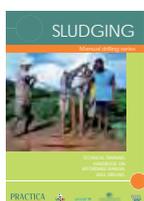
2. Manual drilling series: PERCUSSION

This handbook describes in detail the percussion technique. Although the technique is slower than other drilling techniques, it is the only manual drilling technique that is able to drill through consolidated rock layers.



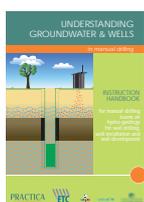
3. Manual drilling series: HAND AUGER

This handbook describes the hand auger technique. This cheap and effective technique is very suitable for sinking shallow wells in soft soils and is excellent for soil surveys. Many drilling teams have this technique in their toolkit to complement other drilling techniques.



4. Manual drilling series: SLUDGING

This handbook describes the sludging technique, and in greater detail the ROTA-sludge technique. It is a combination of sludging and percussion and is particularly useful due to its versatile application for a range of soil formations.



5. Manual: 'Understanding Groundwater and Wells in manual drilling'

The manual 'Understanding Groundwater & Wells in manual drilling' complements the 4 technical training handbooks and highlights those essential subjects which are relevant to manual drilling, geo-hydrology, hygiene, well installation and well development in practice, in simple and understandable language.

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This module creates awareness on manual drilling and provides a road-map for implementation. It is meant for NGO's, governments and implementing organisations and those interested in using manual drilling for affordable water supply.

Module 2

USING THE HAND AUGER TECHNIQUE

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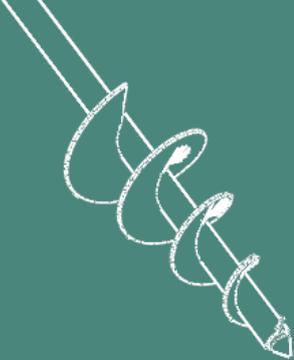
Module 2 describes the drilling technique in detail and includes: how the technique works and where it can be used. This module is a step-by-step explanation that makes use of cartoons to illustrate the drilling process. This module is designed to be used by technical trainers and as a reference for manual drilling teams.

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Module 3 is meant for local workshops that want to fabricate drilling equipment. It consists of a package of technical drawings, tips for construction and a list of materials that are necessary to make a complete set of drilling equipment.



AUGERING

Module 1



THE CONTEXT OF MANUAL DRILLING



1. WHAT IS MANUAL DRILLING

Affordable water

Manually drilled wells for water supply are more affordable than machine drilled wells and more productive than hand dug wells, thereby providing access to improved sustainable water points at a lower cost. This module describes the context in which manual drilling is used in various countries and elaborates on the techniques and its implementation. It gives insights and creates awareness and is meant for NGO's, governments, implementing organisations and those interested in using manual drilling for affordable water supply. This module might also be interesting for the manual drilling teams themselves, especially once they have gained more field experience in well drilling.

Manual drilling is a practical and affordable solution for wells less than 40 meters deep in alluvial soils (loose material, such as clay and sand) and soft weathered rock formations (such as soft sand stone and lime stone). There are many areas around the world where it can effectively provide water for drinking and for irrigation to un-served rural populations at a fraction of the cost of conventional drilling. This is especially true in small isolated communities that will never benefit from the large donor funded drilling programs because they are often not included in national plans.

WHY MANUAL DRILLING?

- Cost savings: 4-10 times cheaper than a machine drilled well of the same depth.
- Better access to drilling sites with lightweight equipment, remote communities can now be reached.
- Locally manufactured drilling equipment, under € 2,000 initial investment for start-ups.
- Ready-to-go in emergency situations and in politically unstable countries.
- It creates jobs and knowledge remains in the country, even after donor projects are finished.
- Overcomes problems in water quality and quantity in comparison with hand-dug wells.
- Can be used for both drinking water and irrigation.

Machine drilled wells are high in quality, but also very expensive. Hand dug wells are lower in cost and very useful in formations with a low permeability due to their capacity to store water which seeps in through well walls overnight. However, the total yield/day may be low, and water quality may be poor because the water comes from an open source allowing pollutants to enter easily. Hand dug wells also often collapse if not properly lined. A hand dug well lined with concrete rings, preventing it from collapsing, has a high yield, but the price will come close to that of a machine drilled well.

The cost of wells vary among countries and will generally be in the range of € 5000 – 15000 for a 30-meter deep machine drilled well and € 2500 - € 8000 for a lined hand dug well. In many countries manual drilling techniques are used as an alternative.

Costs of 30 meter deep manually drilled wells vary from about € 100 - 2500, depending on geology, country and application (i.e. small scale irrigation to high quality community wells for potable water). The equipment for manual drilling can be locally manufactured, transported and maintained.

2. CHOICES: THE 4 MANUAL DRILLING TECHNIQUES

When a borehole is drilled, different types of geological formations (soil layers) can be encountered. To drill through these diverse formations a range of different manual drilling techniques have been developed and are used around the world. In each case the drilling technique must (a) break or cut the formation, (b) remove the cut material (the soil) from the hole, and (c) if necessary provide support to the walls of the hole, to prevent collapse during drilling.

Each drilling technique has been developed for either one or a range of specific formations (soil layers); therefore it may be possible that combinations of different drilling techniques are used to drill a single borehole. All existing drilling techniques can be divided into four main drilling principles: Hand Auger, Manual Percussion, Sludging and Jetting. Within these four main drilling principles, a wide range of variations have been developed in various countries.

THE HAND AUGER consists of extendable steel rods, rotated by a handle. A number of different steel augers (drill bits) can be attached at the end of the drill rods. The augers are rotated into the ground until they are filled, then lifted out of the borehole to be emptied. Specialized augers can be used for different formations (soil types).

Above the water table, the borehole generally stays open without the need for support. Below the water table a temporary casing may be used to prevent borehole collapsing. Drilling continues inside the temporary casing using a bailer until the desired depth is reached. The permanent well casing is then installed and the temporary casing must be removed. Augers can be used up to a depth of about 15-25 meters, depending on the geology.

Geological application; suitable for unconsolidated formations: Sand, silt & soft clay.



MANUAL PERCUSSION uses a heavy cutting or hammering bit attached to a rope or cable and is lowered in the open bore hole or inside a temporary casing. Usually a tripod is used to support the tools. By moving the rope or cable up and down, the cutting or hammering bit loosens the soil or consolidated rock in the borehole, which is then extracted by using a bailer. Just as with hand augering, a temporary casing of steel or plastic may be used to prevent the hole from collapsing. When the permanent well screen and casing are installed, this temporary casing has to be removed. Manual percussion drilling is generally used up to depths of 25 meters.

Geological application; suitable for unconsolidated and consolidated formations: Sand, silt, stiff clays, sandstone, laterite, gravel layers and small stones

SLUDGING uses water circulation to bring the cuttings up to the surface. The drill pipes are moved up and down. On the down stroke, the impact of the drill bit loosens the soil and on the up stroke, the top of the pipe is closed by hand (or valve), drawing up the water through the pipe and transporting the cuttings to the surface. On the next down stroke, the hand (valve) opens the top of the pipe and the water squirts into a pit, in front of the well. In this pit, the cuttings separate from the water and settle out, while the water overflows from the pit back into the well. The borehole stays open by water pressure. Thickeners (additives) can be added to the water in order to prevent hole collapse and reduce loss of working water (drill fluid). Sludging (with or without rotation) can be used up to depths of about 35 meters.

Geological application; suitable for unconsolidated formations: Sand, silt and clay. If rotated (including a drill bit) it may be possible to penetrate softer-consolidated formations such as stiff clays, soft sandstone, and weathered laterite.



JETTING is based on water circulation and water pressure. As opposed to sludging, water is pumped down the drilling pipes. The large volume of water has an erosive effect at the bottom and the 'slurry' (water and cuttings) are transported up between the drill pipe and the borehole wall. A motor pump is used to achieve an adequate water flow. The drill pipe may simply have an open end, or a drill bit can be added and partial or full rotation of the drill pipe can be used.

Thickeners (additives) can be added to the water in order to prevent hole collapse and reduce loss of working water (drill fluid). Jetting (with rotation) is generally used up to depths of 35-45 meters.

Geological application; suitable for drilling in alluvial material such as weakly cohesive sands, silts and thin layers of soft clay .

CHOICES FOR MANUAL DRILLING TECHNIQUES

Drilling Technique*	Equipment cost (€)	Average drilling speed for 15m in different geological formations (days)**				
		Weak cohesive sand, silt gravel	Soft clay <u>Stiff clay</u> formations	Soft consolidated formations	Soft weathered rock	Un-weathered Crystalline basement rock, e.g. granite
Hand auger	200 - 600	1	1-2 <u>2-4</u>	Not suitable	Not suitable	Not suitable
Percussion	300 -1200	2-3	2-3 <u>3-4</u>	> 3	> 8	Not suitable
Rotary Jetting	800 - 1400	1	1-2 <u>Less effective</u>	Not suitable	Not suitable	Not suitable
Rota Sludging	600 - 1000	1-2	1-2 <u>2-3</u>	> 3	Less effective	Not suitable

Drilling Technique*	Advantages	Disadvantages	Average drilling depth (m)
Hand auger	Easy to use above groundwater table. Cheap equipment	Use of the temporary casing if clay layers are penetrated is very limited If a collapsing sand layer is encountered below a clay layer (through which the temporary casing could not penetrate), the borehole does not stay open	15 - 25
Percussion	Drills hard formations	Slow and high equipment costs	25
Rotary Jetting	Quick	Lots of working water is needed at once	35 - 45
Rota Sludging	Easy to use Applicable in most soft formations	Highly permeable layers (coarse gravel) causes loss of working water and cannot be drilled	35

* Note: Drilling teams are keen on using a variety of drilling techniques to penetrate different geological formations.

**Note: Many different soil layers may be encountered during the construction of one borehole. The information given in the table is an indication of the drilling speed in one particular type of soil.

3. WHAT ORGANIZATIONS MUST KNOW

HOW TO IMPLEMENT MANUAL DRILLING

Using manual drilling as implementing tool for affordable water supply is possible for a wide range of qualities and scales. Before one can start the implementation of a manual drilling program there is a whole list of things to be considered. For example:

- What is the required quality of the wells?
- Who will pay for the construction of the water point?
- Who will be the end user of the well (households, community, farmers, refugees in camps, etc)?
- Are we drilling for potable water, irrigation water or multiple use?
- What is the number of wells that need to be drilled per year?
- Is there already an existing manual drilling sector present and what is their capacity?
- What is the need and scale for quality monitoring?
- What is the size of the project area?
- What is the hydro-geologic potential for manual drilling in the project area (type of soil and the depth of groundwater)?
- What is a sustainable number of drilling teams needed (based on the demand)?
- What is the relation between user density and hydro-geology in the project areas (how many people can we reach with manual drilling)?
- What are the objectives of the implementing organization?
- Etc.

The answers to all these questions (and the objectives for scale and costs) provide the basis for making the right choice of the approach for training and implementation. A few examples:

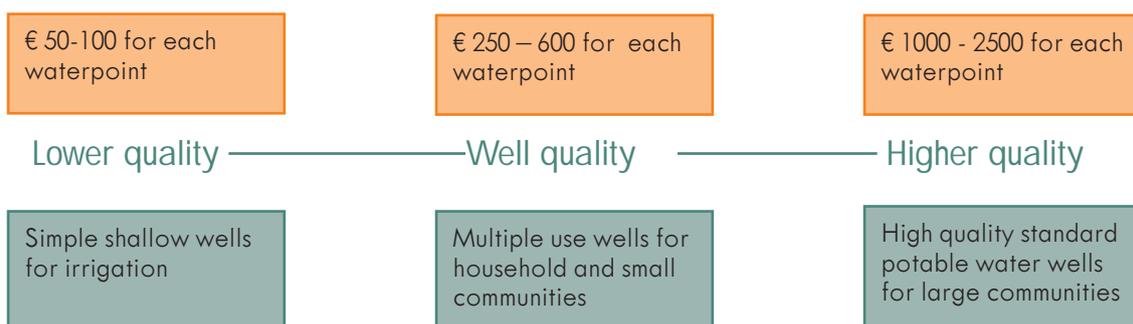
- a) For the introduction of shallow irrigation wells the following criteria are very important: The well has to be affordable for the farmer (i.e. low cost materials and shallow), while the water quality is of less importance. A training program in this case will focus on drilling affordable wells, using low cost materials in areas where shallow groundwater exists and where farmers have access to markets to sell their vegetables. Manual drilling enterprises will work directly with farmers.
- b) For a professional and sustainable water supply to large communities, the government and larger donors are often involved. The most important criteria here are: a very high quality of the well, high quality of drinking water (meeting all standards), sustainability of the well and sustainability of the whole drilling sector. A training program in this case will require a much larger capacity building road map with its focus on professionalization of the drilling sector as a whole, involving technical training, quality control, business skill training, social mobilization and social marketing. Making manual drilling enterprises ready to respond to large tenders and drilling high quality wells, generally through governments or donors.
- c) Multiple use of wells by households and small communities often requires a mix of both previous options: the well should still be affordable (or partly subsidized), but also have an acceptable water quality.

Always realize that the purpose of the well, the water quality, affordability and sustainability go hand-in-hand and that all are important for a right choice of the further approach in training and implementation.

GOING TO SCALE

Once a feasibility study has revealed that there is a high potential for manual drilling in a given area or country

Figure 1. Range of implementation possibilities



and the first team(s) have been drilling successfully, there is potential to scale up the capacity of the sector.

Scaling up is often explained as: training more teams. That is partly what it is, but be careful: training more teams alone is not enough to ensure the quality, affordability and sustainability of wells! When going to scale, not only the drilling enterprises are involved. Other actors play an important role in this process. To visualise this, let's go back to the three examples of the previous page:

a) shallow wells for irrigation, b) high quality communal wells and c) multiple use wells for households.

In all these three examples not only the purpose, quality and price of the wells are different, but also the actors involved. Example b for instance, has its focus on professionalization of the drilling sector as a whole. This involves of course the drilling enterprises, but also quality controllers, the government (responsible for a national quality control system and certification), social actors (to guide communities) and pump suppliers. While in example a, the drilling enterprises, farmer associations and pump suppliers play the biggest role.

Whenever starting a program to go to scale it is important to realize that such a program is not 'a borehole drilling program' only. Going to scale requires a capacity building process with its focus on training, repetition, quality and sustainability of the manual drilling sector. This may take as much as 3-5 years to develop. For an example of a more detailed roadmap on the implementation of larger manual drilling programs please read the manual; **'Professionalizing the Manual Drilling Sector in Africa'** A capacity building program to increase access to safe water in rural areas.

THE FIRST STEPS IN ANY MANUAL DRILLING PROGRAM

Feasibility study

A feasibility study will assess the potential for manual drilling and whether it is a practical solution for water supply under the given conditions. Collecting information on hydrology (depth, quality and quantity of groundwater), geology (soil type) and population density will provide a clear indication of areas with the highest potential. It is also of great importance to assess the existing drilling sector. Do manual drilling enterprises already exist? And if

so, what is quality of their current work? And what training is required? What are the roles of the other actors involved in the sector such as NGO's, workshops, well diggers, Governments, pump suppliers, etc? This information will be used to determine the right approach for training and implementation, building on- and reinforcing the existing local capacity.

Technical hands-on training on manual drilling

If there is not an existing manual drilling sector present or if there is a need for further improvement of technical skills, a technical hands-on training on a specific manual drilling method(s) is required.

The technical trainer will advise on the purchase of tools and well construction materials and assure that the drilling equipment is fabricated properly. During several weeks a hands-on technical drilling training is given to a team(s) of selected manual drilling trainees. During and after this first training several wells are drilled, allowing the teams to practice and improve their technical skills.

Follow-up and geo-hydrological training

Once teams have gained sufficient experience in the use of the equipment while drilling boreholes, they are ready for the next step: a technical follow-up training combined with a training on geo-hydrology, hygiene, well installation and well development.

Although most existing manual drilling enterprises are very capable of drilling a borehole, a lot of improvements can be made during the construction and development of the wells, resulting in a better water quality, quantity and hygienic use of the well. Most manual drilling teams experience problems with site selection, loss of working water, soil texture determination, logging, well casing installation, well development, water quality and well yield (flow rate of the well). These problems may occur when the drilling process is not completely understood and important steps are missed. The classroom training on geo-hydrology 'Understanding Groundwater & Wells in manual drilling', addresses the above issues. During this training, the drilling team will get a technical follow up training in the field to bring the theory and lessons learnt into practice.

Depending on the size and objectives of a program, additional training can be given on business skills and quality control for manual drilling teams.

4. GETTING STARTED

The construction of a well, using manual drilling techniques is a complicated process. Before drilling starts a good drilling site has to be selected, where experience suggests that there will be an adequate quantity of good quality groundwater. During the drilling process there are a lot of different aspects which require attention to prevent things from going wrong. Besides the practical drilling skills which are executed at ground level, attention also has to be paid to important processes which are happening below ground level during drilling. Water used in drilling (working water) could flow away or worse; the borehole could collapse, burying part of the drilling equipment. And finally, once the hole has been drilled, the well casing, screen and sanitary seals have to be installed at the right depth, preventing contaminated water from entering, and ensuring a sufficient yield. With this in mind, it becomes clear that the introduction of manual drilling needs adequate supervision, with proper training and guidance of the drilling teams.

PREPARATIONS AND THE FIRST TRAINING

Making the drilling equipment

The decision to use quality tools is one of the key factors for success that manual drilling teams can make. Although this looks obvious, the quality of the tools is often overlooked, resulting in loss of equipment and breakdowns in the field. How to avoid this?

All tools and equipment are purchased and made locally. It is important that a good workshop is selected to manufacture the drilling equipment. The workshop should have the right equipment and be skilled to do the job! Module 3 of this handbook has all the technical drawings of the equipment and will guide the workshop during construction. Although it may be expected that the workshop is able to make quality drilling equipment from the drawings, when it is the first time for them, additional supervision is useful. Guidance during construction and quality control of the equipment before it leaves the workshop is essential. At first this quality control can be done by a technical trainer. In a later stage, the drilling enterprises will take care of the quality control themselves.

Training the drilling team

Manual drilling must be understood as a profession that develops through training, hands-on experiences, successes and failures. Technical training sessions by experienced

drillers/trainers are an essential base for new teams to become professional manual drillers.

Make a selection of trainees before training starts: It is important that the trainees either have experience or affinity with wells (pump workshops, well diggers) and are motivated to run their own business. On average, a team consists of 5 or more workers and 1 team leader. During several weeks, hands-on technical drilling training is given to the manual drilling trainees. During and after this first training, several wells are drilled. It is good to provide the training and these first wells in an area that consists of loose soils, which are easy to drill. This will allow the team(s) to practise and improve their technical skills, without becoming frustrated.

Important: during this first practice period (a few months) the team(s) will come across problems, may have questions, experience difficult situations or worse may lose some of their equipment. Realize that this is all normal and part of the learning process! It is important that the team(s) are guided well and have access to experienced trainers. After a few months of practise a follow up training will evaluate the problems encountered with the drilling team(s).

GUIDING THE NEW TRAINED TEAM

Drilling in a new area

When a drilling team is new to an area, it is important for them to have information on the geology (soil type) they are going to drill. And how deep they have to drill. In other words: what is the depth of the groundwater and how deep do they need to drill into the groundwater to find a good yielding aquifer?

There are several ways to get this information: Ask villagers to show existing hand dug wells and try to talk with well diggers. They can give information on the different types of formations (soil) and the level of the ground water in dry- and in rainy season. To complement this information; the team should drill its first well to the maximum possible depth. During this exploration, soil sampling will help them to define the depth of a good aquifer. Note that drilling in valley bottoms, floodplains and riverbeds is likely to be more successful than high up in the hills.

Remember; there is NOT a standard for the depth of drilling. This always depends on the depths of an aquifer and the requirements of the users and the pump.

Selecting construction materials

For the well casing different types of PVC pipe are used. The quality can vary from cheap drain pipes with self made filter screens to expensive, high quality factory slotted filter screens and casing pipes.

Around the filter screen a gravel pack or filter cloth is placed to reduce the inflow of fine sand. A sanitary seal is placed to prevent pollution from entering the well. Find more information on construction materials in module 2, chapter 2: What the drilling teams must know.

Finalizing the well

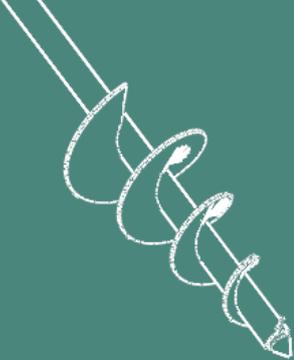
Once installed the well should be further developed to maximize the yield of the well. Then an apron and a pump are placed.

For more details see the manual: **'Understanding Groundwater and Wells in manual drilling'**. An instruction manual on hydro-geology, hygiene, well installation and well development.

Giving a follow up training

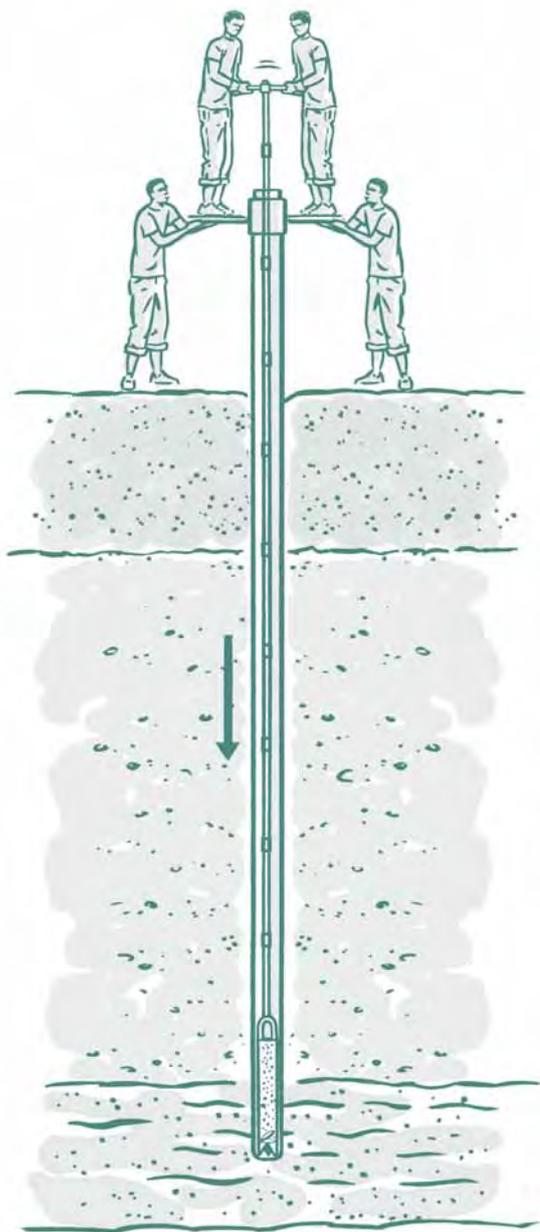
When the team has drilled a number of wells and gained practical experience, they are ready for a follow-up training 'Understanding Groundwater and Wells in Manual Drilling'. This training helps them to understand the drilling process and the theory behind it. It will allow the drilling teams to solve problems in the field. During this training, the teams will get a technical training in the field to bring the theory and lessons learnt into practice.





AUGERING

Module 2



USING THE HAND AUGER TECHNIQUE

1. WHAT IS HAND AUGERING

This second module of the hand auger handbook teaches entrepreneurs and technical trainers how to use the hand auger drilling equipment. It explains how to drill and install wells, using a **temporary** casing. It also explains how to drill wells with a **direct installation** of the **permanent** well casing

HISTORY

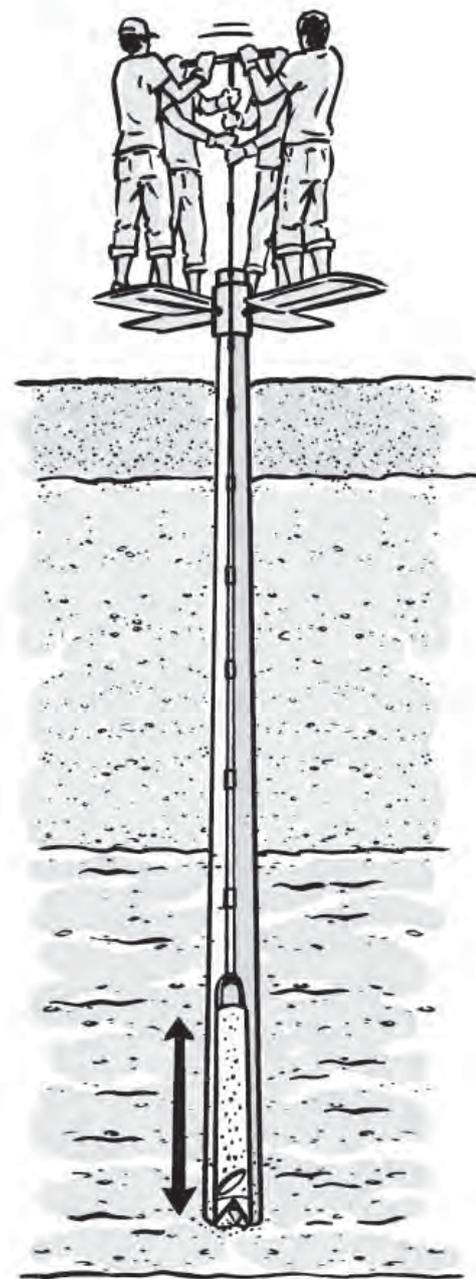
The hand auger is one of the simplest manual drilling methods. Presently hand auger drilling is one of the most common hand drilling techniques. Worldwide it is being used in environmental research for soil sampling and for drilling boreholes for drinking- and irrigation. The hand auger is an excellent tool for drilling shallow wells and for quick site investigation. It can also be used to make starter holes for use in combination with other manual drilling techniques. Many drilling enterprises have these tools in their toolkit to use in combination with other techniques.

This practical module is created with information compiled from available literature, field observations in various African and Western countries, discussions with local drilling teams and interviews with hand auger experts. The existing manual: *Hand Augered Garden Wells*, written by Jon Naugle, Lutheran World Relief, 1996, has been particularly useful. Jon Naugle has been among others a key person in the introduction of improved hand augering in Africa. Nowadays the hand auger is being used in: Niger, Chad, Senegal, The Gambia, Ghana, Burkina Faso, Mali, Uganda, Zimbabwe, Tanzania, Nigeria, Central America and western countries.

This module summarises best practices in drilling with the hand auger technique.

HOW DOES IT WORK?

A hand augered well is a small diameter borehole that is drilled into the ground using soil augers and extendable steel rods that are rotated by a handle. A number of different steel augers (drill bits) can be attached to the bottom end of the drill rods. The augers are rotated into the ground until they are filled, and then lifted out of the borehole to be emptied. Specialized augers can be used for each different formation (soil) type. As the depth increases additional drilling rods are added until the desired depth is reached.



Above the water table, the borehole generally stays open without the need for support. Below the water table a temporary PVC casing is used to prevent the hole from collapsing. Drilling continues inside the temporary casing using a bailer.

Two drillers stand on a working platform attached to the PVC casing. Material at the bottom of the casing is removed with the bailer using a combination of rotation and up-and-down motions. As material is removed the PVC casing sinks down under the weight of the drillers. Weight can be increased by adding more team members. Drilling continues until the desired depth is reached. The permanent well casing and filter screen are installed. Then the temporary casing is removed.

With augering boreholes can be drilled up to a diameter of 180 mm. Augering is generally used up to a depth of about 15-20 meters, depending on the geology.

Where does it work?

Suitable for unconsolidated formations: sand, silt & soft clay. Stiff clays, hard materials and gravels are difficult or impossible to drill through and to remove (unless augering is combined with other manual drilling techniques).

USING A TEMPORARY CASING OR DIRECT INSTALLATION?

When drilling below the water table a PVC casing is used to prevent the hole from collapsing. This can be a **temporary casing** in which later the permanent well casing and filter screen are installed. But it is also possible to drill with the permanent well casing directly. In this case the final well casing is **directly installed**, without the use of a temporary casing.

Drilling with a temporary casing

A borehole of 140 - 180 mm is drilled using the auger until the water table is reached. To continue drilling, a thick wall (5-7.5 mm) temporary casing with an outside diameter of 120 - 160 mm is used. After the installation of the permanent well casing, the temporary casing is removed.

Advantages of a temporary casing

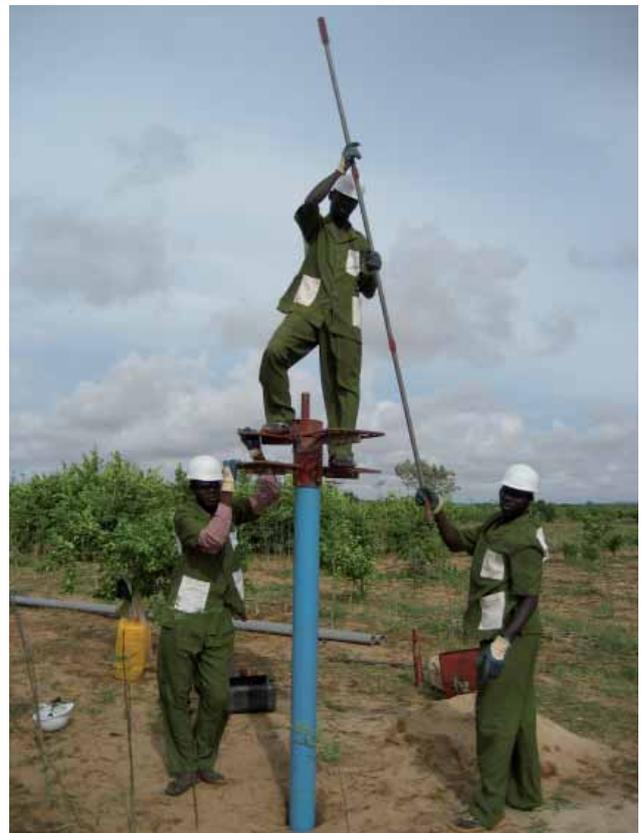
- o Low cost: A low cost well casing (cheap PVC pipe) can be installed. The expensive temporary casing, used for

drilling, will be removed after the low cost well casing has been installed.

- o A gravel pack can be installed
- o It is possible to drill through thin layers of clay

Disadvantage of a temporary casing

- o It may take extra time compared to direct installation. A bigger borehole has to be drilled and the temporary casing has to be removed.



Drilling with direct installation

A borehole of 120 – 160 mm is drilled using the auger until the water table is reached. Then a permanent well casing (wall thickness 5-7.5 mm) with a diameter of 125-140 is prepared. In fine sands, a geo-textile or polyester filter cloth is wrapped around the filter screen. When drilling continues, the permanent well casing is used instead of a temporary casing. The drilling is finished when you have reached the final depth.

Advantages of direct installation

- o Drilling goes quickly because the diameter of the borehole is smaller. There is no temporary casing used, which has to be removed.
- o No need for gravel pack.

Disadvantages of direct installation

- o Expensive: An expensive permanent well casing has to be used
- o Only for drilling in pure sand. Clay layers cannot be drilled. Filter cloth has to be used in fine sand. Clay will block the filter cloth.

OTHER TYPES OF AUGERING

A variety of auger methods have been developed over the years in several countries.

- o The Vonder Rig is one example and makes use of a tripod and working table. The technique is more expensive and equipment is heavier, but it ensures a straight borehole.
- o Driven wells are sometimes used in combination with augers in collapsing sand layers. If augers cannot penetrate further into a collapsing sand layer, and a temporary casing cannot be used (for example, the casing is stuck in a clay layer, see description above), a well point and well screen can be driven into the ground using a hammering tool or normal hammer.

ADVANTAGES & DISADVANTAGES

Advantages of hand augering

- o Suitable and fast for small diameter boreholes up to 15-20 meters in 'soft' formations.
- o A good team may easily drill 1-2 shallow wells per day.
- o The drilling equipment is simple, inexpensive, easy to transport and made from local available materials.
- o Simple to operate and low maintenance cost.
- o Easy to use above the groundwater table.

Disadvantages of hand augering

- o The well depth is limited to 15 - 20 meters.
- o The method is only suitable in 'soft' formations. Boulders, stones and very stiff clay can not be drilled.
- o The drilling is rapid for the first few meters, but becomes slow at greater depths. This is because the extension rods must be uncoupled each time the augers and bailers are lifted to the surface. Then emptied and lowered again into the borehole, which takes time and physical effort.
- o It may be very difficult to remove the temporary casing when drilling through clay layers (especially in swelling clays) as the casing will stick to the wall of the borehole.
- o If a collapsing sand layer is encountered below a clay layer (through which the temporary casing could not penetrate), the borehole does not stay open.
- o If a clay layer needs to be drilled below the water table, the direct installation technique cannot be used. This is because the clay will block the slots of the filter screen as the screen is pushed through the clay layer.

2. WHAT DRILLING TEAMS MUST KNOW

BEFORE YOU START DRILLING

Before you start drilling, there are some important things you need to know. First; a good drilling site needs to be selected, where a good quantity (high yield) and quality (no pollution) of groundwater is expected. Second; some knowledge of construction materials such as PVC casings and also of soil sampling and drilling safety could help you to become a better driller.

Selection of the drilling site

Selecting a good location for the well is not always easy and depends on: needs and preferences of the users, expected groundwater level, type of formation (soil) and any nearby sources of pollution (latrines) that may be harmful.

Some tips to help you in site selection:

- o The needs, preference and ideas of the users should be placed first when you select a location.
- o Always discuss advantages and disadvantages of the selected location with the users (you are a specialist who has knowledge about the expected quantity and quality of water in relation to the selected site).
- o Ask villagers to show existing hand dug wells and try to talk with hand diggers. They can give useful information on the different types of formation (soil) and the level of the ground water in dry- and in rainy season.
- o Note that drilling in valley bottoms and riverbeds is likely to be more successful than high up in the hills. Keep in mind that the selected site is not flooded during the rainy season (if it is the lowest point in the landscape).
- o Always choose a site at least 30 m away from a latrine. Avoid other possible sources of pollution such as waste dumps, fire places and fuel stations.

MATERIALS

What about the PVC pipes?

For the well casing, you can use different types of PVC. The quality can vary from cheap drain pipes with self made filter screens to expensive, high quality factory slotted filter screens and casing pipes. The choice of pipes depends on: diameter of the pump (the pumps should fit the pipe), type of the well (irrigation or potable water), user intensity (household or communal) and the users budget (low or high).

Buying the pipes

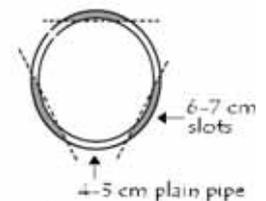
You can buy high quality factory slotted pipe in a specialized hardware store. The pipe has a thick wall, is strong and has a lot of slots per meter filter screen, resulting in a high water inflow. The pipes are expensive and are often used for large communal wells.

When you are buying pipes for the temporary casing or direct installation, you will need pipes with a thick wall (5 mm or more) to prevent the pipes from breaking during drilling, when you are using the working platforms (casing clamps).

You can also buy cheaper PVC pipes, but only use these when you are installing smaller well casing inside your temporary casing. You can find these regular pipes in almost any hardware store; these pipes should have a wall thickness of 3 mm or more. In this case you have to make the slots of the filter screen yourself.

Making the slots in the filter screen

Use a hacksaw to make slots in the pipe. For a 4-inch screen, 6 parallel lines are drawn along the full length of the pipe. The spaces between the alternate lines should be about 4-5 and 6-7 cm (see drawing). The slots are sawn between 6-7 cm lines. The distance between the slots should be about one centimeter.



Guideline: the length of the filter screen should be at least 3 meter. The last meter of pipe has no slots. This is called the sump in which fine particles which enter the well screen can settle, without blocking the filter screen. The bottom is closed with a PVC cap or by cutting and bending the bottom of the PVC pipe.

Gravel pack (when drilling with a temporary casing)

Coarse river sand in the range 1.5-3 mm is used as a gravel pack. The gravel pack fills the space between the borehole wall and the filter screen. It may also serve to filter some of the fine sand particles from entering the well. Use a minimum and a maximum sized sieve to prepare the 'gravel'.

Sanitary seal (when drilling with a temporary casing)

During installation a sanitary seal is placed on top of the gravel pack to prevent pollution entering the well. A sanitary seal is made of clay or cement grout. If cement is used for the seal, first a half meter of clay is backfilled on top of the gravel pack to prevent the cement from penetrating the gravel pack.

TO REMEMBER DURING DRILLING

Take soil samples

Soil sampling helps you to understand what material you have been drilling through and helps you to indicate when you have reached the final depth of drilling.

Sampling is also a good way to determine where the different layers of soil are located. Sand and gravel are very *permeable*. They allow the water to flow easily through the pores (open space) and are therefore suitable layers for placing the filter screen. If the drilled material is very fine, such as silt and clay, it will not transmit water easily and is called *impermeable*. Do not install the filter screen in this formation.

Field tricks

Take a sample of the soil and squeeze it into a ball, between your hands. Then drop the ball from a height of one meter above ground level.

- o If the ball consists of non cohesive (non-sticky) particles, the ball totally falls apart. In this case the material is *permeable*. The particles of sand or gravel will be easily visible.
- o If the ball falls apart only partially, the soil contains some silt or clay and sand. The formation has a *low permeability*.
- o If the ball only deforms and remains more or less in shape, it is composed of clay, and is described as *impermeable*.

Drilling safety

When you have to leave the site overnight during drilling, you need to take important precautions:

- o Take the auger out of the borehole. This will prevent the auger from getting stuck.
- o Protect the borehole. Take measures to prevent cattle or people from stepping into it.



Please be aware that drilling can be a dangerous activity. Watch each other and ask villagers (especially children) to watch you from a safe distance. This prevents them from accidentally being hit by one of the extension rods.

NOTE

These are a few guidelines to help you during drilling. You can find more information on soil, groundwater, hygiene, sampling, well installation and well development in the manual '[Understanding groundwater and wells in manual drilling](#)'.

3. WHAT TO BRING

Tools & materials



Bailer (1 piece)



Conical auger (1 piece)



Riverside bit (2 pieces)



Auger platform (2 pieces)



Extension holder (1 piece)



Extension rod 1,5m
(1 piece)



Extension rod 3m (5 pieces)



Tamp (1 piece)



T-handle (1 piece)



Hacksaw (2 pieces)



Shovel (1 piece)



Pin (extensions) (10 pieces)



Filter cloth



Iron wire



Top cap (1 piece)



Inner tube (3 meter)



PVC casing



Temporary casing 3m (3 pieces)

Temporary casing 1,5m (6 pieces)



Sieved gravel pack 50kg (1 bag)



Open clay auger



Depth measuring tool (1 piece)



Bucket 12 liters (2 pieces)



Sieves 1,5 mm & 3 mm (1 piece)



Toolbox (full)

Spare bolt and nut (5 pieces)

4. HOW TO DRILL A BOREHOLE USING THE HAND AUGER AND A TEMPORARY CASING

STEP 1 PREPARING THE AUGER

Connect the auger to the handle

Place the handle over the 'male' connection of the conical auger bit.



Secure this connection with a pin.



Wind the iron wire a few times around the end of the pin. This is to secure the pin in the connection (the pin cannot fall out during drilling)



Tip!

Do not use galvanised wire as it tends to break. Use normal iron tying wire used for tying rebar.

STEP 2 DRILLING ABOVE THE WATER TABLE

Make the starter hole

Place the conical auger on the soil.



Turn the handle in clockwise direction until it has drilled 30cm into the soil.



The auger is now filled. Lift the auger out of the borehole.



Shake the auger (away from the hole) to remove the cuttings

Place the auger back into the hole and repeat again. Continue drilling until the handle has reached the ground.

Tip!

When you are drilling in dry sand (often the first meter of the hole) and the cuttings fall out of the auger, add some water to make the sand more 'sticky'.

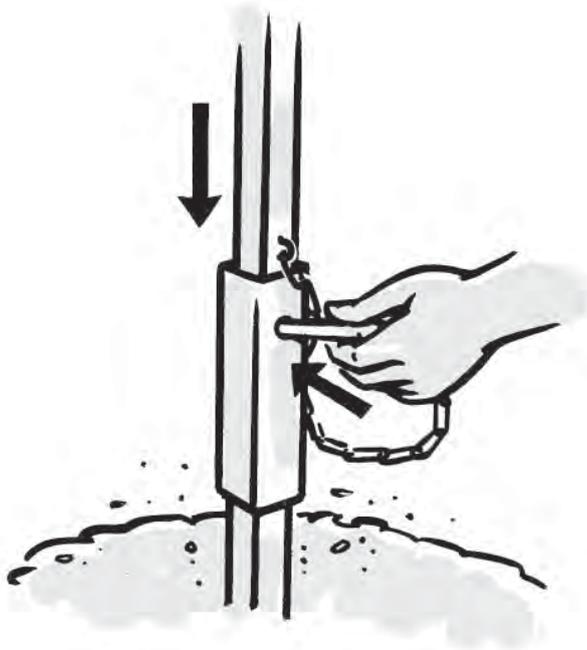
Connect the first extension rod

Continue drilling until the handle has almost reached the ground. Remove the iron wire, pin and handle.

Place the 1.5 meter extension rod



Place the pin and wind the iron wire.



Place back the handle on top of the extension rod.

Drill deeper

Continue drilling until the 1.5 meter extension rod has been drilled.

Tip!

In the first meters of drilling it is very important to drill a straight borehole. A borehole which is not straight will cause problems later during installation of the casing and pump.

Connect a next extension rod

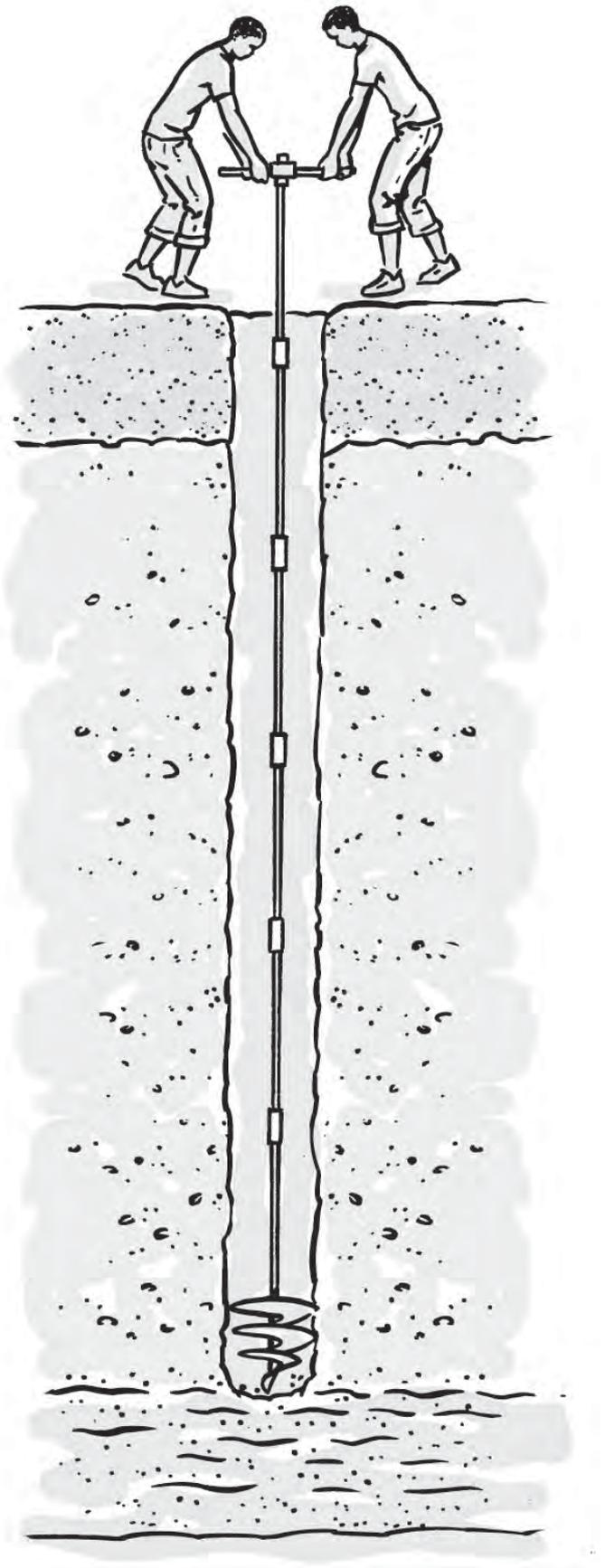
Replace the 1,5 meter extension rod by a 3 meter extension rod and continue drilling again.

Again connect the 1,5 meter extension rod to the top of the 3 meter extension rod, once the 3 meter extension rod has been drilled almost to ground.

- o Keep on drilling and adding extension rods until you reach the water table.

Tip!

Always securely HOLD extensions that are inside the drilled hole when you add or remove extensions. It prevents the extensions and auger from falling back inside the drilled hole!



STEP 3 DRILLING BELOW THE WATERTABLE

What to do when you see wet cuttings?

You will notice that the cuttings will become wet when you are approaching the water table.

What to do next:

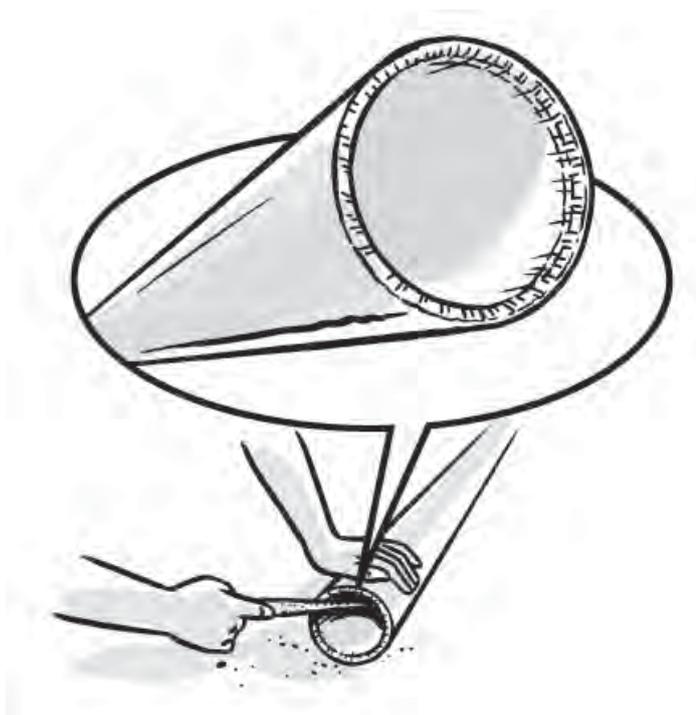
- o In sand: try to drill half a meter into the wet sand with the conical auger.
- o When you are drilling in clay or sandy clay, keep on drilling until you reach a sand layer.
- o Remove the extension rods and COUNT the number of rods you take out of the borehole.
- o When you take this number of rods and you add the length of the conical auger you have calculated the depth of the borehole.

Tip!

When sand is too wet it may fall out of your auger and drilling becomes difficult. When that happens do NOT drill any deeper. Sand is now starting to collapse on the bottom of the borehole.

The sand may collapse on top of your auger, you can lose your equipment if you drill deeper.

When you are drilling BELOW the water table you must use a temporary casing to prevent the hole from collapsing.



Prepare the temporary casing

File or sand the bottom end of the temporary casing into an angle.

This will make it easier for the casing to cut its way down.

Tip!

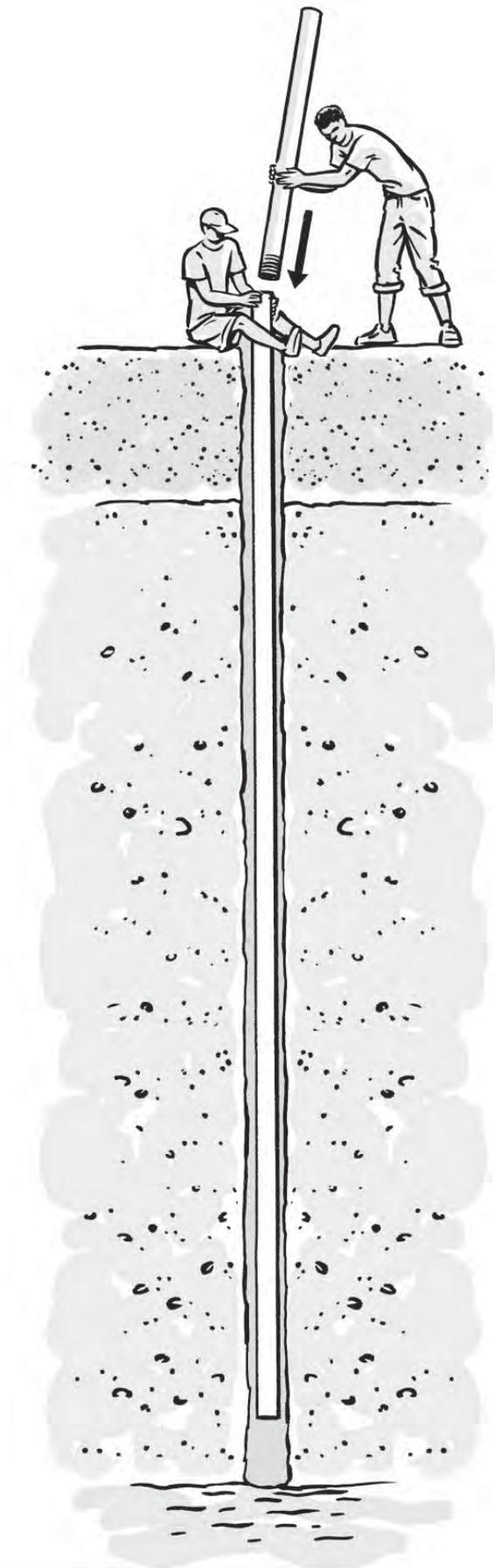
The bottom end of the temporary casing must have NO threads.

Install the temporary casing

- o Calculate how many meters of casing you need to reach the bottom of the hole (remember your calculation from counting the extension rods).
- o The PVC casing is now lowered inside the drilled hole. Install a maximum of **6-9 meter at a time**, to prevent the pipe from breaking.
- o Hold the casing tight (do not drop it in the hole!)
- o Another casing pipe is now added.
- o Keep adding casing pipes until you have reached the bottom of the borehole.

Tip!

Clean the treads of the casing before connecting.



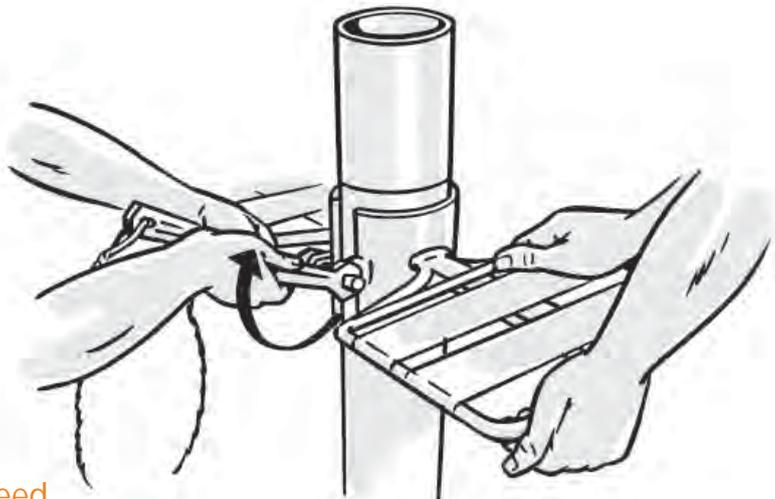
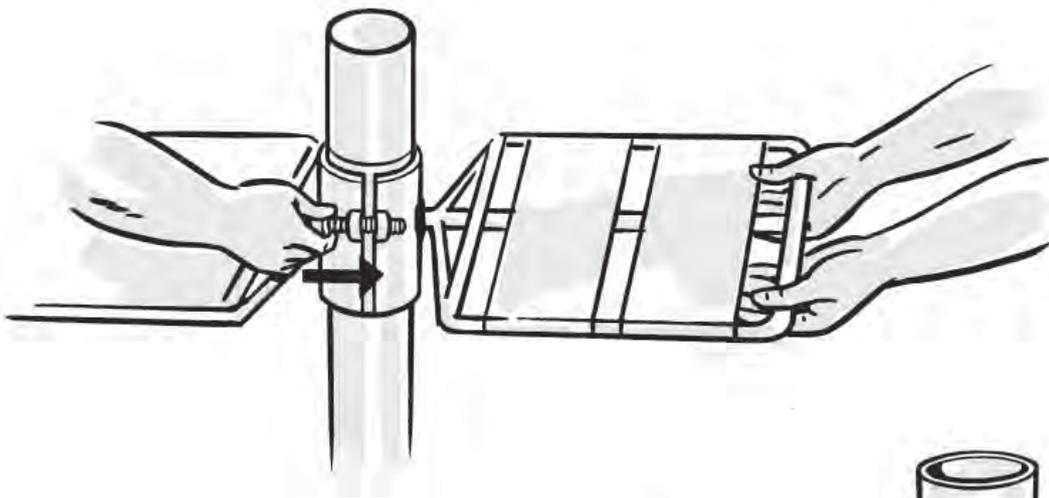
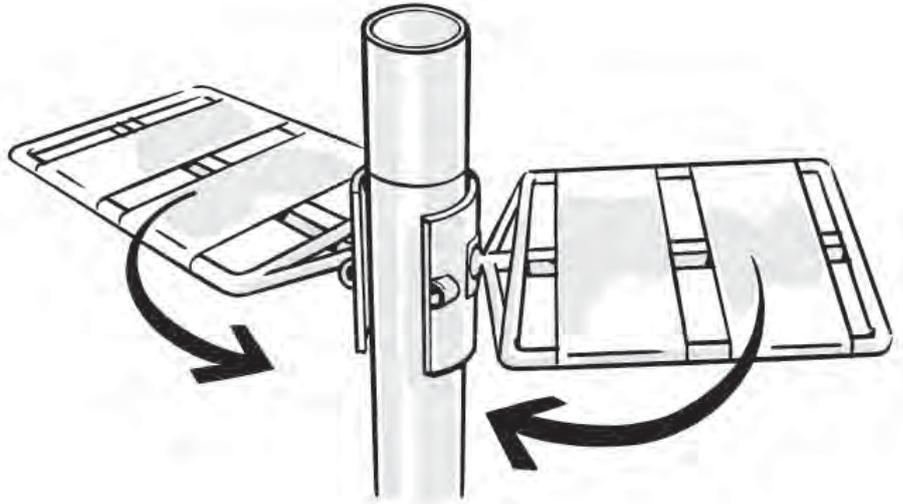
Attach the PVC top cap to the temporary casing

Screw the PVC top cap on top of the temporary casing to protect the threads from damage.
(the construction of this top cap is explained in module 3).



Attach the platform (clamp) to the temporary casing

Place the working platform (clamp) around the top end of the temporary casing. It is connected to the casing.



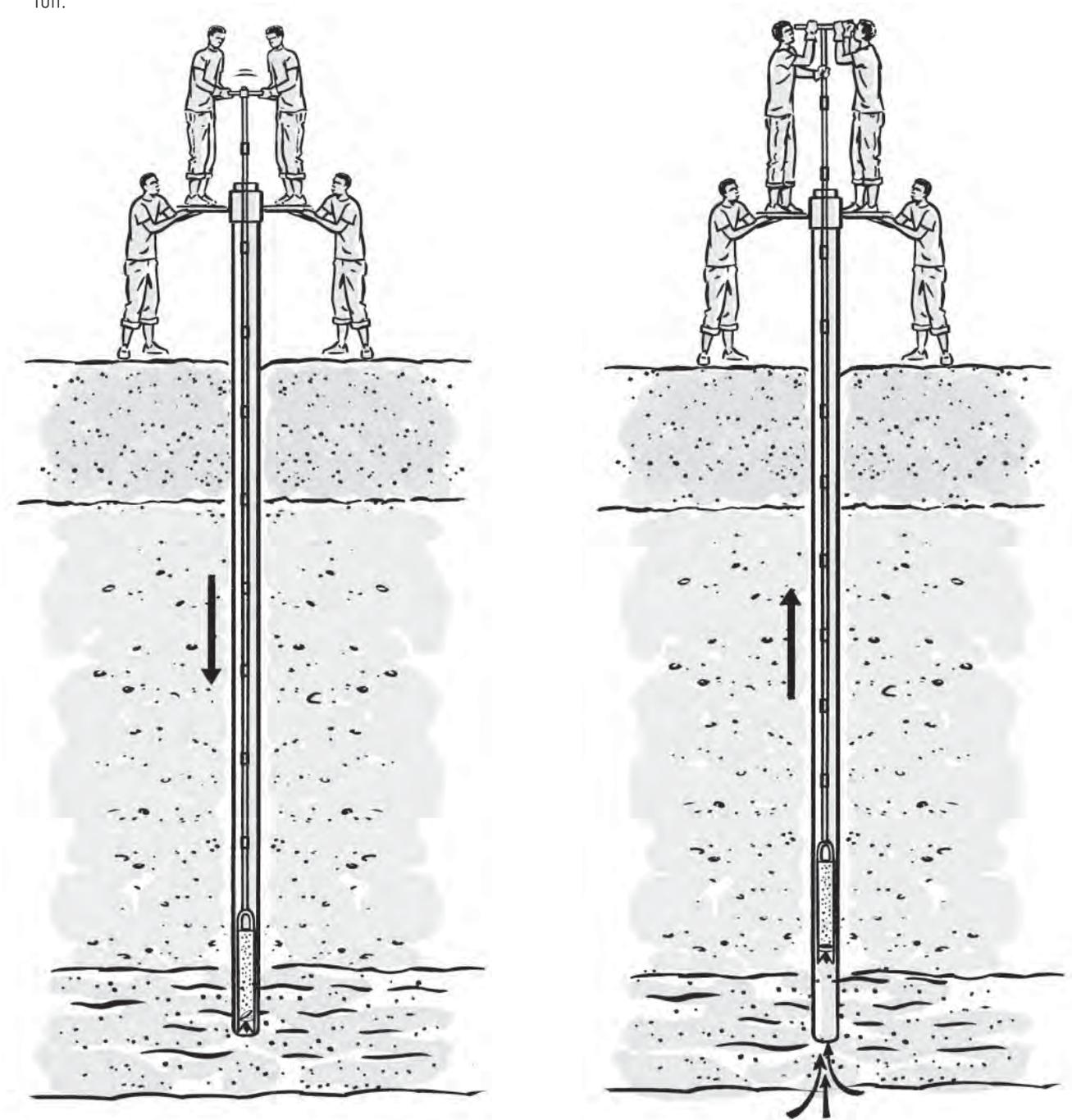
When you have drilled deeper and you need to attach more casing pipes, you;

- o Loosen the working platform
- o Remove the top cap,
- o Add another length of casing
- o Attach the top cap and working platform again
- o Continue drilling

STEP 4 DRILLING WITH THE BAILER

Drill inside the casing with the bailer

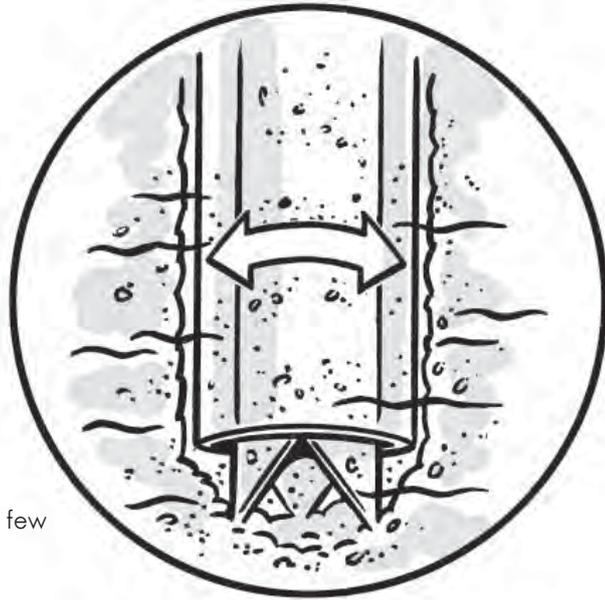
- o Attach the bailer to the extension rods and lower the bailer in the hole.
- o Now make an up and down movement of 30-50 cm, to fill the bailer.
- o Make this movement continuously for about 10 times until the lifting becomes much heavier. The bailer is now full.



Tip!
When you are standing on the platform, it will move from side to side. Make sure that other workers hold the platform in a fixed position.

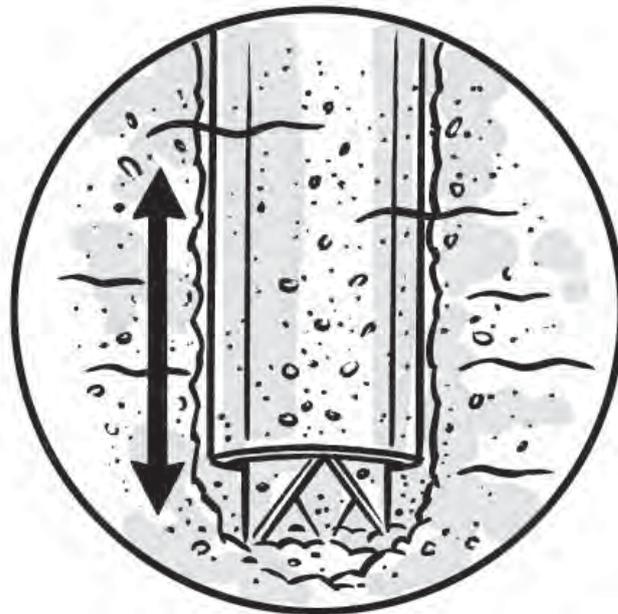
Rotation movement in compacted sand

How to drill in compacted sand? If you can not drill deeper when making up and down movements (it feels like you are hitting a stone), you are drilling in compacted sand.



Rotate the bailer a quarter turn and back, repeat this a few times.

Then make up and down movements.



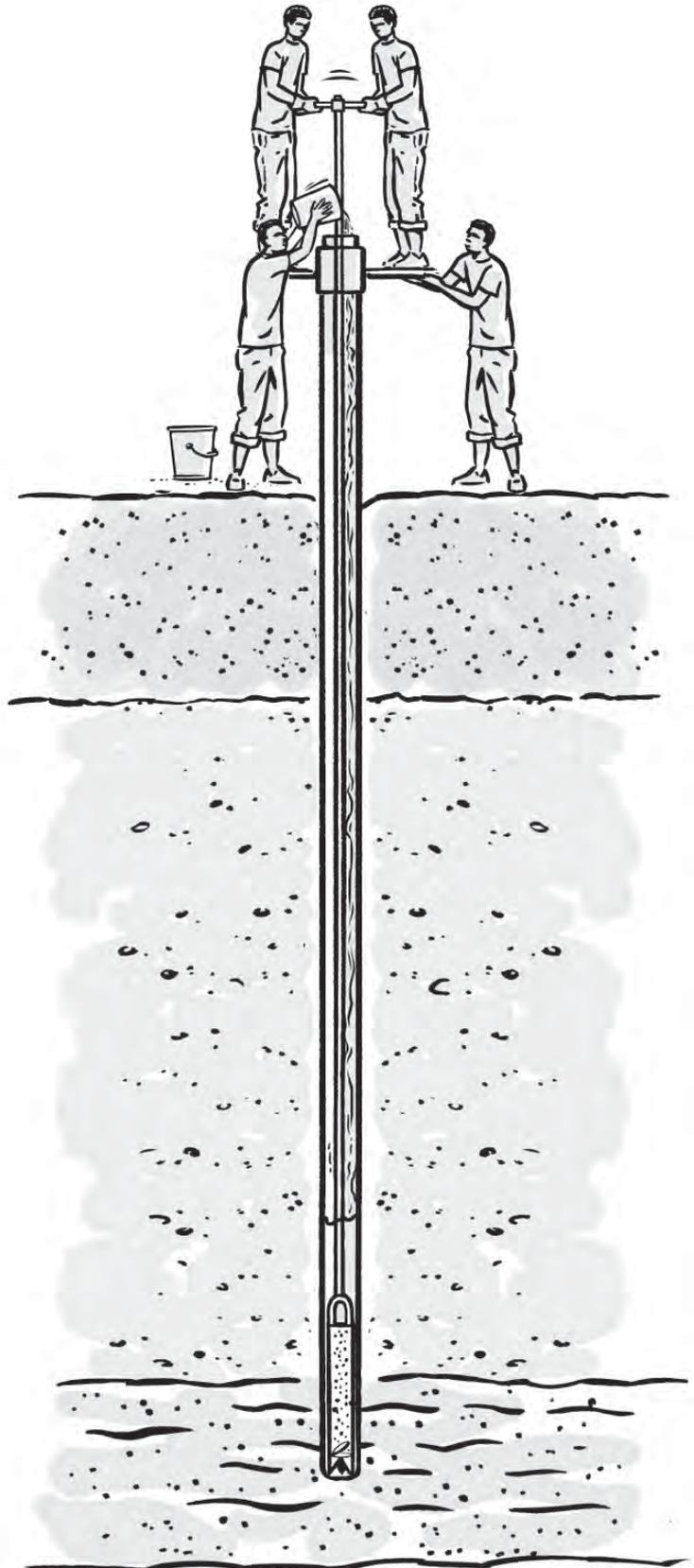
Continue the rotations and up and down movements until the bailer is filled.

The rotation movement will loosen the sand. The up and down movement will fill the bailer.

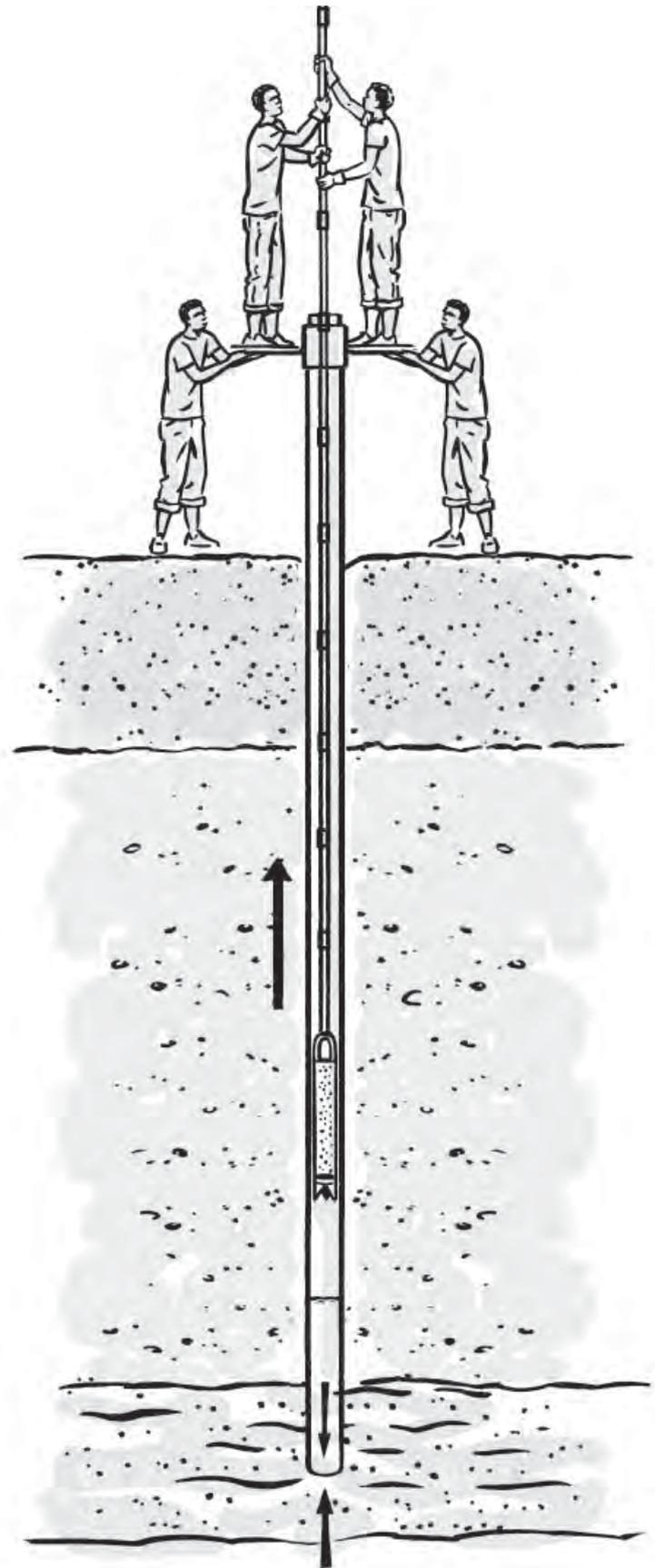
Add water

Pour one or two buckets of water in the casing before removing the bailer from the borehole. This is to prevent sand to flow into the bottom of the casing.

Pour one or two buckets of water in the casing. The water level in the casing will now be higher than the groundwater level.



Lift up the bailer. The weight of the water in the casing prevent sand to flow into the bottom of the casing.

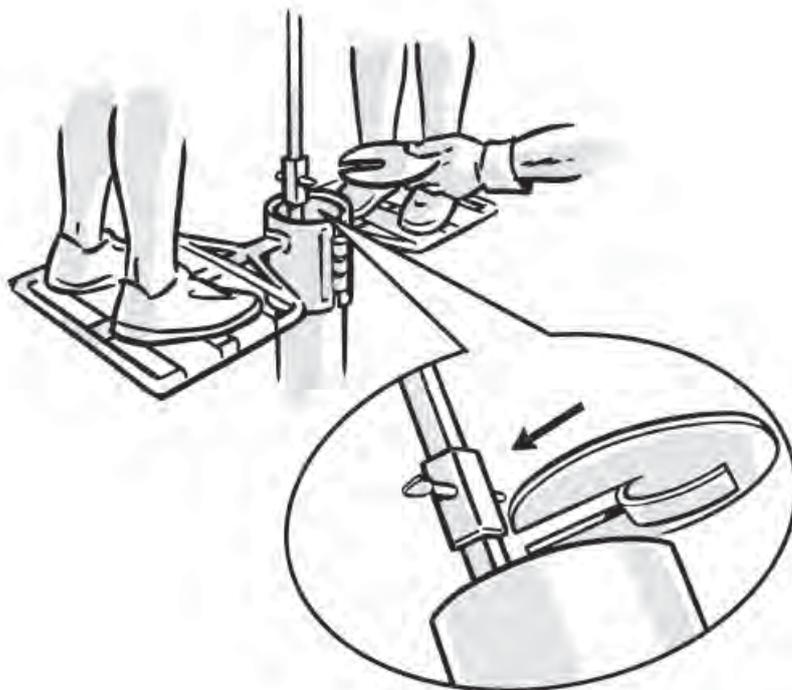
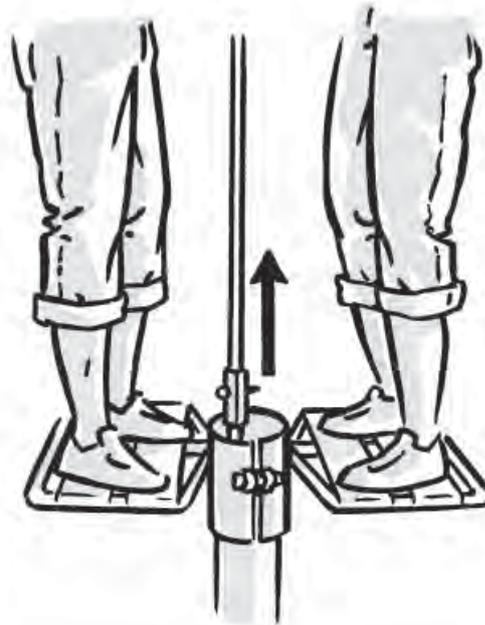


STEP 5 REMOVING THE EXTENSION RODS

Remove the extension rods

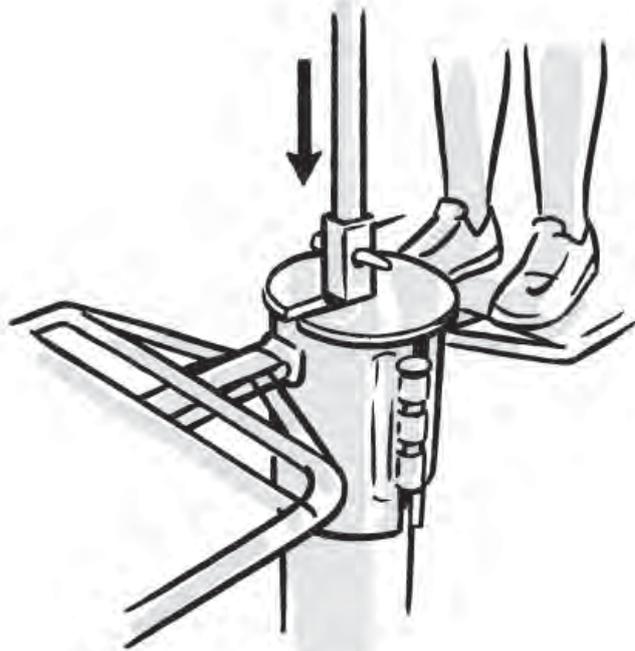
How do you remove the bailer from the bore hole?

Lift up one or two extension rods.

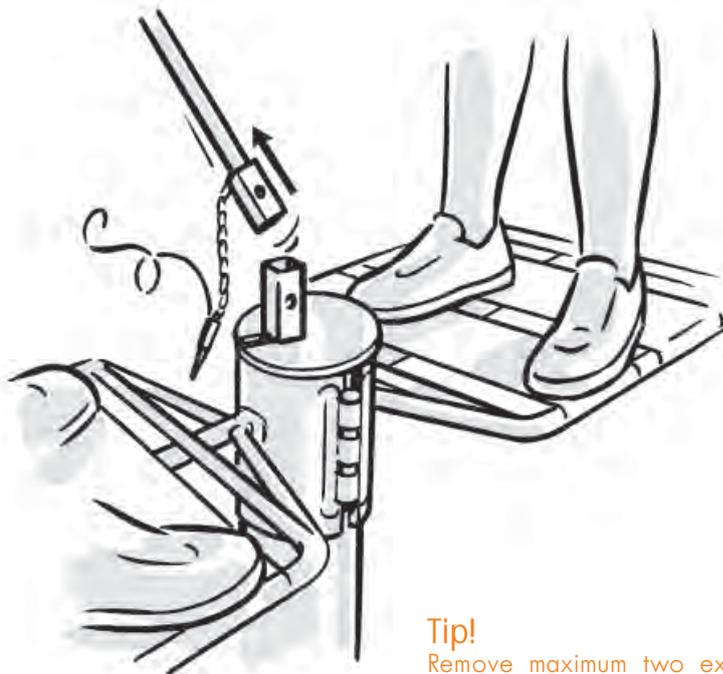


Place the extension holder on the top of the casing, just below one of the connections.

Let the connection rest on the holder



Remove the pin and then remove the extension rod



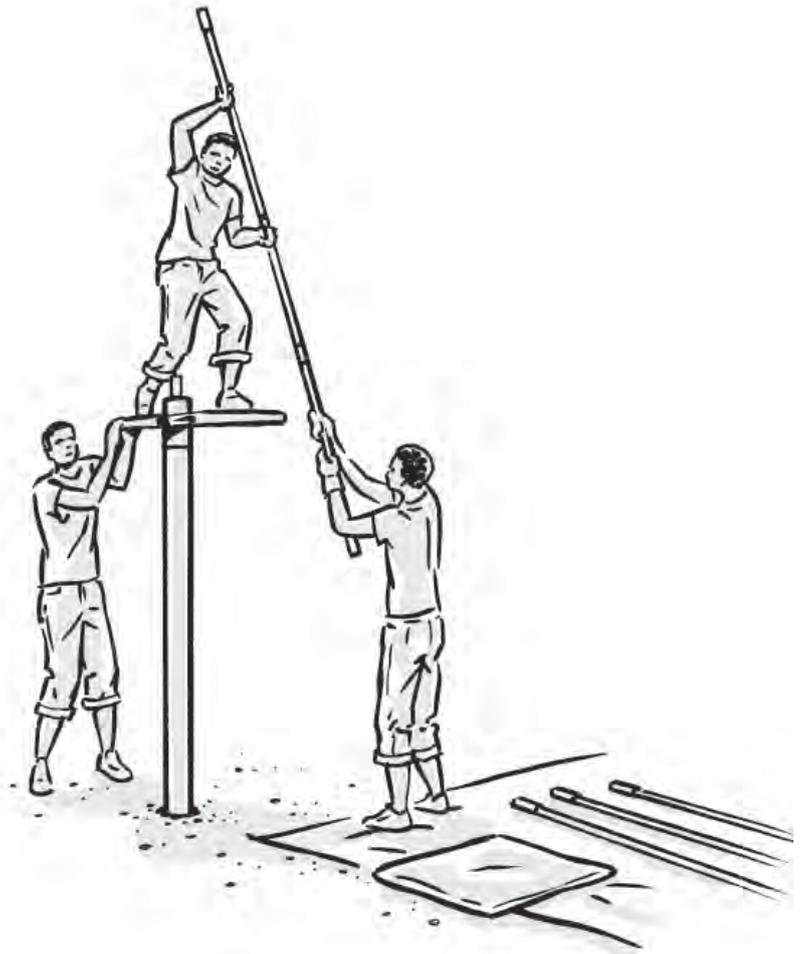
Tip!

Remove maximum two extension rods (6 meter) at the time. Removing longer pieces will bend the rods and the connections.

STEP 6 REMOVING THE CUTTINGS

Remove the bailer

Remove all your extension rods and the bailer from the borehole.

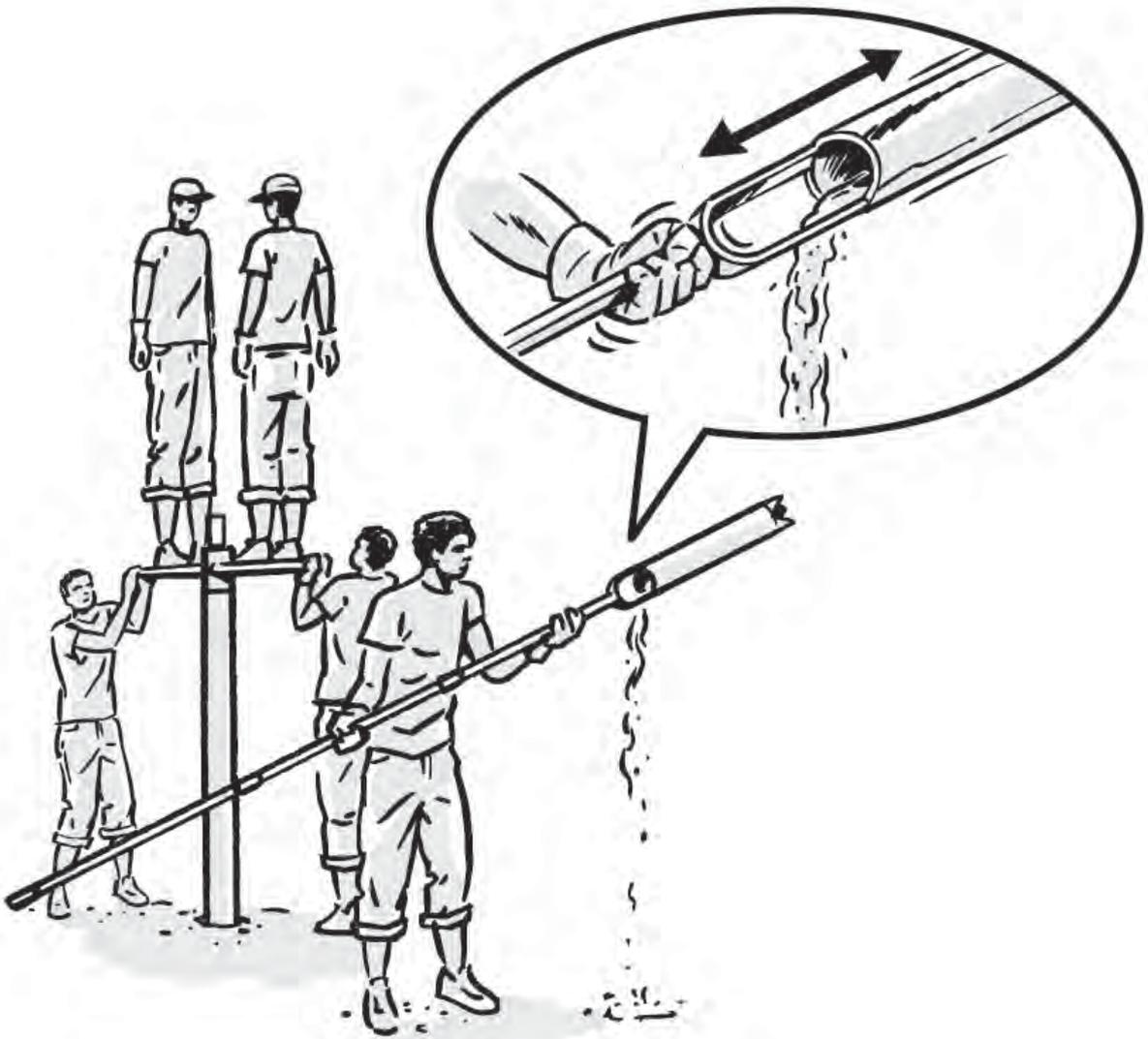


Tip!

Avoid any sand to enter the male-female connection of the extension rods. Place them on a piece of plastic when not in use.

Empty the bailer

Hold the bailer in upright position and shake it till it is empty.



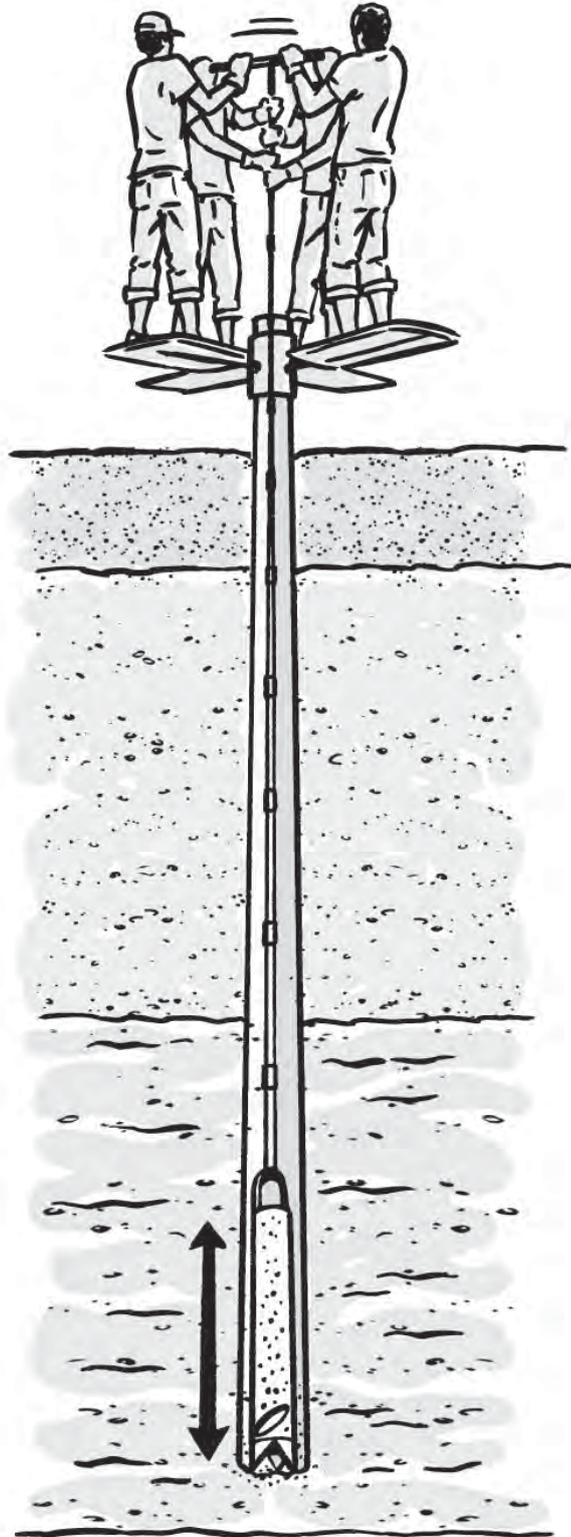
Place back the bailer and the extension rods. Use the extension holder.

STEP 7 ADDING MORE WEIGHT

Attach a second platform

If the casing is not going down while you are drilling deeper, you may need to add more weight to push the casing down.

Attach a second platform to the PVC casing, just below the first platform. Now 4 people can stand on the platform during drilling.



STEP 8 BAILING AT THE RIGHT DEPTH

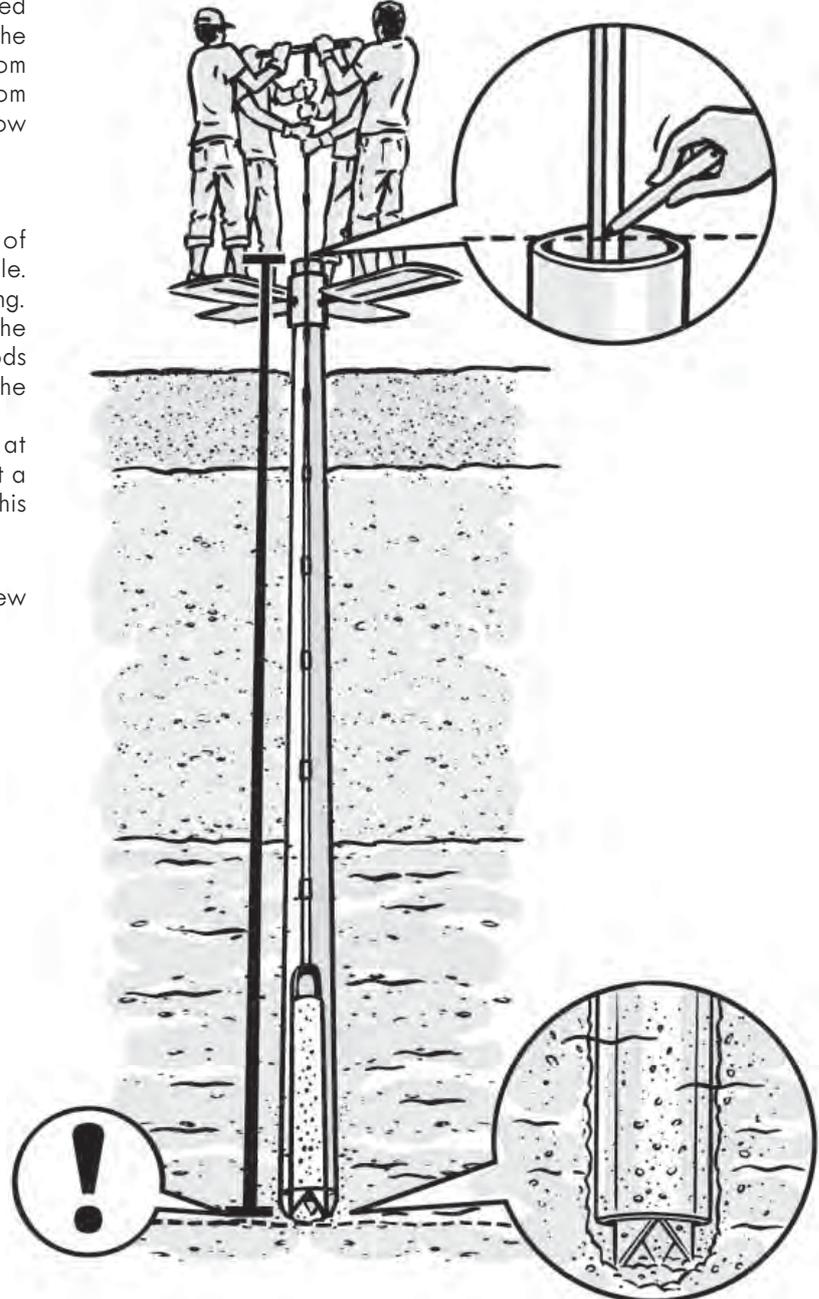
Measure the depth of your bailer

When you want the casing to go down, you need to remove the sand just below the bottom of the casing. In other words: during drilling the bottom end of the bailer should be close to the bottom of the casing. So it is important for you to know the depth of the bailer during drilling.

How to measure this:

1. Always count (and measure) the number of PVC pipes that go down in the borehole. Calculate the total length of the PVC casing.
2. Measure the length of the bailer and the extension rods. Lower the bailer and the rods in the borehole (for the same length as the PVC casing)
3. When the bottom of the bailer is exactly at the bottom end of the casing, you can put a mark on the extension rod to remember this depth of the bailer.

Place a new mark each time you add a new casing pipe.



Tip!

When the marked line is ABOVE the top of the casing, you need to continue drilling to empty the casing (in this case there is sand in the casing).

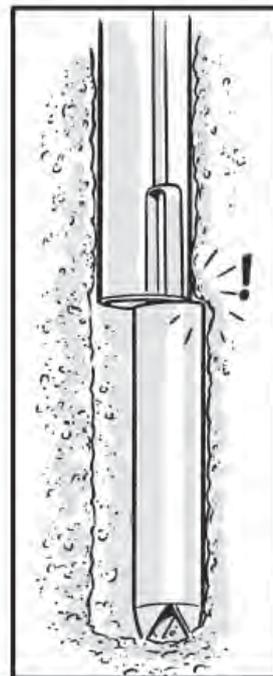
When the marked line comes BELOW the top of the casing, you are drilling deeper than the casing. Do NOT drill deeper, your bailer will get stuck under the casing.

Tip!

In practise you will be drilling most of the time in the bottom 50cm of the casing. The closer you drill to the bottom of the casing, the faster the drilling will be.

What to do when the bailer gets stuck

Rotate the auger 90 degrees backwards (anticlockwise), and lift up the auger carefully.



STEP 9 DRILLING TO THE RIGHT DEPTH

Take soil samples

Take a sample of the drilled soil, every time you empty the conical auger or bailer.



The right depth of drilling

Continue drilling until you have reached the final depth. The final depth of drilling is reached when you have drilled at least 4 meter into a coarse layer of sand/gravel.

Tip!

It is very useful to place all samples on a piece of plastic and write down the depth.

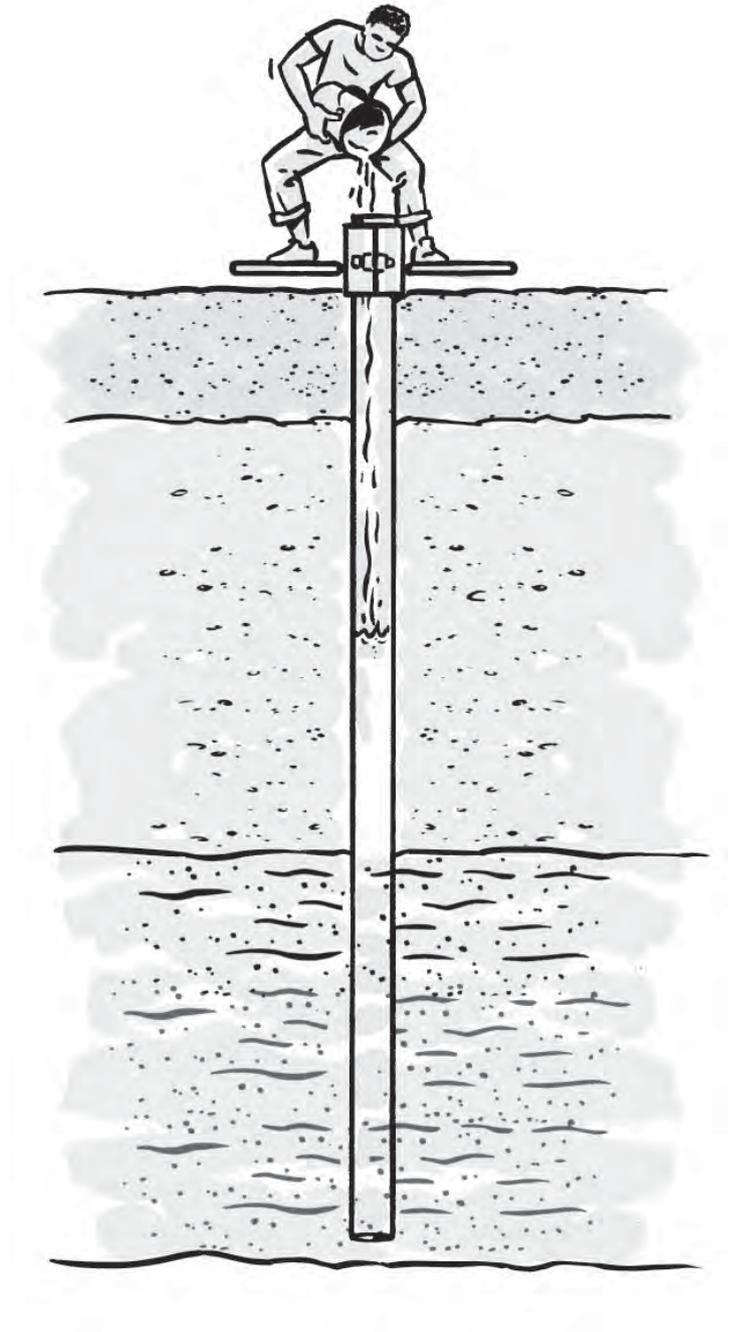
STEP 10 CLEANING THE CASING

Only continue with the next step if you have reached the final depth of drilling

Clean the casing

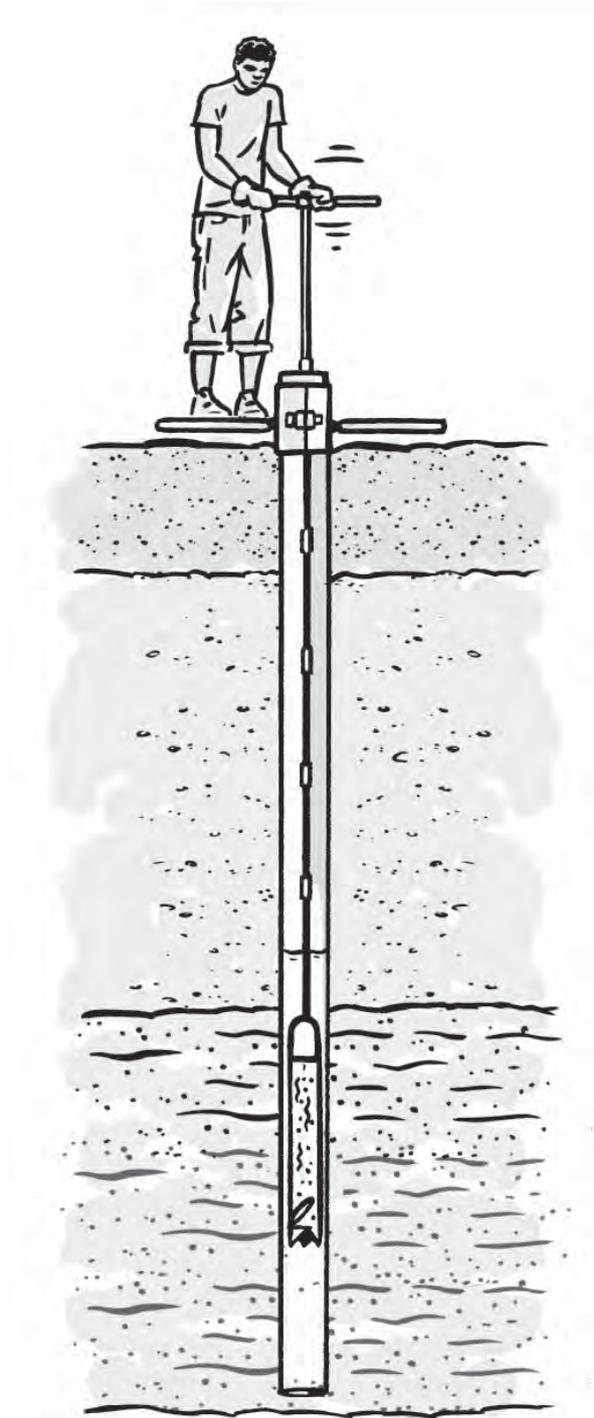
The next step is to clean the inside of the casing

Pour a few buckets of water into PVC casing.



Remove all the cuttings from the bottom of the borehole with the bailer. This time move the bailer SLOWLY up and down. DO NOT drill any deeper.

Do this until the casing is clean, then remove bailer and the rods. The final installation can begin.



Tip!

Always make sure that the water level in the casing is higher than- or equal to the level of the groundwater. Do NOT remove all the water from the casing during bailing, as sand will start flowing in from the bottom of the casing.

STEP 11 THE FINAL STEPS

Measure the depth of drilling

Measure the exact depth of your borehole. This gives you information on the total length of casing pipes needed.



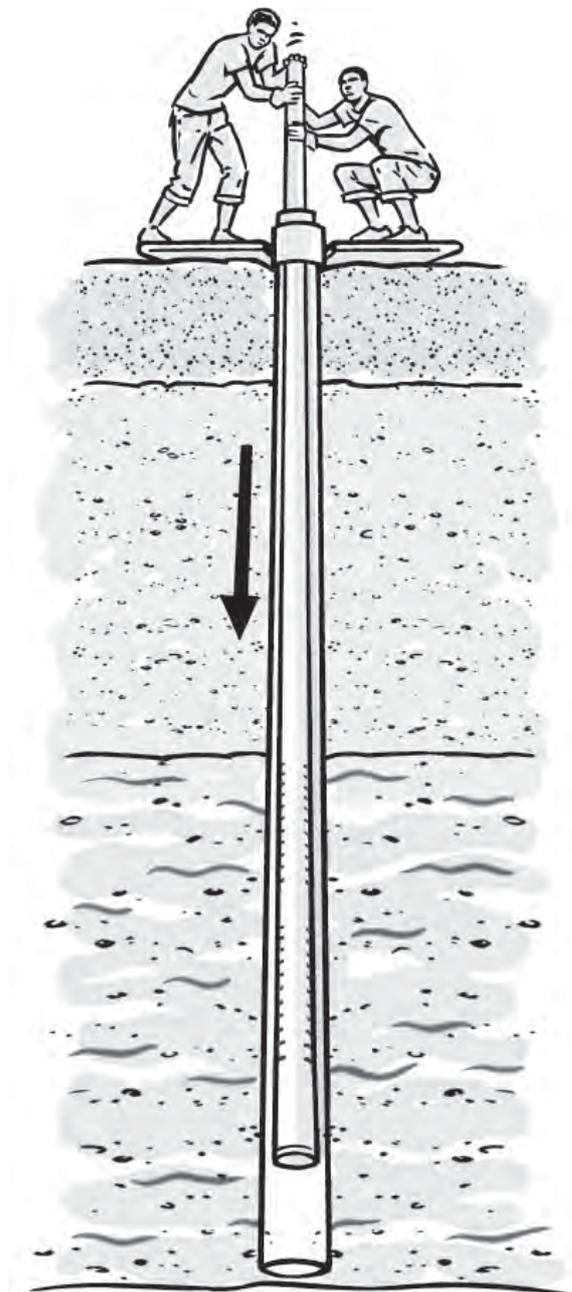
Tip!

For measuring; use a rope or long measuring tape with a small weight attached. Measuring with a rope can be best done when you make small knots at every meter.

Installation of the PVC well casing

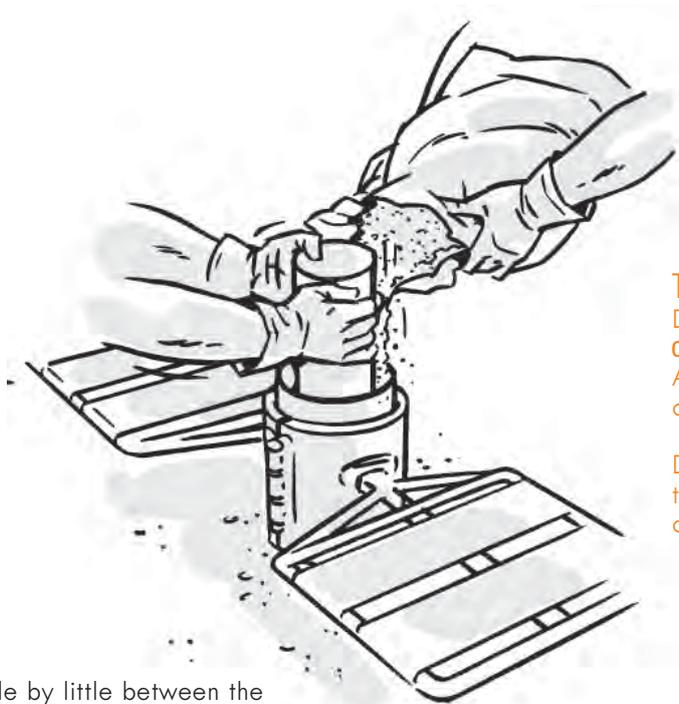
Prepare the filter screen, the sump and the well casing, before you start the installation.

- o Lower the filter screen into the borehole. Make sure to close the bottom with a PVC cap!
- o Then screw or glue the first PVC casing pipe to the screen.
- o Lower the casing further into the borehole. More PVC pipes are added one by one.



Tip!

Always make sure that one person is holding the well casing to prevent it from dropping into the borehole.



Tip!

Do this slowly and **lift up the temporary casing at the same time.**

Add 50 cm of gravel and lift the casing for 50 cm (read the next step).

Do NOT fill all the gravel at once, because the well casing will get stuck in the temporary casing.

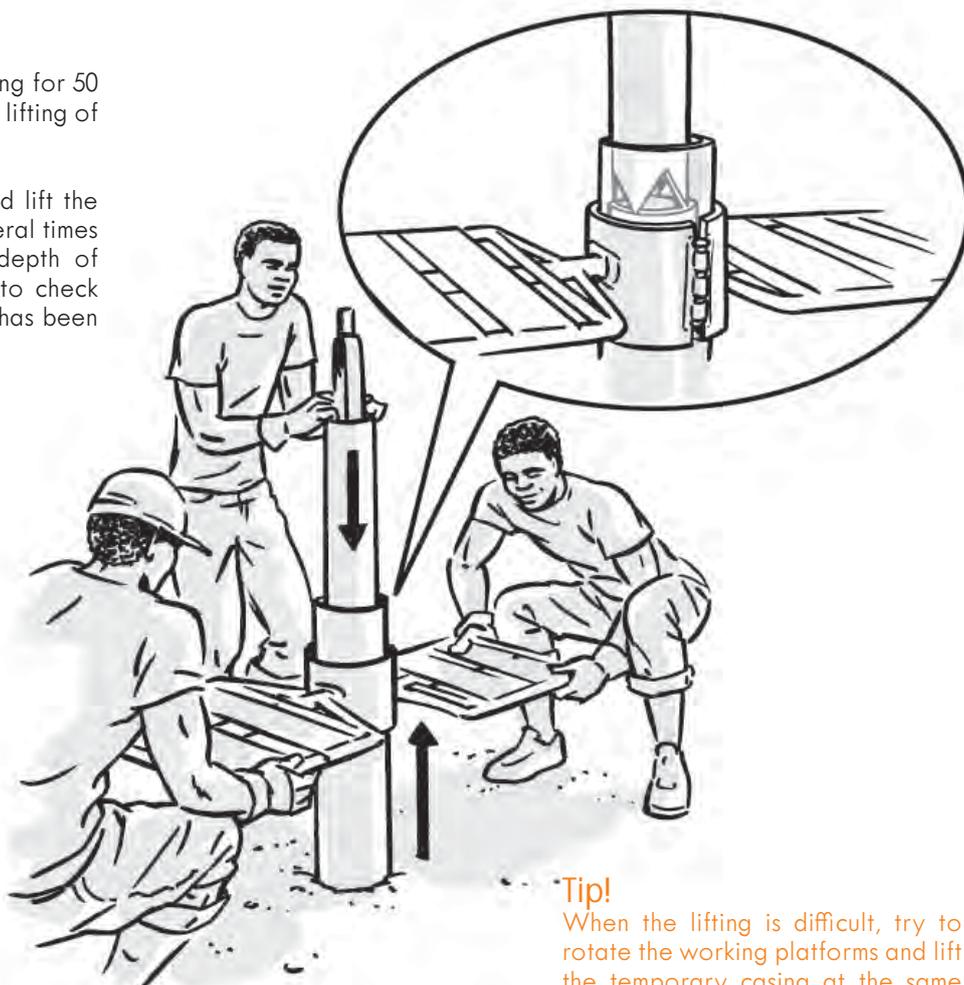
Gravel packing

Pour some gravel little by little between the well casing and the temporary casing.

Lifting the temporary casing

Add 50 cm of gravel and lift the casing for 50 cm. Push down the well casing during lifting of the temporary casing.

Then again add 50 cm of gravel and lift the casing for 50 cm. Repeat this for several times until you have reached the right depth of gravel packing. Measure regularly to check if the right depth of gravel packing has been reached.



Tip!

When the lifting is difficult, try to rotate the working platforms and lift the temporary casing at the same time.

Use the bailer to keep pushing DOWN the well casing when you are lifting UP the temporary casing.

Measure the depth of the gravel pack

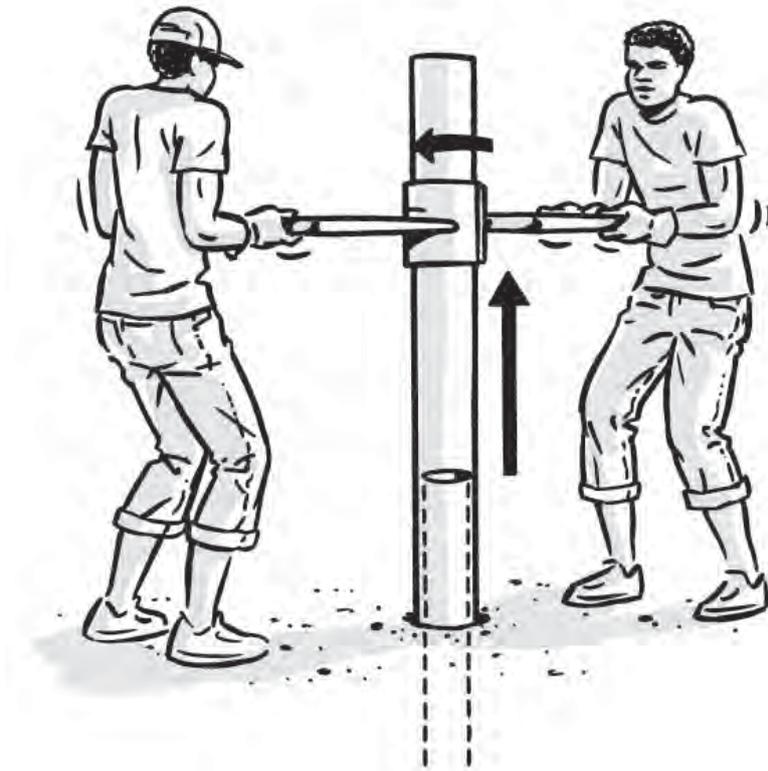
Fill the open space between the casing pipe and the borehole wall for 1-2 m above the top of the filter screen.



Remove the temporary casing

Now the temporary casing can be removed from the hole.

- o Pull and rotate the working platforms to lift up the temporary casing.
- o Loosen the clamp of the working platform, lower it on the pipe and tighten again.
- o Lift up the temporary casing again until the coupling is out of the borehole
- o Uncouple and remove the temporary casing one by one.



Backfilling

After you have removed the temporary casing, you can install the sanitary seal and add the rest of the backfilling (see the chapter: "What drilling teams must know")

Leaving the well behind

When the drilling is finished and you are leaving the site, remember to cover the PVC casing!

This can be done with a PVC cap or plastic bag tightly wrapped with inner tube. It is needed to assure that nothing can be dropped into the well by children, before the pump is installed.



5. SPECIFIC SITUATIONS AND COMMON PITFALLS

Use the right drill bit!

As you are drilling, you will find different types of soil. Some are hard and compact and others are soft and loose. You will also be drilling above (dry) and below the water table. Because of this it is important to choose the right drill bit in each situation.

Auger type	Where to use	Comments
Conical auger (large)	Above the water table	To use for clay, sand, silt
Open clay auger (large)	Above the water table	Excellent for sticky clay
Riverside auger (large)	Above the water table	For use in sand, small gravel and silt material
Riverside auger (small)	Inside the casing, above and below the water table	For use in sand, small gravel and silt material
Bailer	Inside the casing, below the water table	To use in sand and gravel. The material will enter through the bailer's foot valve and collect inside.

The package of technical drawings in module 3 shows how to fabricate the different augers as these are the most common types for basic use.

There are many more types of augers that are used for drilling in different soil types. Ask a technical trainer for advice if you want to experiment or fabricate other augers than those explained in this manual.

Fishing when an extension has dropped

When an extension with attached bailer has fallen back into the borehole by accident, it needs to be recovered quickly!

- Try to make a hook out of strong material and attach it to a rope. Lower this about a meter above the bottom of your well and try to find top of the bailer. Then slowly lift the bit and extensions again.
- Another way of 'fishing': Lower your extension rods and try to find the top of the lost extension rod or bailer. Place your extension rod on top of the lost rod. Make 'lasso' of a short piece of chain, attached to a rope. Lower the 'lasso' around your extension rods, until you reach the lost rod. Tight the loop and lift up the rope and extension rods.

Never forget

1. Always choose a site at least 30 m away from a latrine and other sources of pollution.
2. If you pause drilling for more than a few minutes (for example for lunch break), lift the extension rods out of the borehole. This will prevent the bit from getting stuck.
3. Always take soil samples. Place them on a plastic sheet and write down the depth. This will help to determine the depth of your drilling.
4. Always place your filter screen in the coarsest layer of sand or gravel.
5. Use a sump (blind pipe) below your filter screen to collect any fine material that enters the well.
6. A guideline for the most regular length of the filter screen is 3 meter.
7. When the drilling is finished and you are leaving the site, remember to cover the PVC casing! This can be done with a PVC cap or a plastic bag tightly wrapped with inner tube. It is needed to assure that nothing can be dropped into the well by children.
8. Augers and bailers should not be over-filled with cuttings.
9. When you are drilling inside the casing, never uncouple the extension rods without using the extension holder. Only disconnect 6 meters at a time.
10. Hold the casing platform when workers are standing on top of it.

Tool maintenance

- Look after your drilling equipment! Clean the connections of the extension rods and drilling bits from sand.
- Regular sharpen the teeth of the drilling bit using an angle grinder.
- Check the welds on the extension rods, working platforms and drilling bits.
- Regularly check the extension rods for their straightness.
- Check if the tools are complete and purchase or replace if necessary.

6. DIRECT INSTALLATION

When drilling in pure sandy soils (without any clay or silt), the final casing can be installed directly (only if the client wants to have expensive thick wall (> 5mm) casing).

A borehole of 120 – 160 mm is drilled using the auger until the water table is reached. Then a permanent well casing (wall thickness 5-7.5 mm) with a diameter of 125-140 is prepared. In fine sands, a geo-textile or polyester filter cloth is wrapped around the filter screen. When drilling continues, the permanent well casing is used instead of a temporary casing. The drilling is finished when you have reached the final depth.

TEMPORARY CASING VS DIRECT INSTALLATION

The drilling method and tools for direct installation are the same as for drilling with the temporary casing, but there are some small differences.

- o A temporary casing is not used, you are drilling with the permanent well casing
- o Gravel packing is not possible
- o In fine sands, a geo-textile or polyester filter cloth is wrapped around the filter screen. It is drilled down together with the casing.

The filter cloth

Gravel packing is not possible when you do direct installation. A filter cloth (100% polyester or geo-textile) is used as an alternative, to prevent fine sand entering the screen. Drilling without a filter cloth is only possible when the screen is placed in a coarse layer of sand (the coarse sand will not enter the slots of the screen).

The use of filter cloth it is limited to drilling in pure sands. When a filter cloth penetrates a layer of clay, the filter cloth will get blocked and become unusable. Even small amounts of silt and clay can completely block the filter cloth. Whenever you use a filter cloth remember not to rotate the casing during drilling, because this could tear the filter cloth.

STEP 1-10 THE DRILLING PROCESS

Follow the drilling steps of 1 - 10 that have been explained for the use of a temporary casing, but first look at a few important changes: **Step 3 and step 11 are different.**

Steps 1 and 2

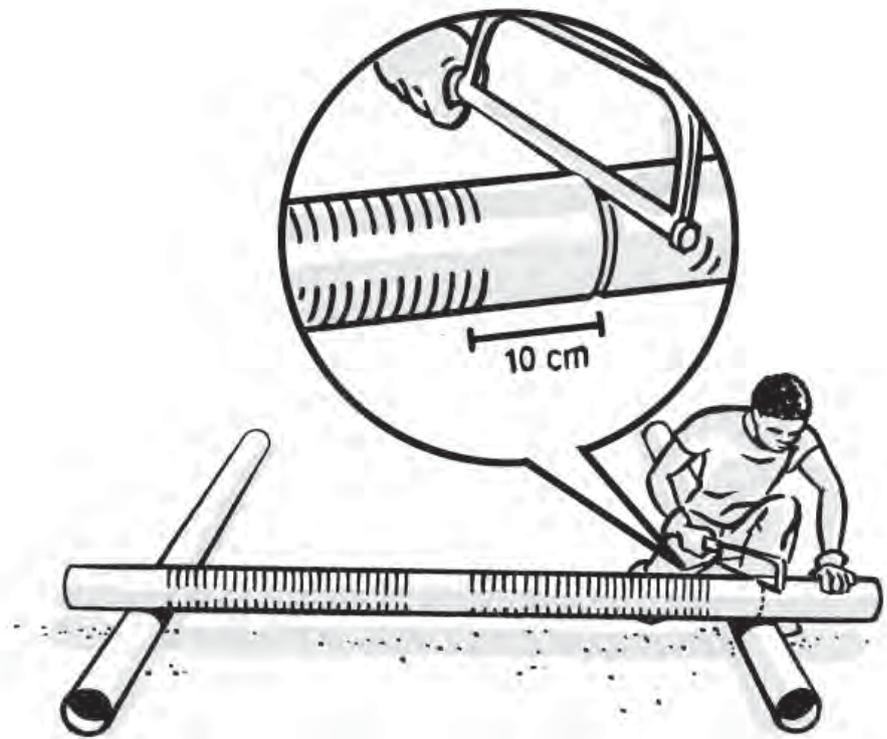
First follow the drilling steps 1 and 2: Drill a borehole with the auger until you have reached the groundwater level.

STEP 3 PREPARING THE CASING

Make a groove

Make a small groove in the filter screen (just enough for a metal wire to fit 2 times).

Do this on the upper end and lower end of the filter screen.

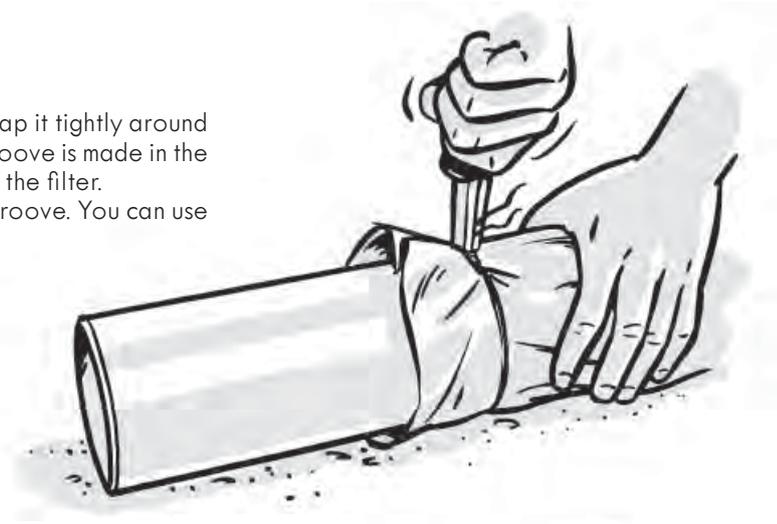


The filter cloth

Wrap a filter cloth (geo-textile) tightly around the filter screen.

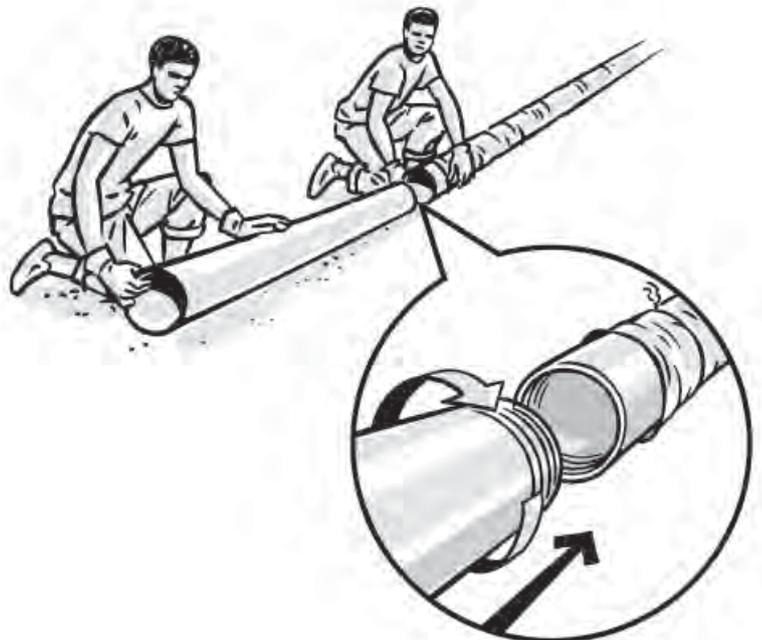
Tighten the filter cloth

Take a piece of galvanised wire and wrap it tightly around the filter cloth at the place where the groove is made in the casing. Do this at the bottom and top of the filter. Wrap the iron wire for 2 times in each groove. You can use pliers to secure them.



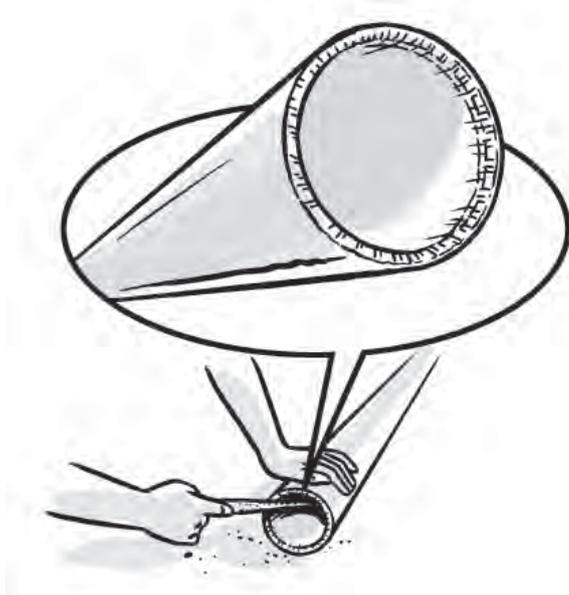
Attach the sump

Connect a sump (0.5 – 1 m) to the bottom end of the filter screen.



Attach the casing

Finally, attach the filter screen to the casing.



Tip!

File or sand the bottom end of the sump into an angle. This will make it easier for the casing to cut its way down.

CONTINUE WITH DRILLING STEP 3

Follow the drilling steps of 3 - 10 that have been explained for the use of a temporary casing. Start with **install the casing, PVC top cap and the platform**

After step 10, go to step 11.

STEP 11 THE FINAL STEPS

Measure the depth of drilling

Measure the exact depth of your borehole.

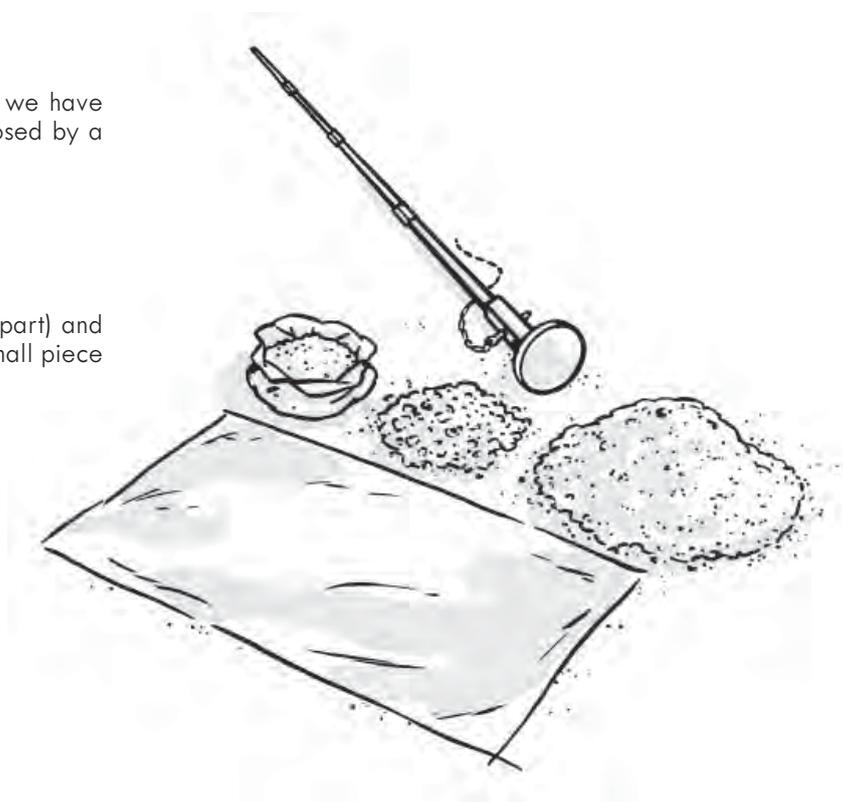
Tip!

For measuring; use a rope or long measuring tape with a small weight attached. Measuring with a rope is easy when you make small knots at every meter.

Make the plug

The bottom of the casing is still open, because we have been drilling through it. Now it needs to be closed by a plug to prevent sand entering the well.

Mix a small amount of cement (1 part), gravel (1 part) and sand (2 parts) with water and place this into a small piece of filter cloth to form a sack.



Close the sack by stitching.



Place the plug

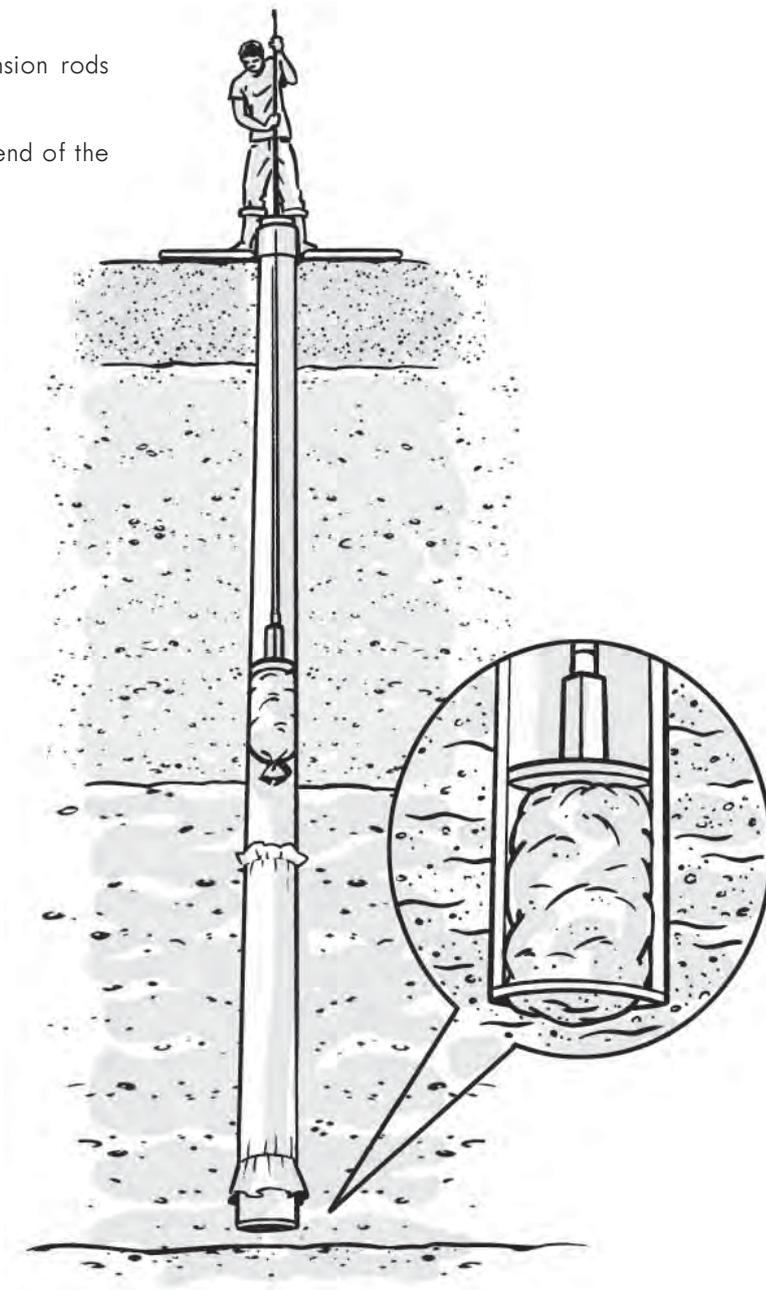
Attach the tamp tool to the extension rods.

Drop down the sack and push it to the bottom with the tamp tool and tamp the sack in place.



Remove the tamp tool and the extension rods from the borehole.

The sack has now closed the bottom end of the well.

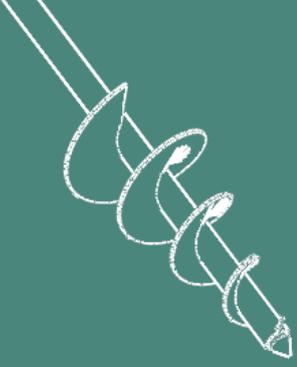


Leaving the well behind

When the drilling is finished and you are leaving the site, remember to cover the PVC casing!

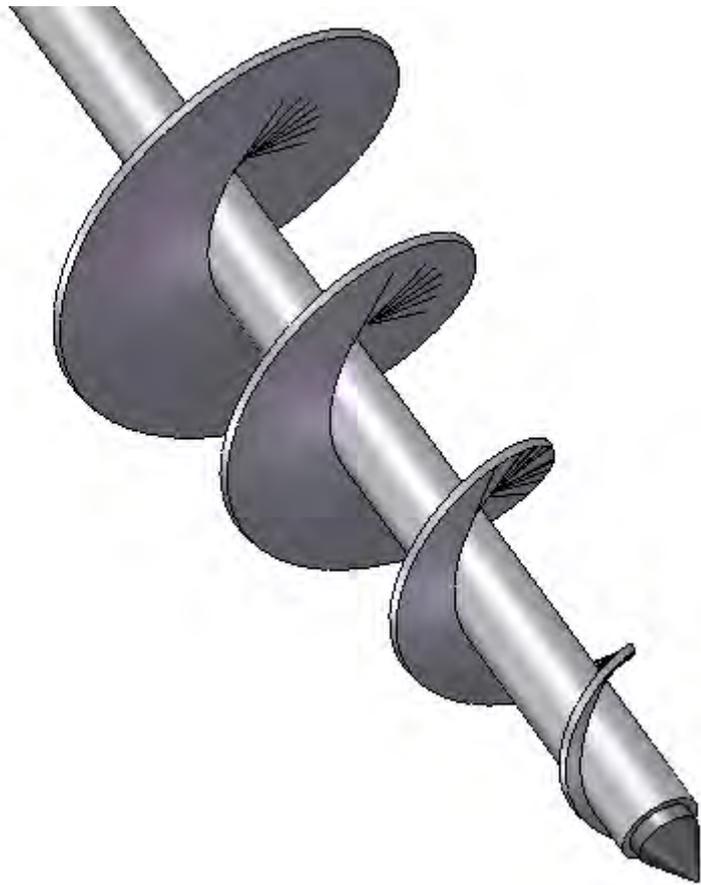
This can be done with a PVC cap or a plastic bag tightly wrapped with inner tube. It is needed to assure that nothing can be dropped into the well by children, before the pump is installed.





AUGERING

Module 3



MAKING THE DRILLING EQUIPMENT



1. WHAT TO BUY

This module explains how to fabricate all drilling equipment. It consists of a materials list for the drilling equipment and tools and a package of technical drawings, including tips that are necessary to make a complete drilling set.

Material list for the construction of drilling equipment

	Part	Material	Dimension (mm)	Thickness (mm)	Amount	Additional information
Auger platform	footrest	round bar	Ø14 x 1600	14	4	steel
		sheet metal	90 x 650	2	4	steel
		profile	T - 60 x 60 x 330	7	4	steel
	hinge	flat bar	150 x 30	8	4	steel
		pipe	Ø 25 x 25	5	8	steel
	clamp	round bar	Ø 14 x 105	14	2	steel
		sheet metal	Ø 25 x 2	2	4	steel
		plate	550 x 180	8	2	steel
		flat bar	45 x 40	12	2	steel
		bolt	M12 x 80	12	2	bolt + nut (steel)
Extension holder	holder	sheet metal	Ø 175	2	1	steel
Tamp	tamp	square pipe	35 x 35 x 100	1.5	1	steel
		sheet metal	Ø 89	4	1	steel
T-handle	t-handle	pipe	Ø 27 x 500	2.8	1	steel
		square pipe	50 x 50 x 50	6	1	steel
Extension rods 3 m	rod	square pipe	35 x 35 x 250	2	5	steel
		square pipe	30 x 30 x 250	1.5	5	steel
		pipe	Ø 27 x 3000	2.8	5	steel
Extension rods 1.5 m	rod	square pipe	35 x 35 x 200	2	1	steel
		square pipe	30 x 30 x 200	1.5	1	steel
		pipe	Ø 27 x 1500	2.8	1	steel
Conical auger 160 mm	bar	square pipe	35 x 35 x 150	2	1	steel
		square pipe	30 x 30 x 50	1.5	1	steel
		pipe	Ø 27 x 1000	2.8	1	steel
	point	round bar	Ø 21 x 30	21	1	steel
	flight 160	sheet metal	Ø 160	3	1	steel
	flight 129	sheet metal	Ø 129	3	1	steel
	flight 98	sheet metal	Ø 98	3	1	steel
Riverside bit 160 mm	bit	square pipe	35 x 35 x 100	2	1	steel
		flat bar	35 x 350	5	1	steel
		pipe	Ø 160 x 350	3	1	steel
	teeth	leaf spring	185 x 115	7	1	spring steel
Riverside bit 100 mm	bit	square pipe	35 x 35 x 100	2	1	steel
		flat bar	35 x 350	5	1	steel
		pipe	Ø 100 x 350	3	1	steel
	teeth	leaf spring	70 x 115	7	1	spring steel
Open clay bit 160 mm	bar	square pipe	35 x 35 x 150	2	1	steel
		square pipe	30 x 30 x 50	1.5	1	steel
		pipe	Ø 27 x 800	2.8	1	steel
		flat bar	60 x 600	5	1	steel
Bailer 100 mm	bit	square pipe	30 x 30 x 100	1.5	1	steel
		flat bar	35 x 600	5	1	steel
		pipe	Ø 100 x 700	2	1	steel
	valve	sheet metal	Ø 86	2	1	steel
		sheet rubber	Ø 86	2	1	rubber
		round bar	Ø 6 x 315	6	1	steel
		sheet metal	25 x 55	2	1	steel
		bolt	M8 x 25	8	2	bolt + nut (steel)
teeth	sheet metal	314 x 70	5	1	steel	
Pin (extensions)	pin	steel	Ø 15 x 80	15	10	steel

Purchase list for additional tools

	Part	Material	Dimension (mm)	Thickness	Amount	Additional information
<u>Tools</u>	hacksaw				2	(buy also spare blades)
	shovel				1	
	toolbox (full)				1	basic use (rope, glue, spanners)
	wire				1	nylon, galvanized
	top cap	PVC			1	depends on diameter casing
	inner tube	rubber			2m	
	temporary casing				3	3m length each pipe
	temporary casing				6	1,5m length each pipe
	needle				2	sturdy
	buckets	plastic	12 liters		2	
	sieves		mesh 1mm and 3mm		2	
	measuring tool	metal	pipe Ø 50 x 80 mm		1	steel
		metal	round bar 8 x 1000		1	steel
<u>Materials</u>	filter cloth	polyester/nylon			1	100 % synthetic
	PVC casing				1	size depends on pump/user requirements
		nylon rope		6mm	30m	
	gravel pack		1mm and 3 mm		50 kg	

2. TIPS FOR CONSTRUCTION

Read the following tips together with the technical drawings at the end of this module. These tips will help you in the fabrication of the top cap and the measuring tool. The other drilling equipment can be made with the technical drawings only.

TIPS FOR MAKING THE TOP CAP

The top cap is screwed on top of the casing when the working platform is connected. This protects the threads when drilling inside the casing. The top cap is made out of a short piece of thick wall casing pipe. Use the hacksaw to cut a piece of male-threaded PVC pipe (15 cm).



TIPS TO FIT THE PLATFORM AROUND THE PVC PIPE

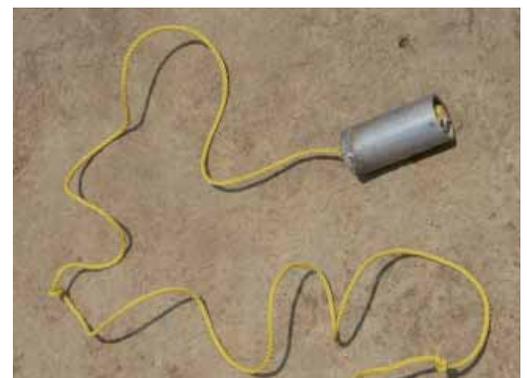
The working platforms can be used around casings with different diameters ranging from 100 mm to 160 mm. If you use a casing smaller than 160 mm, you will need a shim. The shim is a short (half) piece of PVC pipe that is placed between the casing and the working platform to fill up the space between them. This assures a tight fit of the working platform on casing.

TIPS FOR MAKING THE DEPTH MEASURING TOOL

Take a rope (6mm) of about 35 meters long and make knots at every meter.

Option 1: measuring the depth of the water table. Use a short piece of pipe (Ø 50 x 80 mm) and close one side, by welding on a small plate. Drill a hole in this side to attach the rope.

Option 2: measuring the depth of the gravel pack. Take the same rope, and remove the short piece of pipe that was used in option 1. Attach a long re-bar (Ø 6 x 1000 mm).



3. TECHNICAL DRAWINGS

Auger T-handle
Drawing 007



Auger extension rods
Drawing 007



Conical auger
Drawing 008,009,010



Riverside bit
Drawing 011, 012



Bailer
Drawing 004, 005



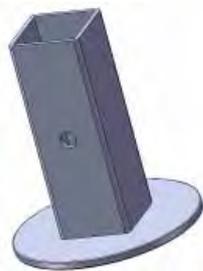
Pin
Drawing 007



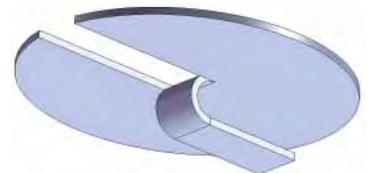
Open clay bit
Drawing 013



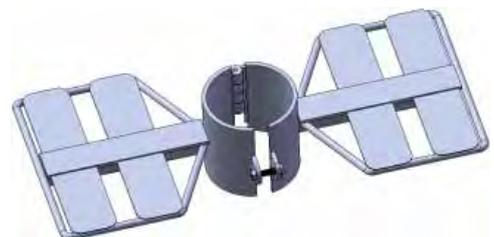
Tamp
Drawing 007



Extension holder
Drawing 006



Auger platform
Drawing 001, 002, 003



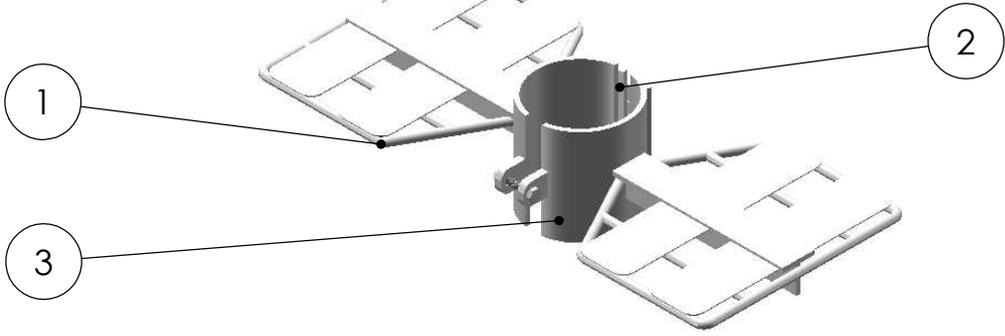
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2

3

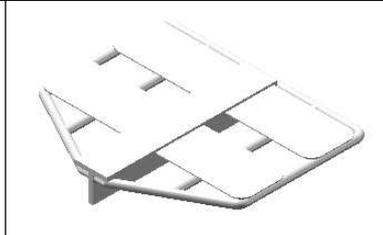
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A

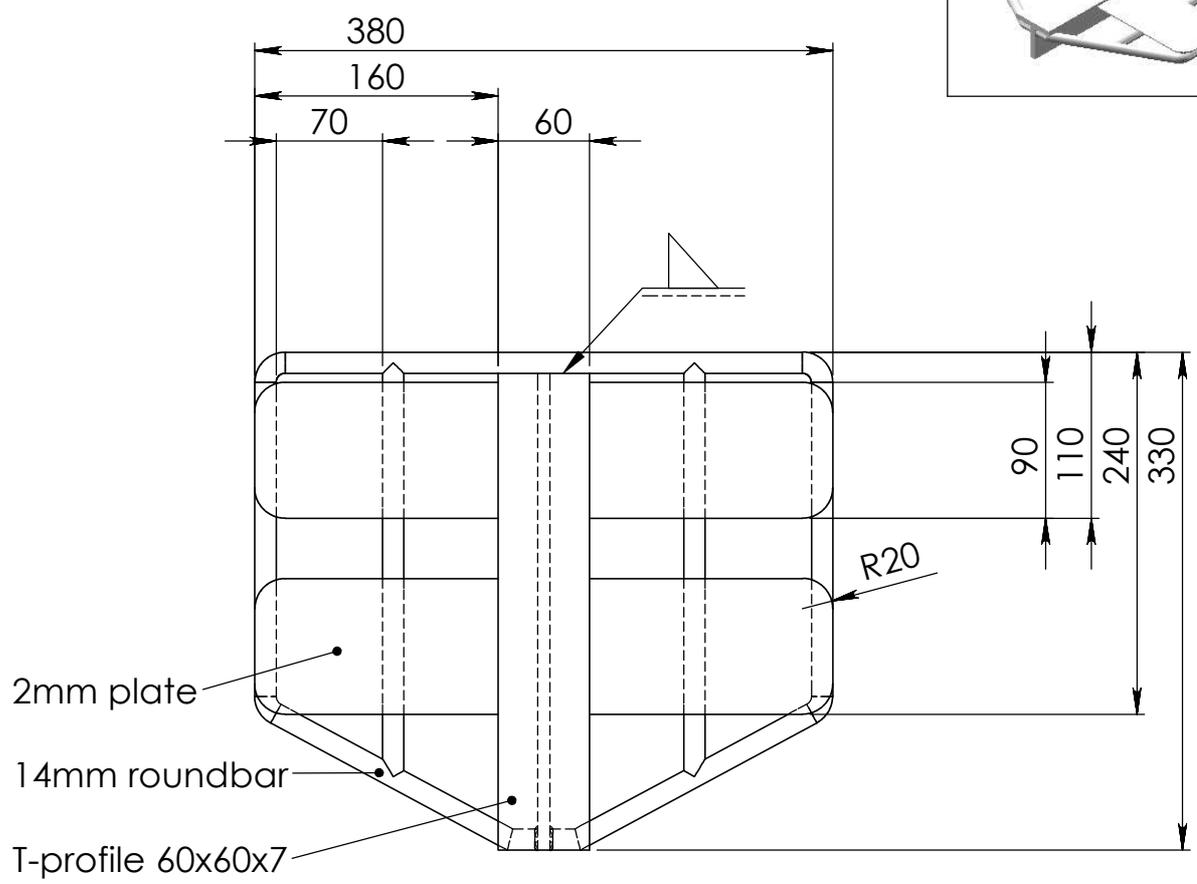


B

1

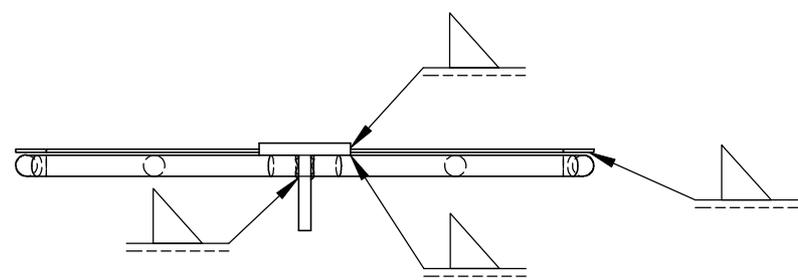


C



D

E



F

01	Platform footrest
02	Platform hinge
03	Platform clamp



TITLE: **Auger platform (1)**

DRAWN BY: Don de Koning

DATE: 01-06-2010

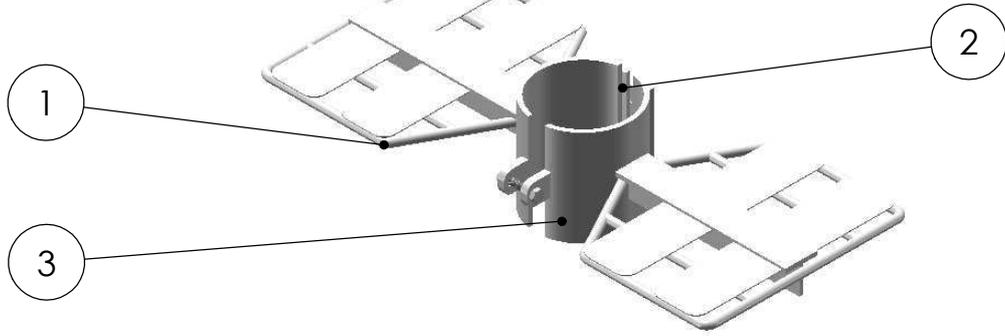
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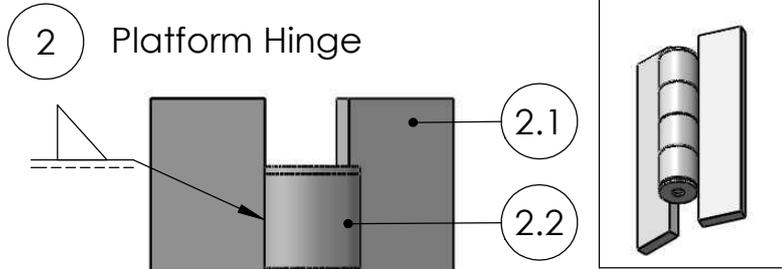
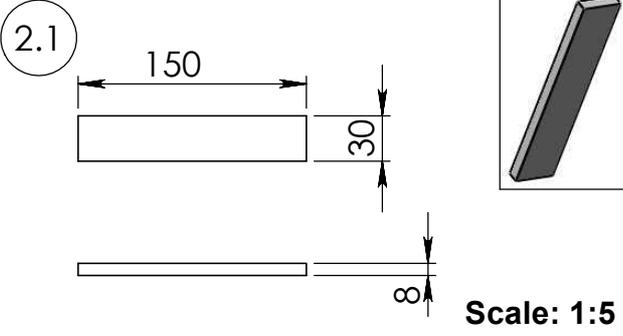
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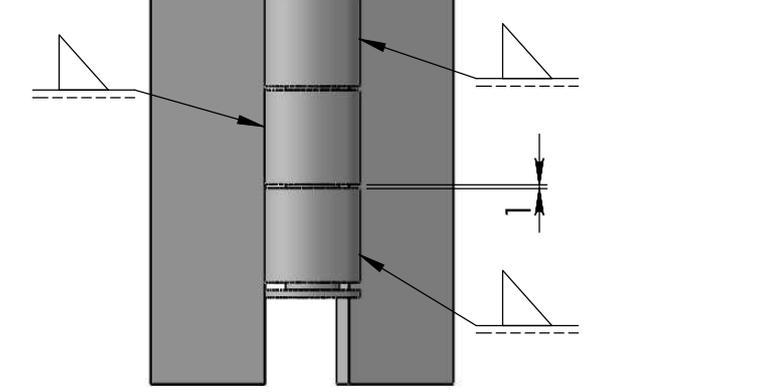
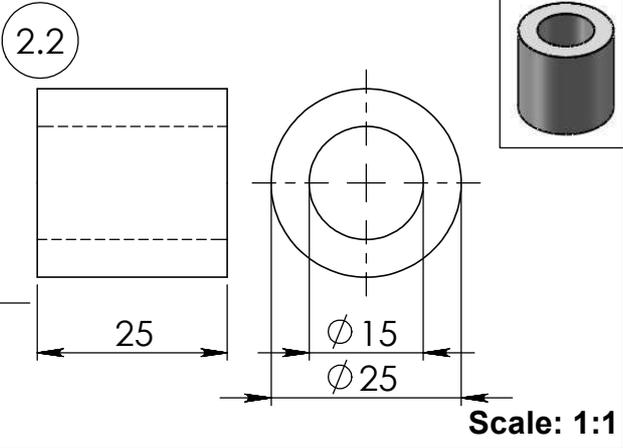
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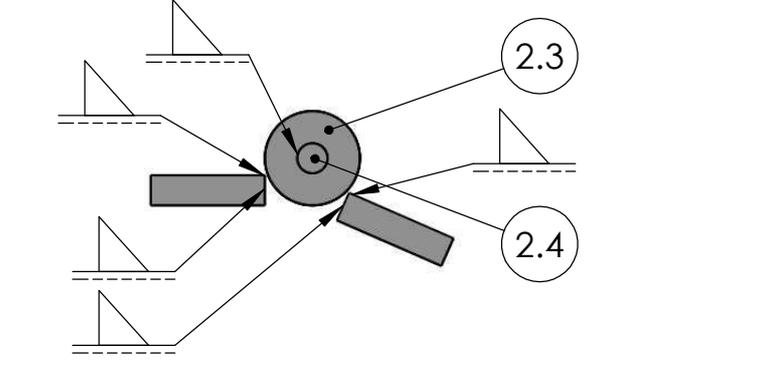
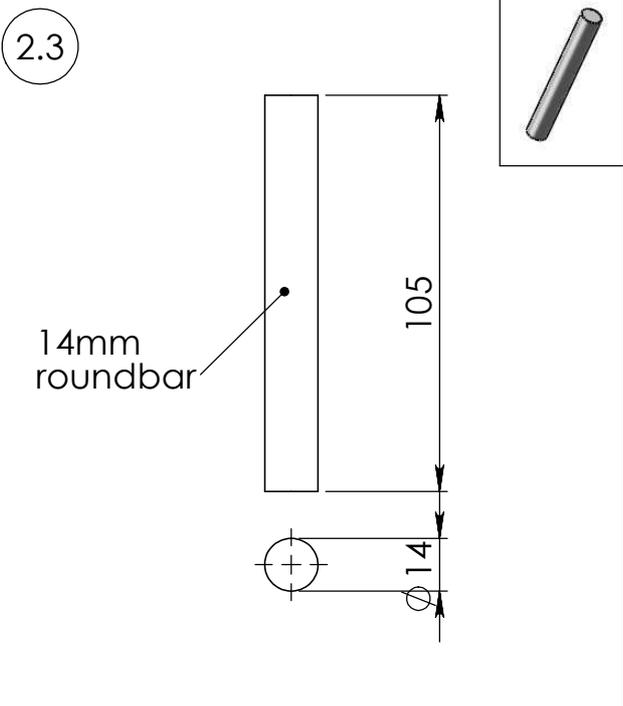
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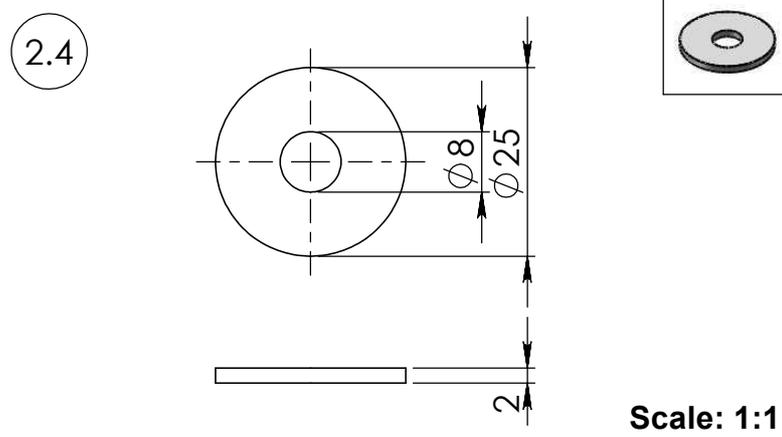
C



D



E



F

2.1	Platform hinge plate
2.2	Platform hinge bushing
2.3	Platform hinge pin
2.4	Platform hinge weld ring



TITLE: **Auger platform (2)**

DRAWN BY: Don de Koning

DATE: 01-06-2010

VERSION: Final v1.0

DWG NO. **002**

SCALE: **1:2**

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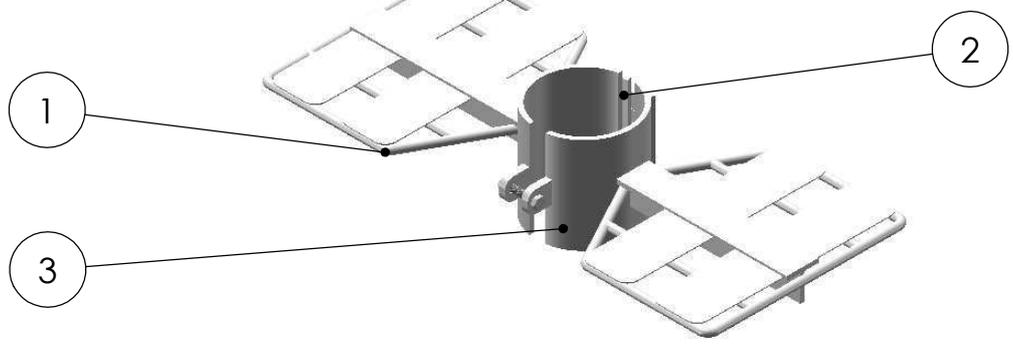
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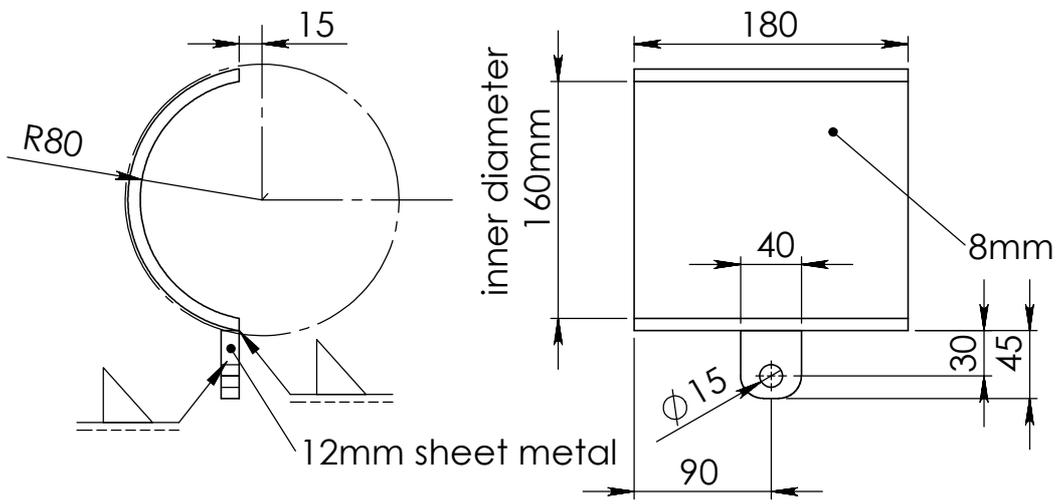
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A



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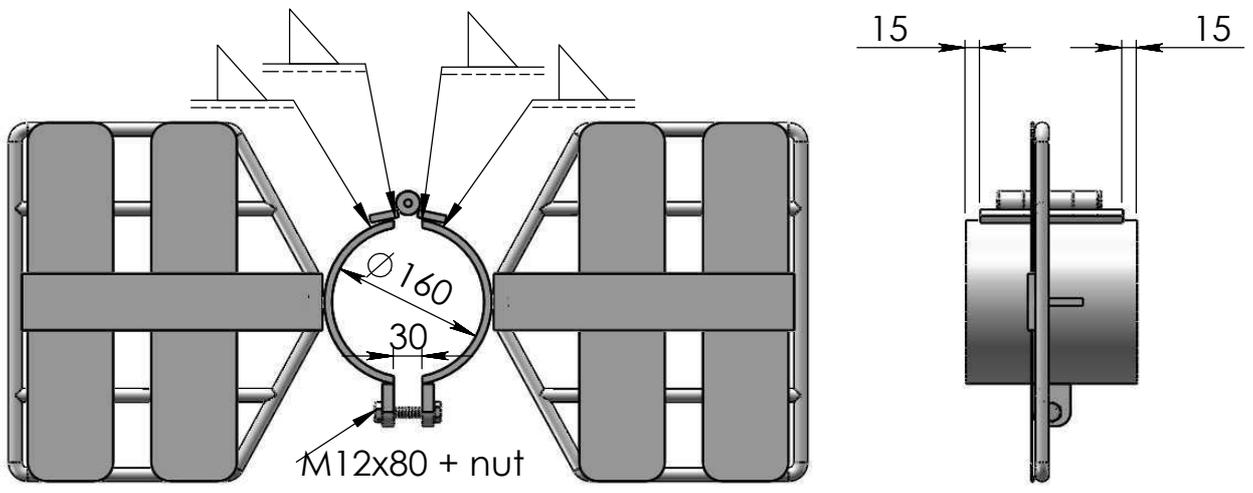
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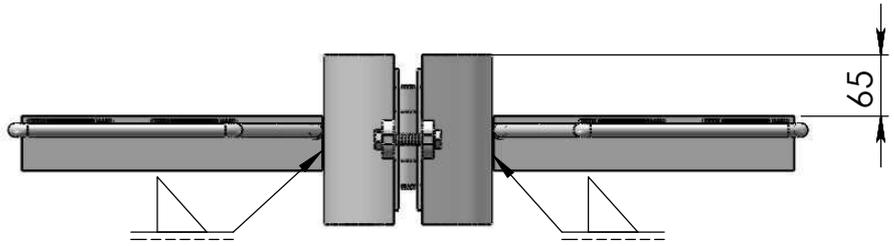
C

Platform assembly

D



E



F

01	Platform footrest
02	Platform hinge
03	Platform clamp



TITLE: **Platform assembly**

DRAWN BY: Don de Koning

DATE: 01-06-2010

VERSION: Final v1.0

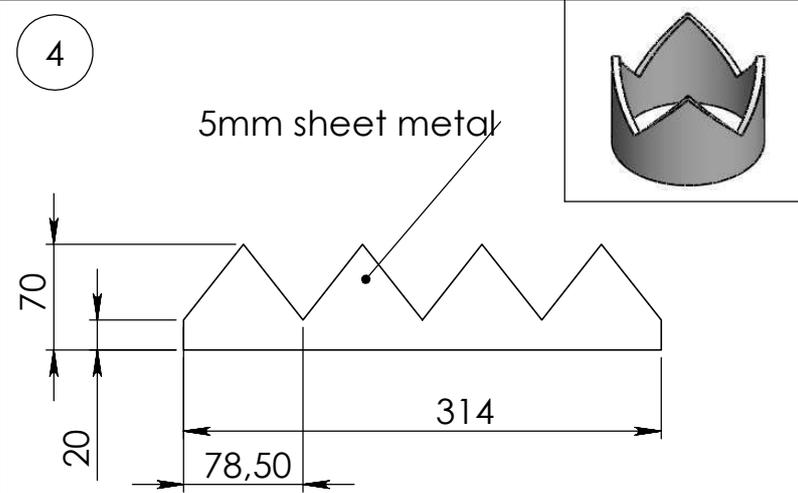
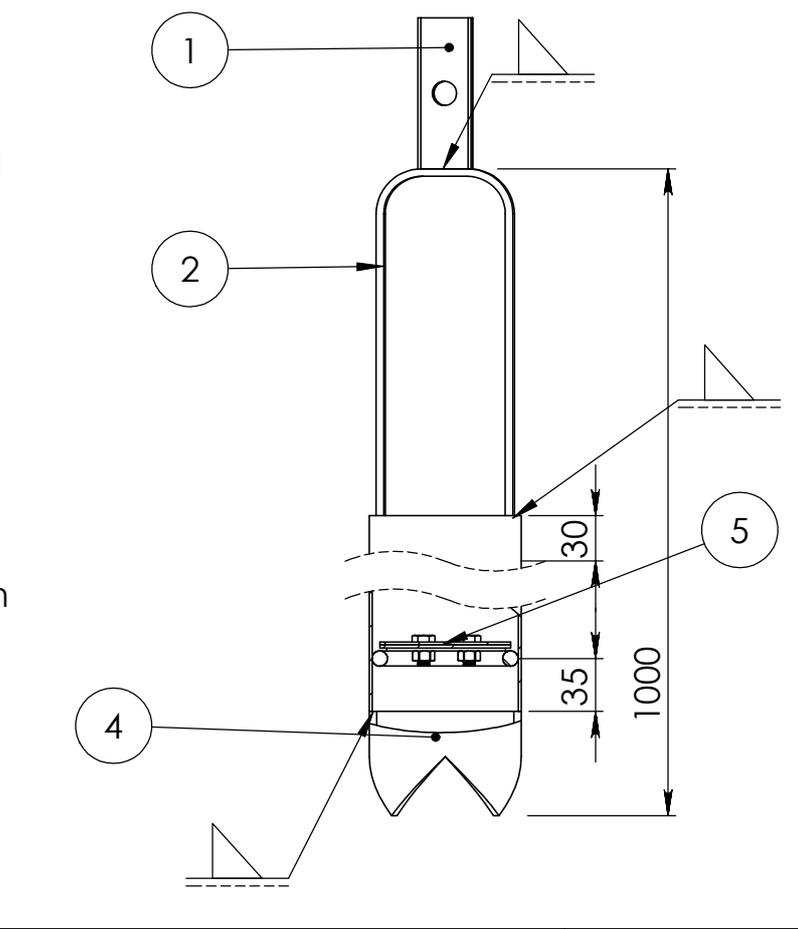
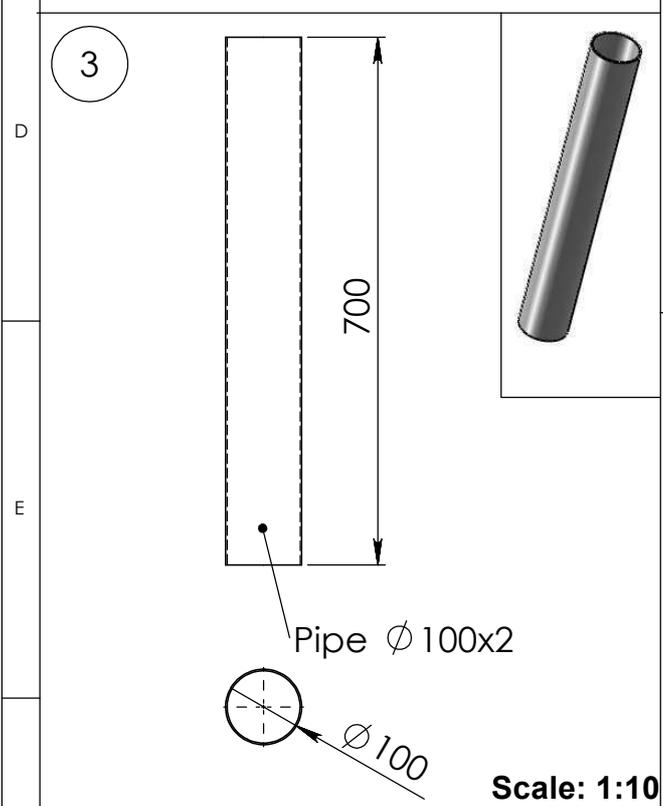
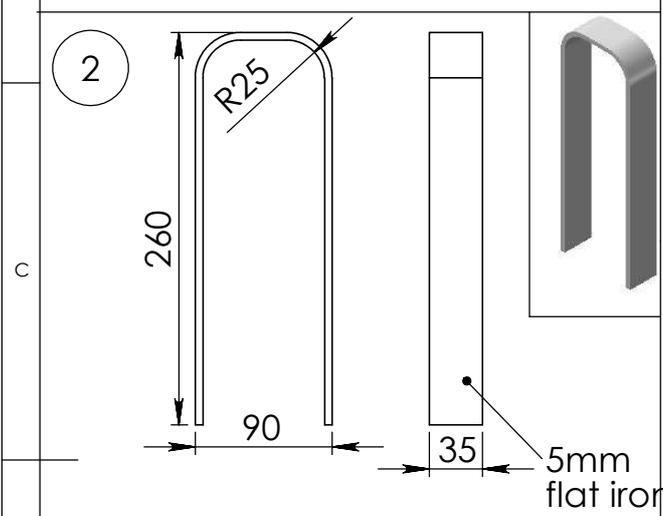
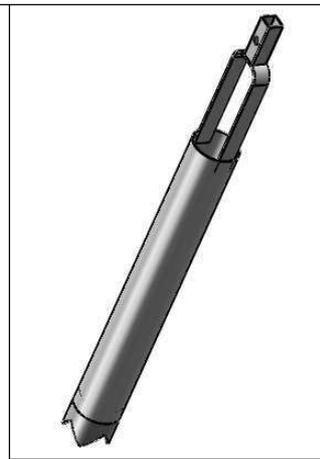
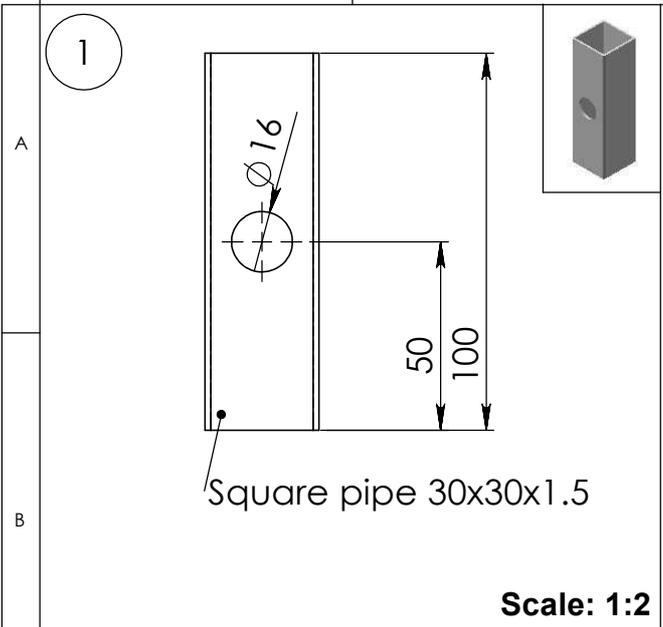
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A4

DWG NO.

1 2 3 4



F	01	Square pipe 30x30x1.5
	02	Bended plate 35x5
	03	Pipe ϕ 100x2
	04	Drilling bit
DRAWN BY:		DATE:
Don de Koning		01-06-2010
VERSION:		DWG NO.
Final v1.0		004
SCALE:		TITLE:
1:5		Bailer(1)
A4		

PRACTICA
FOUNDATION

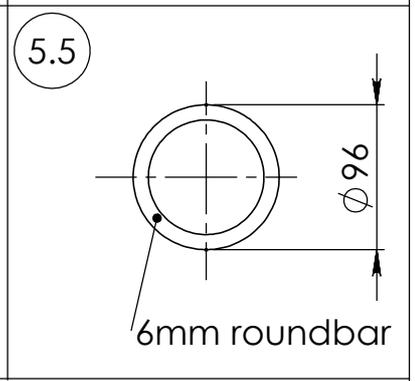
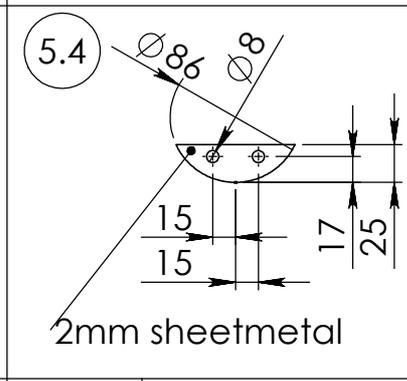
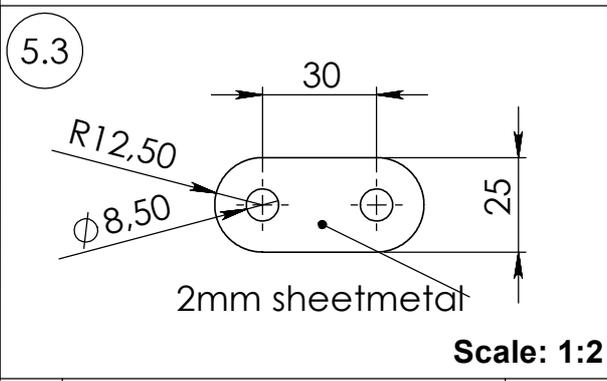
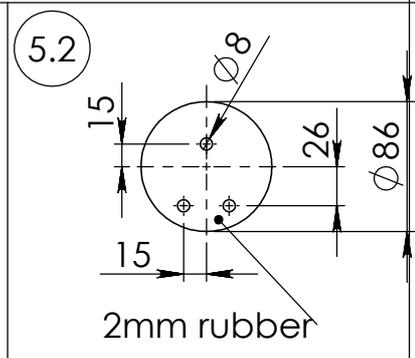
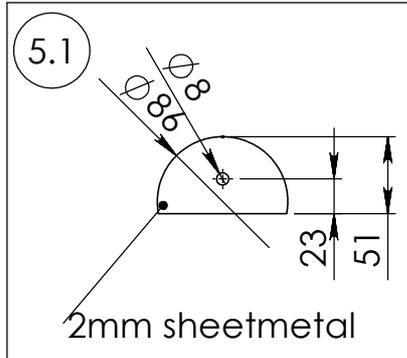
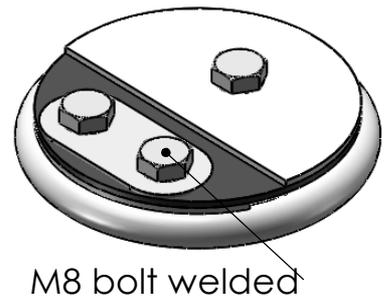
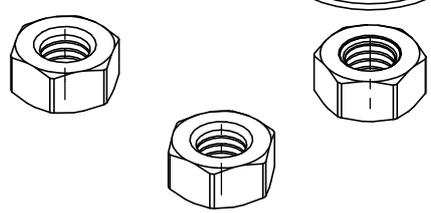
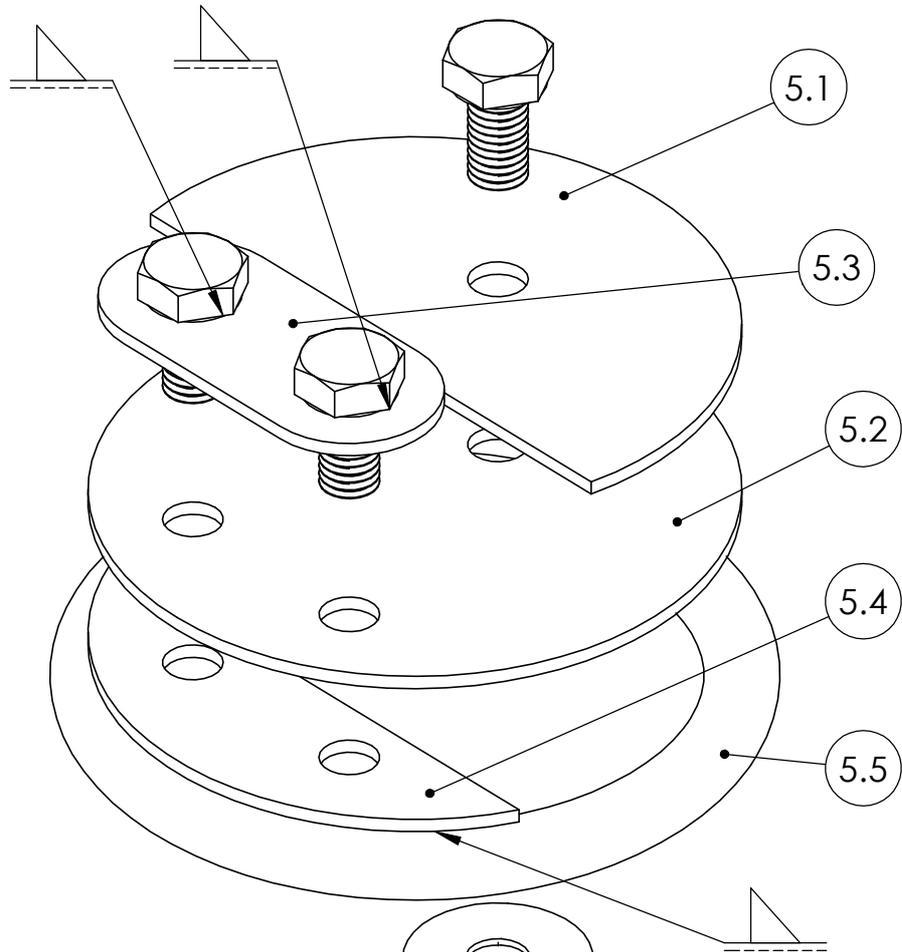
TITLE: **Bailer(1)**

DWG NO. **004**

SCALE: **1:5**

A4

A
B
C
D
E
F



05	Valve assembly



TITLE: **Bailer(2)**

DRAWN BY: Don de Koning

DATE: 01-06-2010

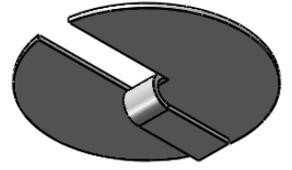
VERSION: Final v1.0

DWG NO. **005**

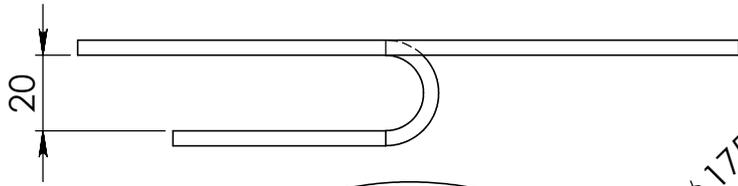
SCALE: **1:5**

A4

Extension holder

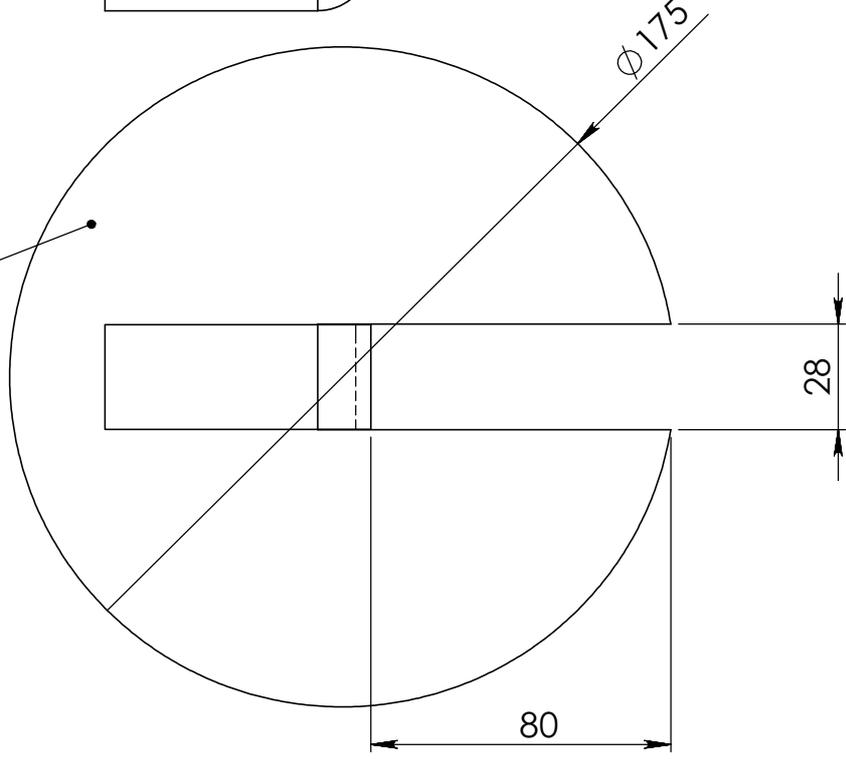


A



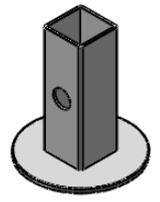
B

4mm sheetmetal



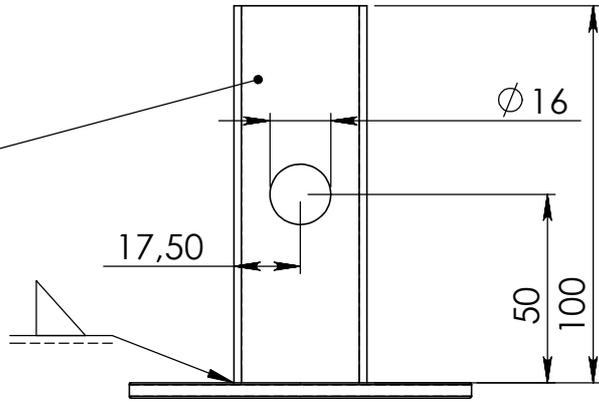
C

Tamp



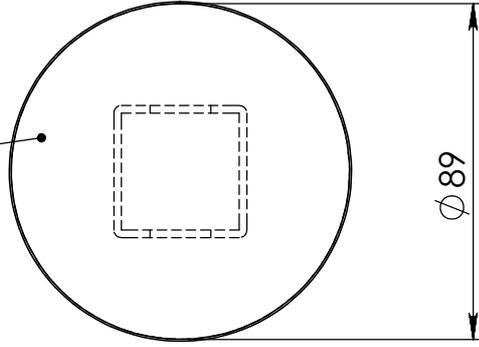
D

Square pipe 35x35x1.5



E

4mm sheetmetal



F



TITLE:

Extension holder / Tamp

DRAWN BY:
Don de Koning

DATE:
01-06-2010

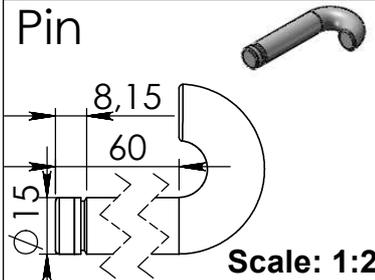
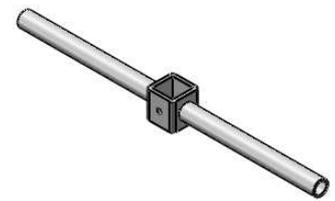
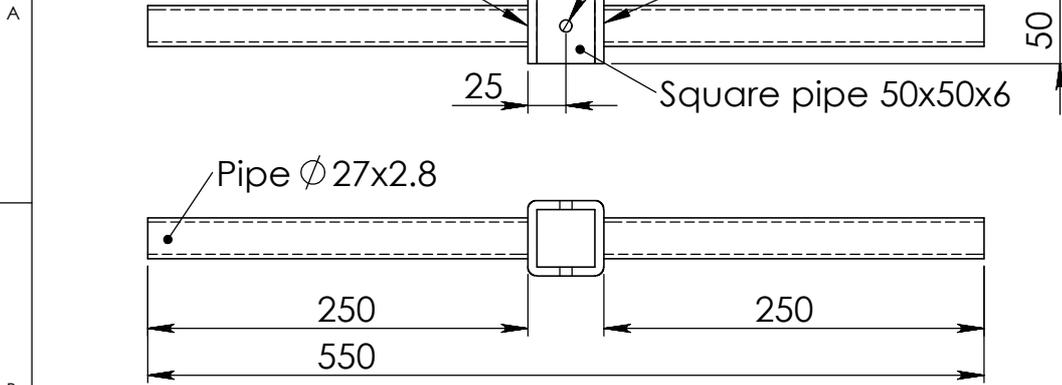
VERSION:
Final v1.0

DWG NO.
006

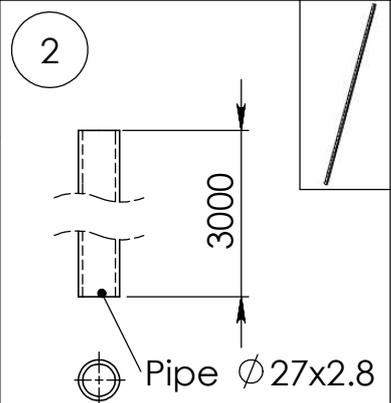
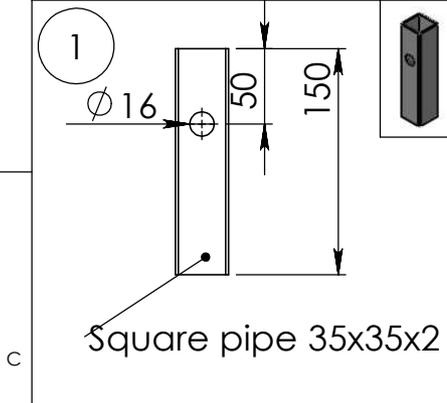
SCALE:
1:2

A4

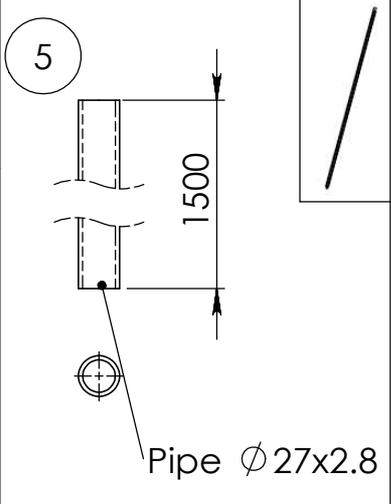
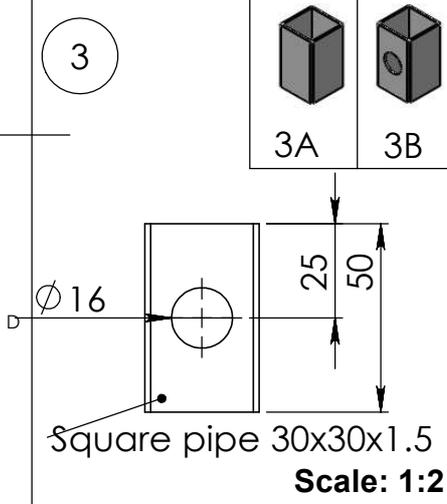
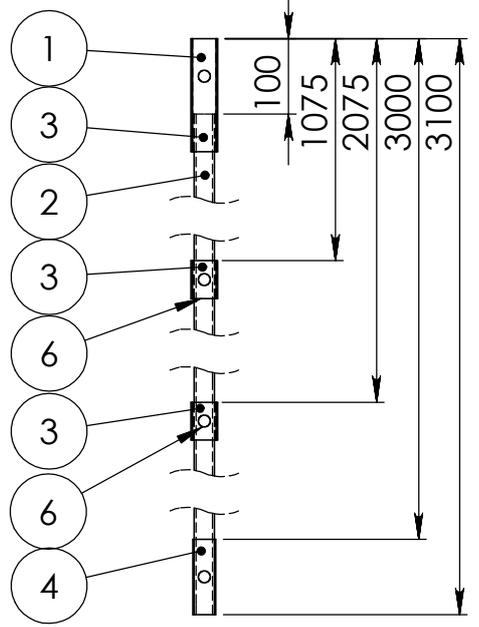
T-handle



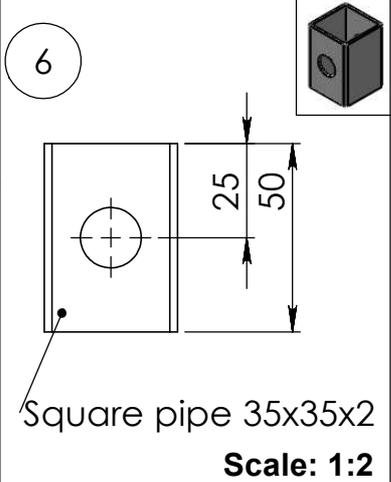
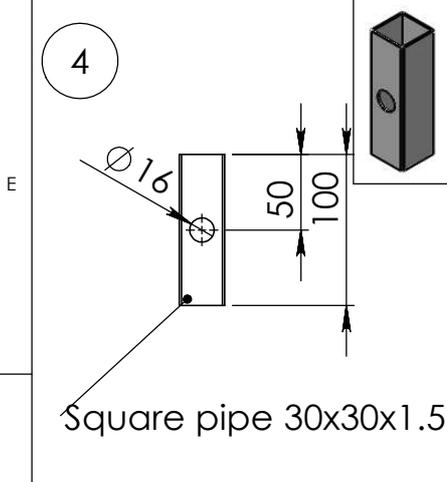
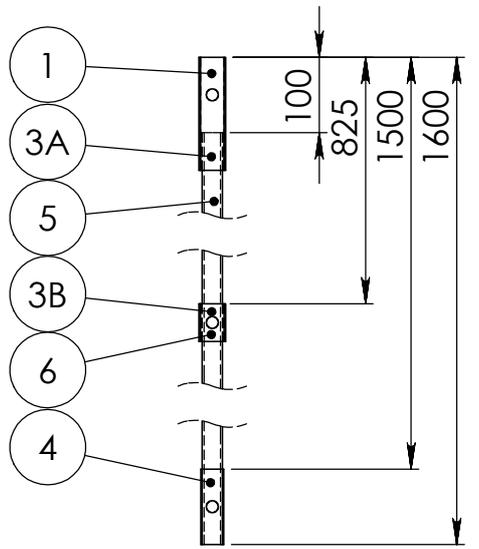
Scale: 1:2



Extension rod 3meter



Extension rod 1.5meter



01/06	Square pipe 35x35x2
02/05	Pipe ϕ 27x2.8
03	Square pipe 30x30x1.5
04	Square pipe 30x30x1.5



TITLE: T-handle / extension rods

DRAWN BY: Don de Koning

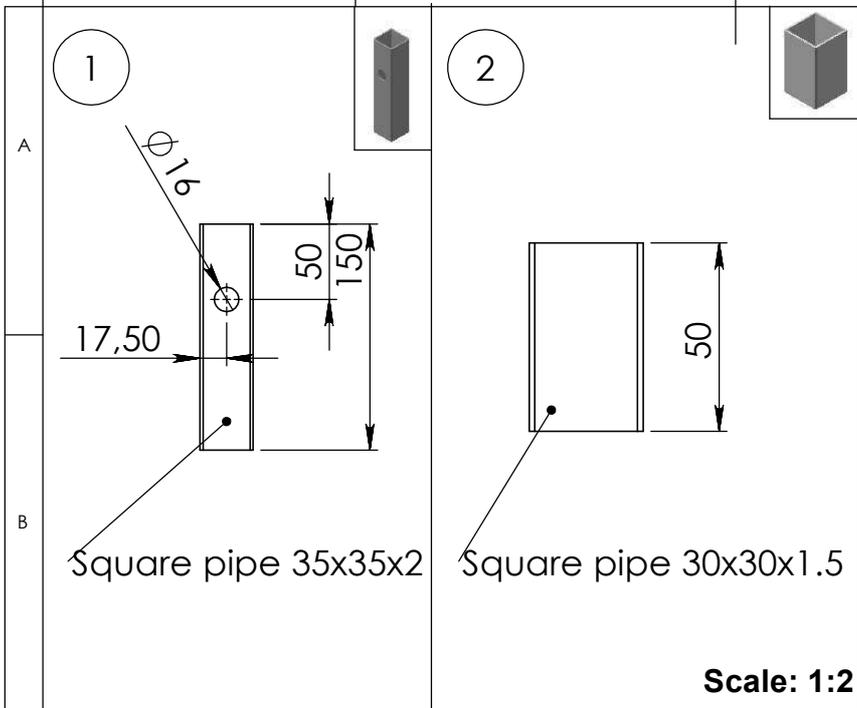
DATE: 01-06-2010

VERSION: Final v1.0

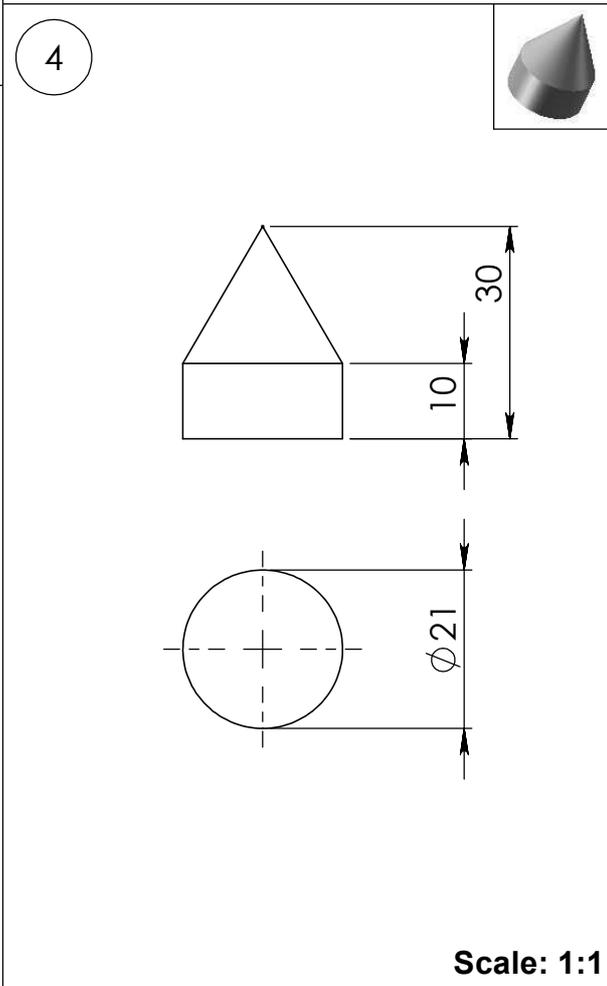
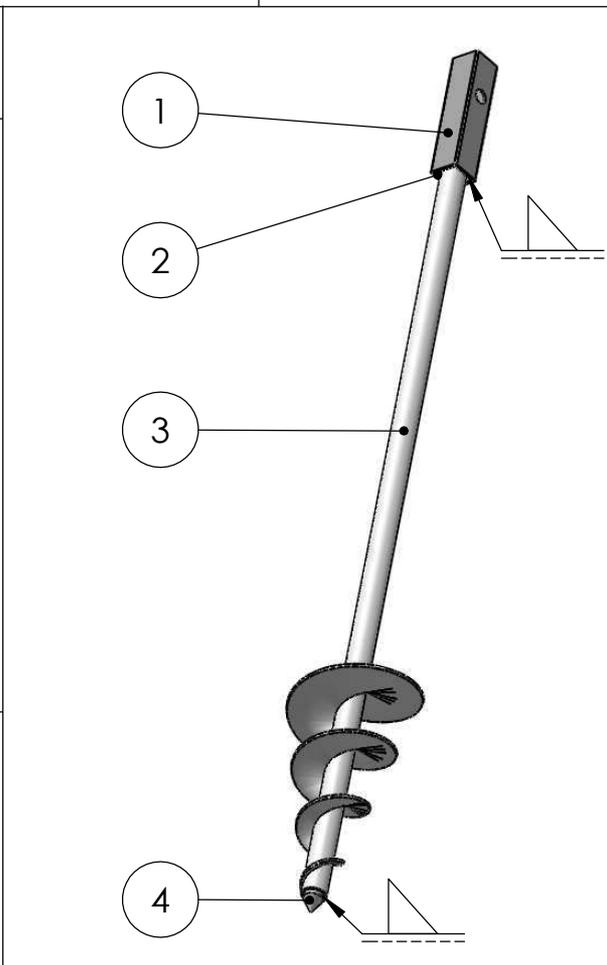
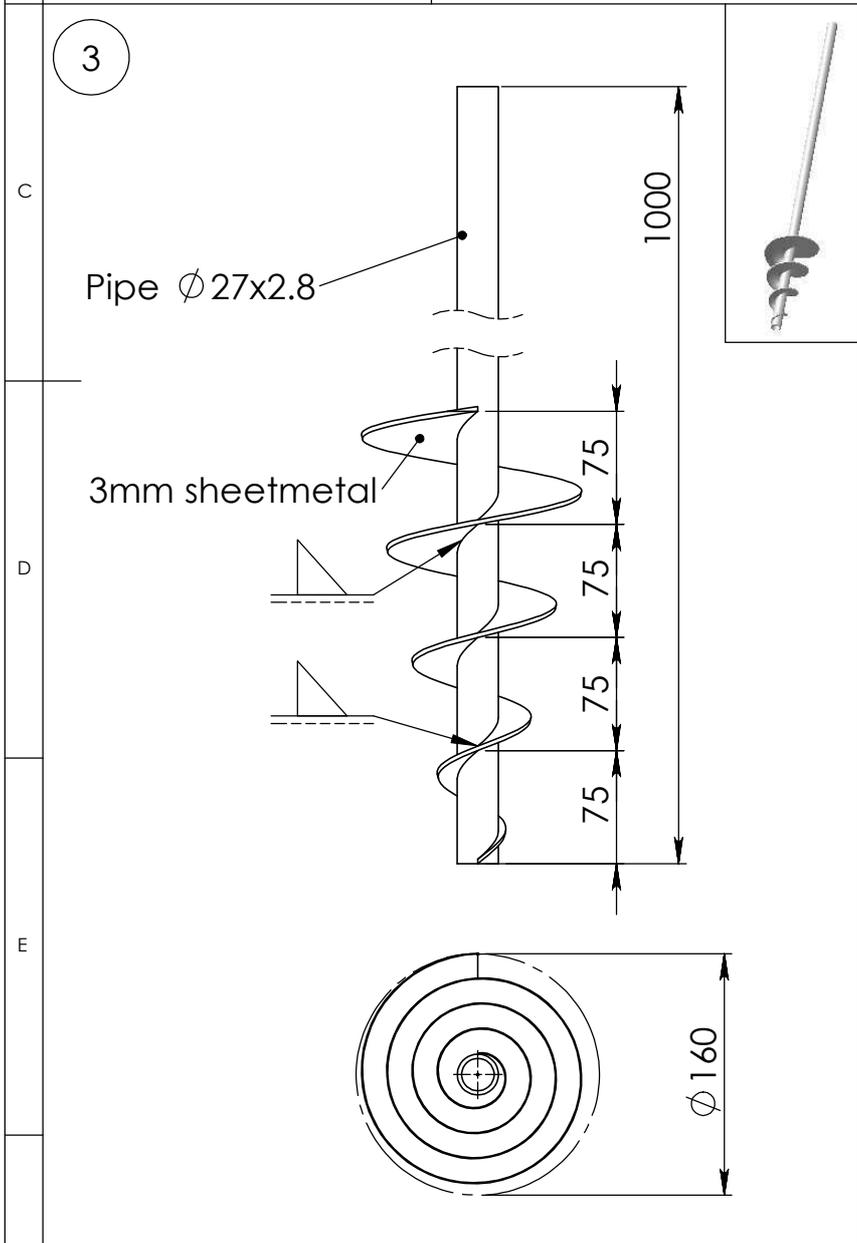
DWG NO. 007

SCALE: 1:5

A4



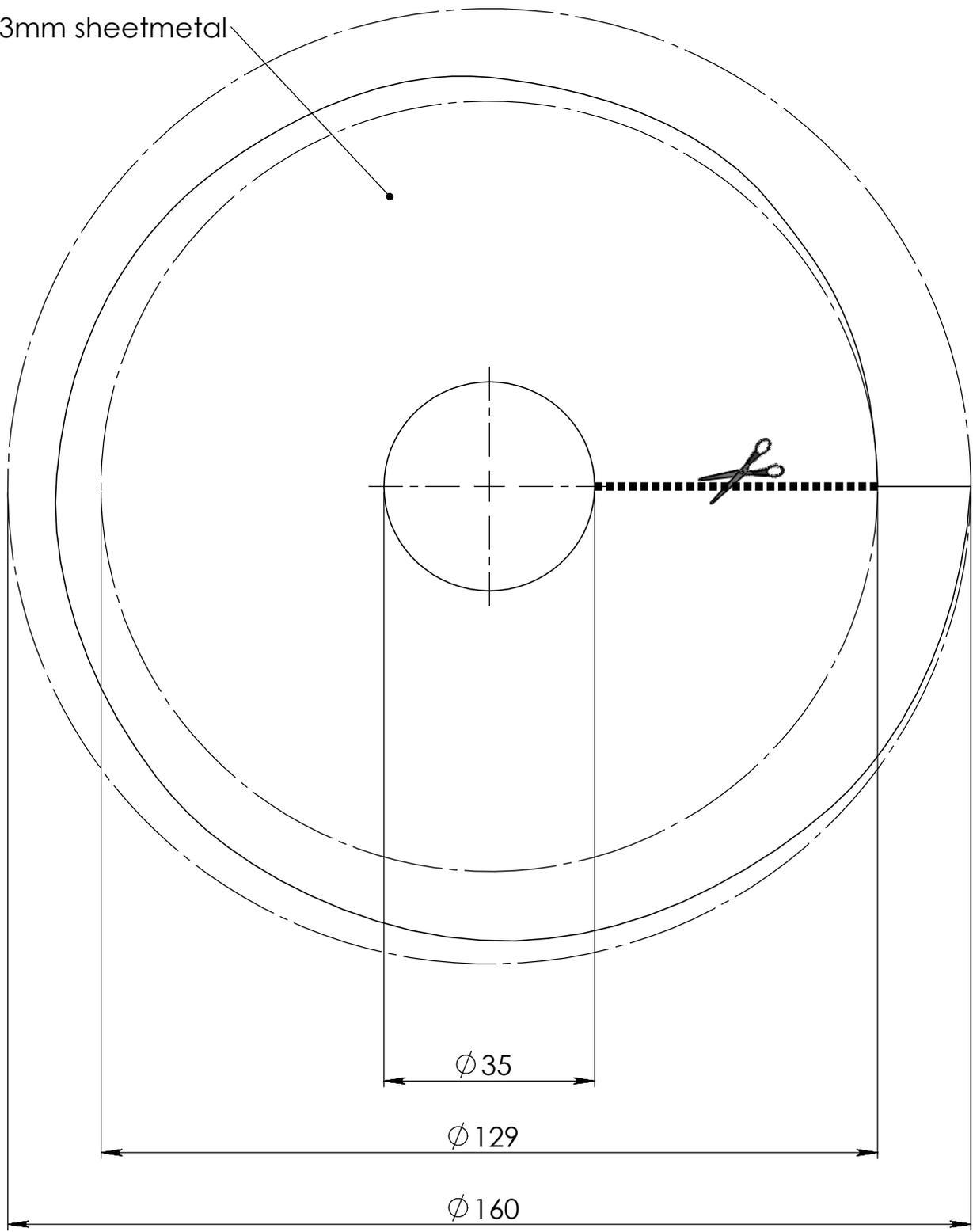
Scale: 1:2



Scale: 1:1

F	01	Square pipe 35x35x2		TITLE: Auger 160mm (1)		
	02	Square pipe 30x30x1.5		DWG NO. 008	SCALE: 1:5	A4
	03	Auger 160mm				
	04	Auger point				
DRAWN BY: Don de Koning		DATE: 01-06-2010	VERSION: Final v1.0			

3mm sheetmetal



Ø 35

Ø 129

Ø 160

A
B
C
D
E

F

PRACTICA
FOUNDATION

TITLE:

Auger 160mm (2)

DRAWN BY:
Don de Koning

DATE:
01-06-2010

VERSION:
Final v1.0

DWG NO.
009

SCALE:
1:1

A4

1

2

3

4

A

B

C

D

E

F

3mm sheetmetal

3mm sheetmetal

3mm sheetmetal

$\phi 35$
 $\phi 98$
 $\phi 129$

$\phi 35$
 $\phi 66$
 $\phi 98$

$\phi 35$
 $\phi 66$

TITLE:
Auger 160mm (3)

PRACTICA
FOUNDATION

DRAWN BY:
Don de Koning

DATE:
01-06-2010

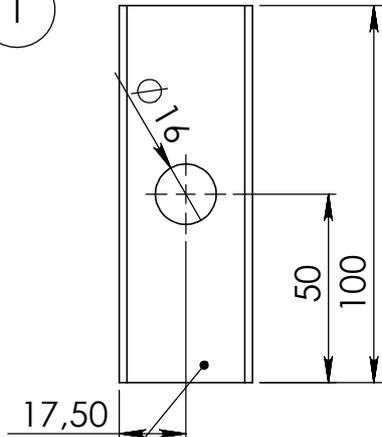
VERSION:
Final v1.0

DWG NO.
010

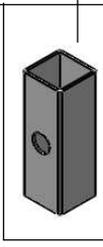
SCALE:
1:1

A4

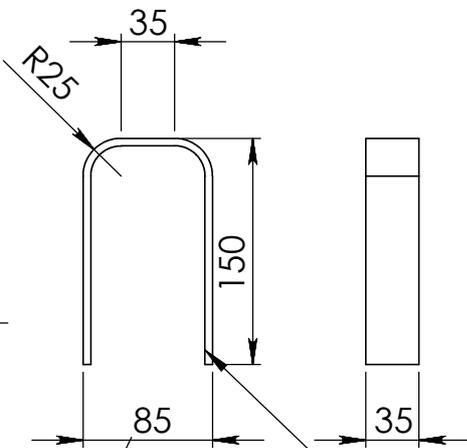
1



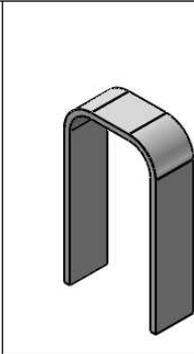
Square pipe 35x35x2



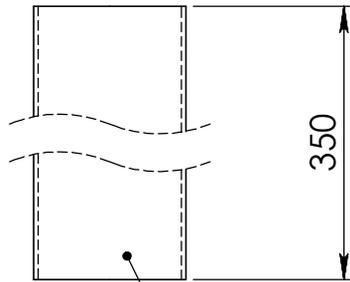
2



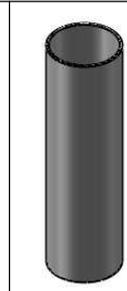
metal strip 35x5mm
has to fit inside (3)



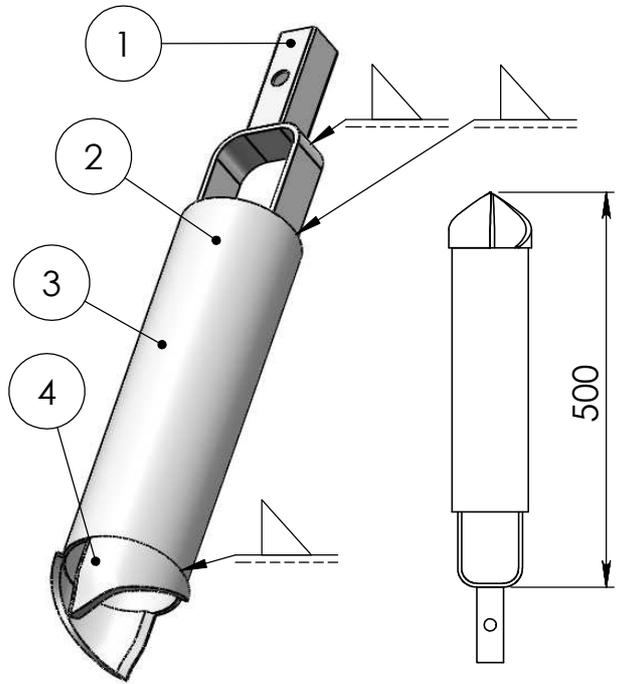
3



Pipe ϕ 100x3mm

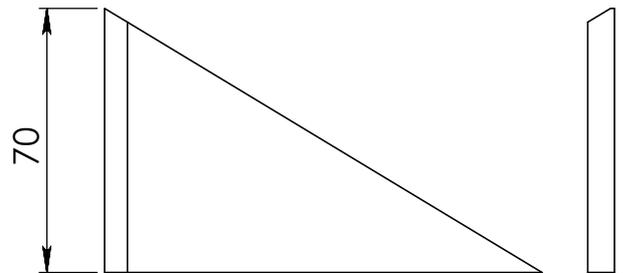
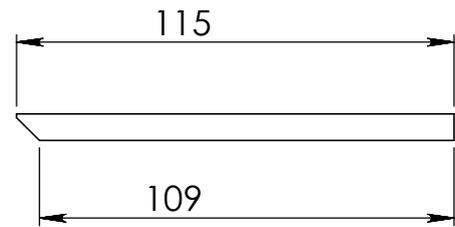
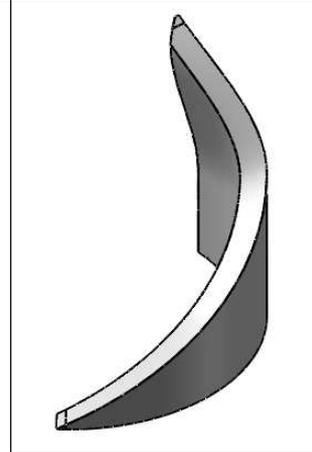


Scale: 1:5



Scale: 1:10

4



A
B
C
D
E
F

01	Square pipe 35x35x2
02	Metal strip 35x5mm
03	Pipe ϕ 100x3mm
04	Leafspring 7mm



TITLE:

Riverside bit 100mm

DRAWN BY:
Don de Koning

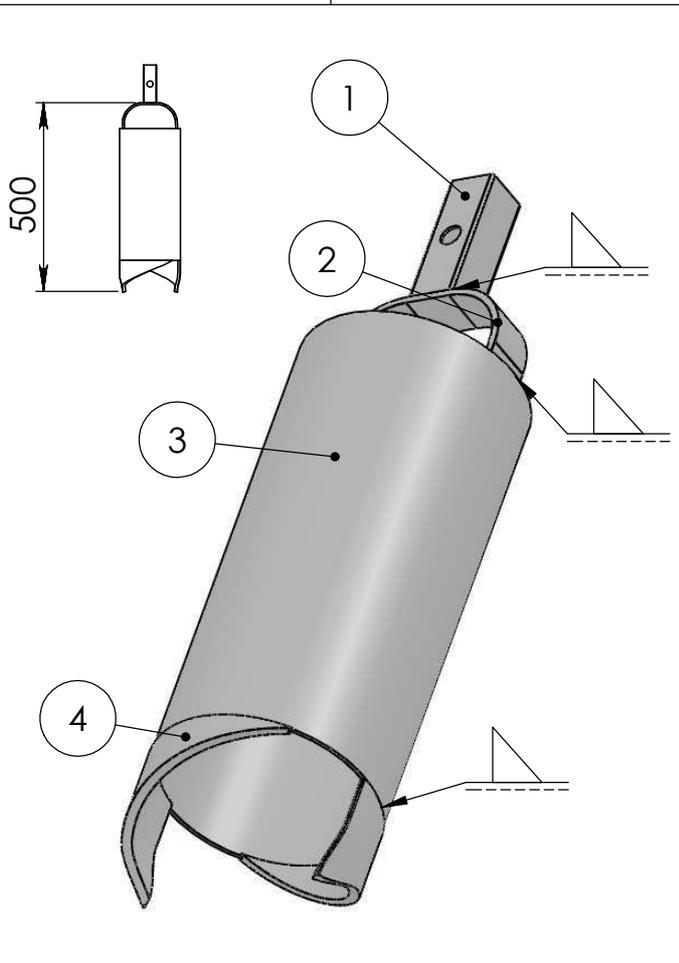
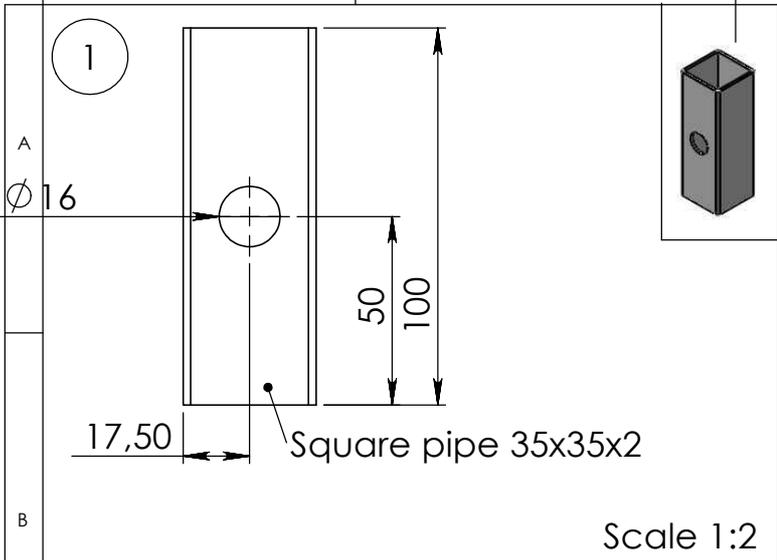
DATE:
01-06-2010

VERSION:
Final v1.0

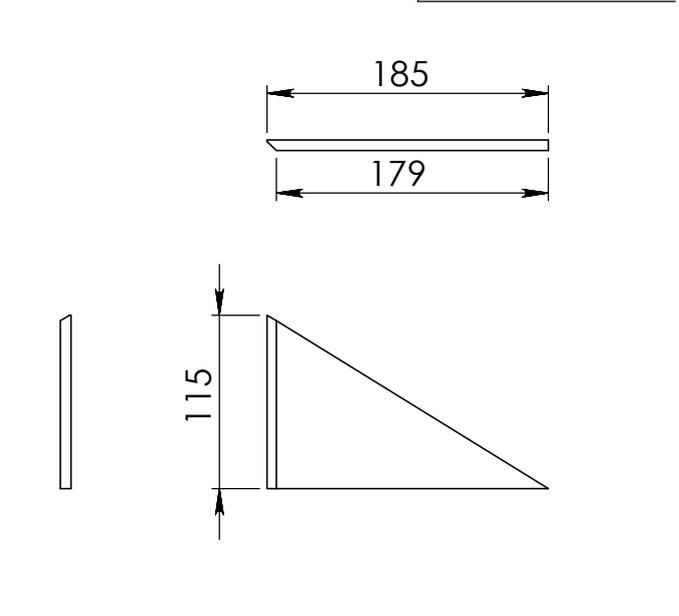
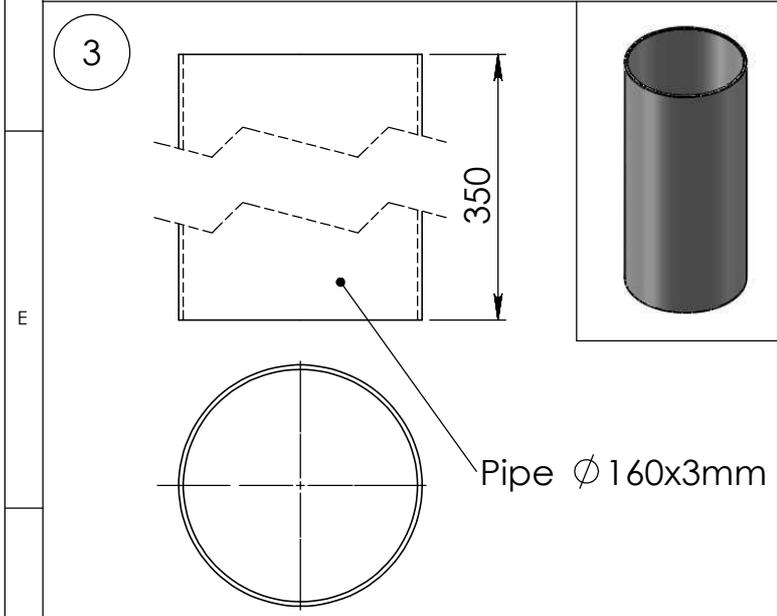
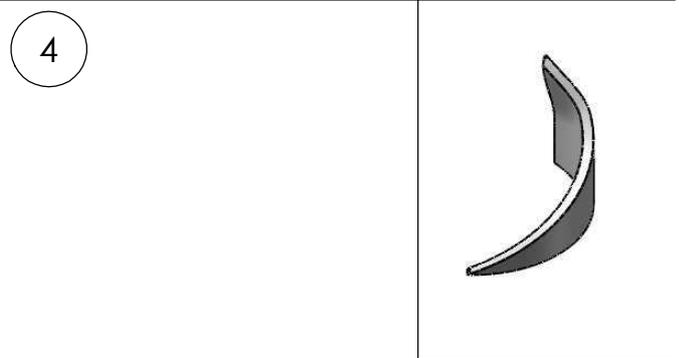
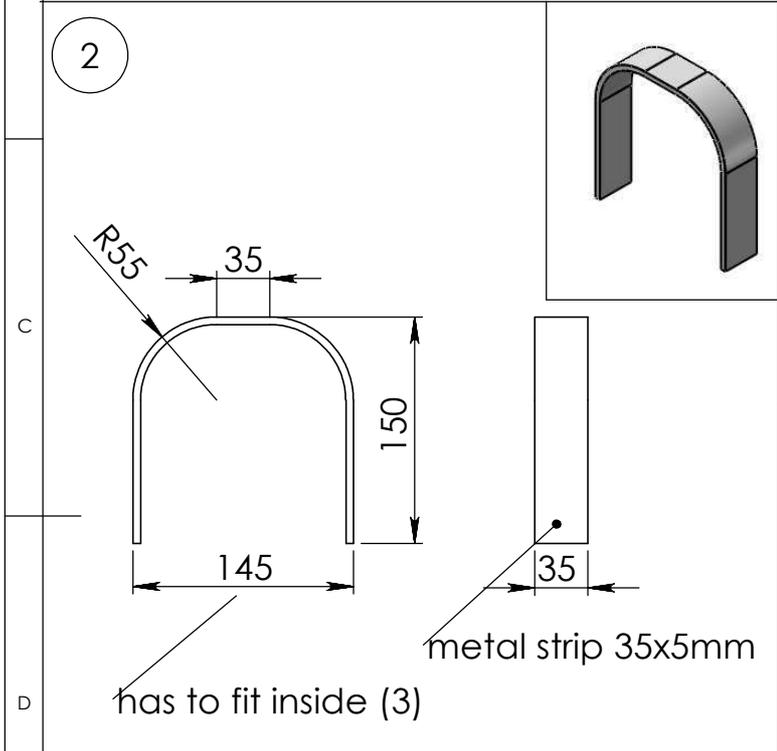
DWG NO.
011

SCALE:
1:2

A4



Scale 1:2

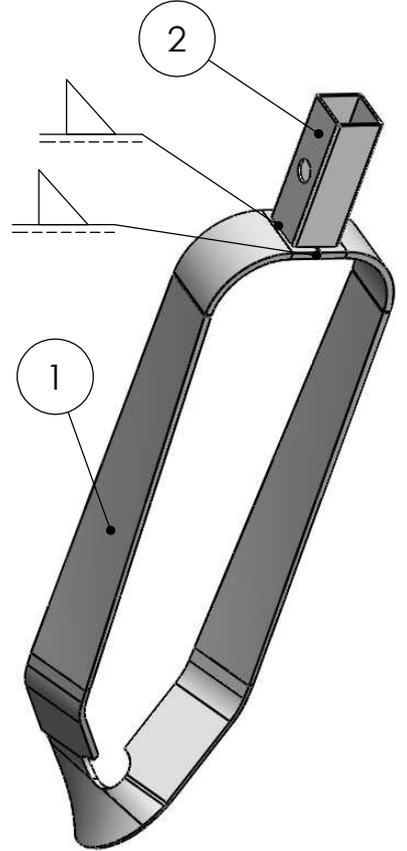
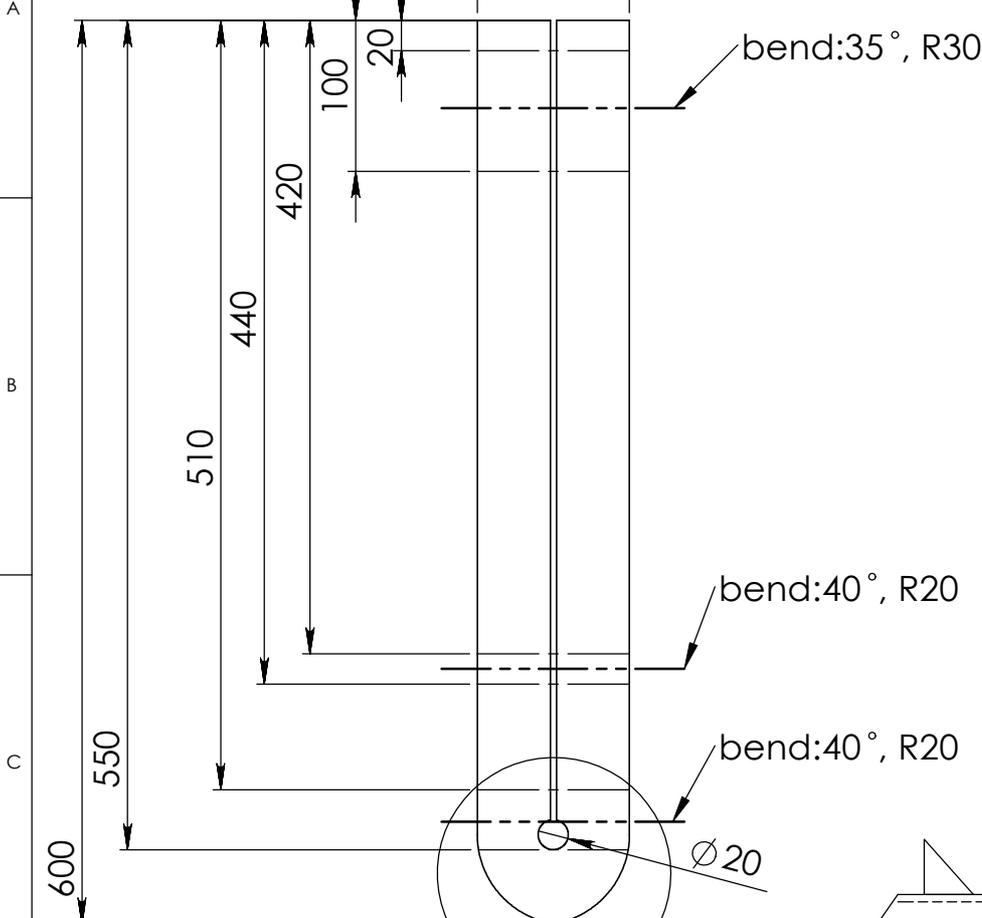


F	01	Square pipe 35x35x2
	02	Metal strip 35x5mm
	03	Pipe $\varnothing 160x3\text{mm}$
	04	Leafspring 7mm
DRAWN BY: Don de Koning		DATE: 01-06-2010
		VERSION: Final v1.0

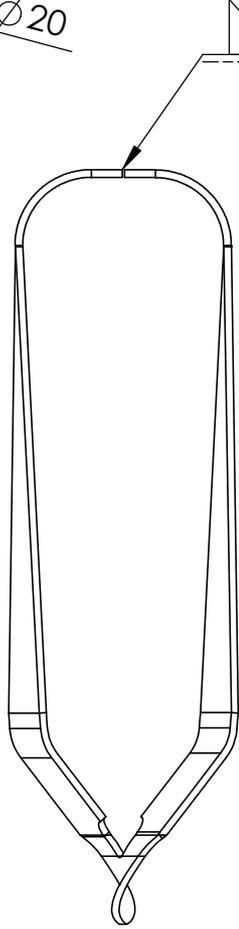
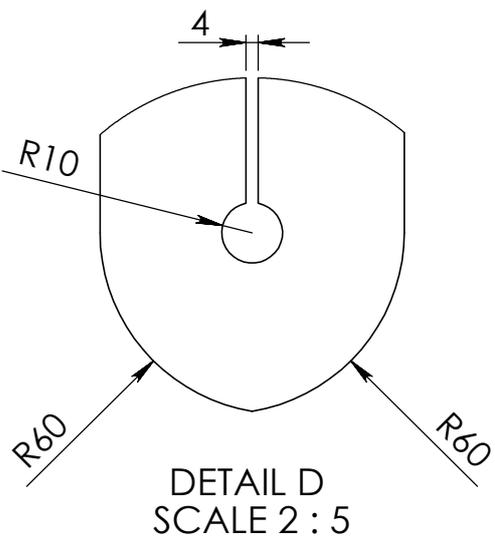


TITLE: Riverside bit 160mm	
DWG NO. 012	SCALE: 1:5
A4	

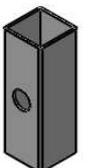
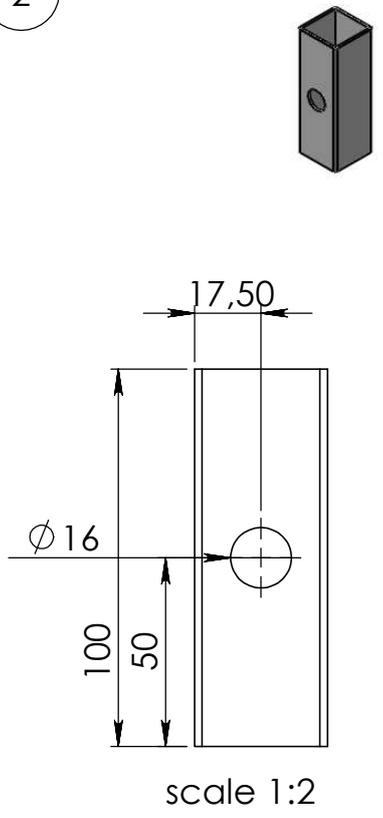
1



D



2



F	01	Open Clay Bit 160mm
	02	Square Pipe 35x35x2
DRAWN BY: Rob Dedden		DATE: 01-06-2010



TITLE:	Open Clay Bit	
DWG NO.	013	SCALE: 1:5
		A4