

# INSTALLATION & REMOVAL OF DEWATERING PUMP

Installation: step 1

**Take all the equipment out of the crate.**

Be aware that the pump itself might be a different model / brand as the one depicted.



Installation: step 2

**Wind some Teflon tape around the male part of the 2" Galvanised Iron (GI) pipe.**



Installation: step 3

**Fit the 2" GI pipe in the T-piece of the second 2" GI pipe.**

Make sure that the knobs of both gate valves are pointing in the same direction as the free outlet of the T-piece, once "tightened".



# INSTALLATION & REMOVAL OF DEWATERING PUMP

Installation: step 4

## Install the big T-piece assembly on the well.

The gate valves, pointing downwards, should be positioned outside of the lining to avoid the big T-piece assembly falling inside the well.

This big T-piece assembly will function as well as support and as connection for the dewatering pump.



Installation: step 5

## Connect one or two spiralled hoses to the dewatering pump and tighten their Guillemin half couplings with hook spanners.

The choice between one or two spiralled pipes depends on the depth the pump needs to be installed.



Installation: step 6

## Connect the rope with a solid knot to the handle of the dewatering pump.



## INSTALLATION & REMOVAL OF DEWATERING PUMP

Installation: step 7

**Bring the dewatering pump as close as possible to the big T-piece assembly already installed on the well.**

Be careful not to drop the pump inside the well.



Installation: step 8

**Wind the rope 2 times around the big T-piece assembly.**

The rope length between the handle of the pump and the big T-piece assembly should be as short as possible to ease the lowering afterwards.



Installation: step 9

**Lower the dewatering pump inside the well until the desired depth and fix the rope with a solid knot on the big T-piece assembly.**

With the rope winded around the big T-piece assembly, the lowering should be easy. It might be necessary however to hold the big T-piece assembly to avoid that it would be spinning around as the pump is lowered.

The electrical cable and the spiralled hose(s) should be guided to avoid that they get damaged and that their free extremities would fall inside the well.

The dewatering pump should ideally be installed 50 cm above the bottom of the well, except if it is used for well cleaning where it can be put deeper.



## INSTALLATION & REMOVAL OF DEWATERING PUMP

Installation: step 10

**Connect the spiralled hose to the free opening of the big T-piece assembly and tighten the Guillemin half couplings with hook spanners.**



Installation: step 11

**Connect the flat hose to one of the gate valves of the big T-piece assembly and tighten the Guillemin half couplings with hook spanners.**

The gate valve will serve to regulate the desired flow without surpassing the well's maximum yield (the maximum pumping rate of the well).

The other gate valve should be closed if not used.



Installation: step 12

**Plug the dewatering pump's electrical cable in a network or a generator.**

The connection of the electrical cable should preferably be outside of the well. If this is not possible, a protection cover can be placed over the plug and the socket. Be aware however that this cover is not watertight (only splash tight), although it looks like a boey!

Verify if the generator can deliver the needed current to start the dewatering pump. Be aware that the starting current of the dewatering pump is several times higher than its nominal current.

The generator should be used as described in its owner's / users' manual.



# INSTALLATION & REMOVAL OF DEWATERING PUMP

Removal: step 1

**Get the dewatering pump out of the well by pulling on its rope.**

Never pull on the electrical cable as this will damage it, which could lead eventually to electrocution! It should also be disconnected before the pump is pulled up.

The intension is that the dewatering pump is the least possible in contact with the well's lining when it is pulled up.

An alternative way is to grab the extremities of the big T-piece assembly with two persons and start walking away from the well, whilst a third person guides the spiralled pipes, the rope and the electrical cable.



Removal: step 2

**Disconnect all elements in the reversed order as described in the installation protocol.**



Removal: step 3

**Clean, dry and maintain all the elements before they are repacked.**

The dewatering pump should be rinsed inside and out. The easiest way for its inside is to plunge it in a relatively big recipient with clean water and to let the dewatering pump run.

For the maintenance of the dewatering pump, consult its manual.



**Find more information within the Public Health Engineering guidelines on:**

- Cleaning and disinfection of a well.
- Centrifugal pumps
- Determination of the maximum pumping rate of a well

## T.B. 2.03 Cleaning and disinfection of a well

The cleaning and disinfection procedure is done with the objective to eliminate pathogens (bacteria and viruses) that could be present in the well. This procedure is implemented after the well is built or after maintenance or rehabilitation works have been done inside the well or on the pump. It can also be done when there are some reasons to suspect that a contamination was (punctually) introduced in the well (e.g. floods), or if a sanitary inspection shows a risk of an existing pollution.

### Operation

#### Technique A.

If it is possible to empty the well completely, it's the preferred method as it gives the best results.

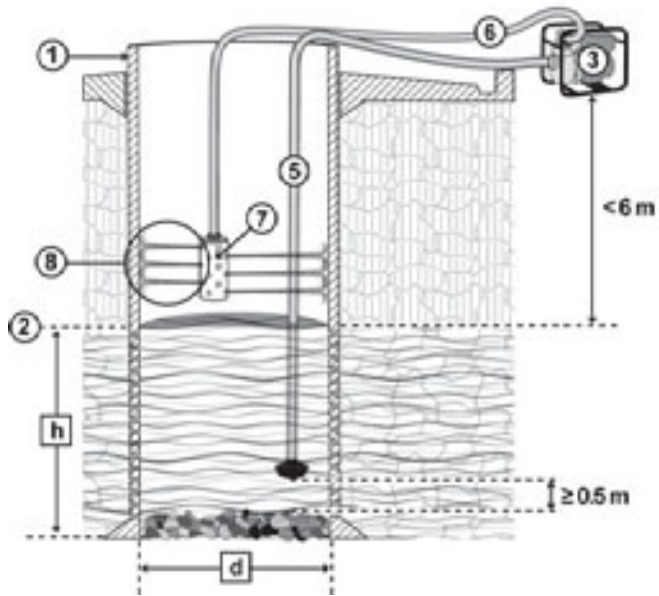
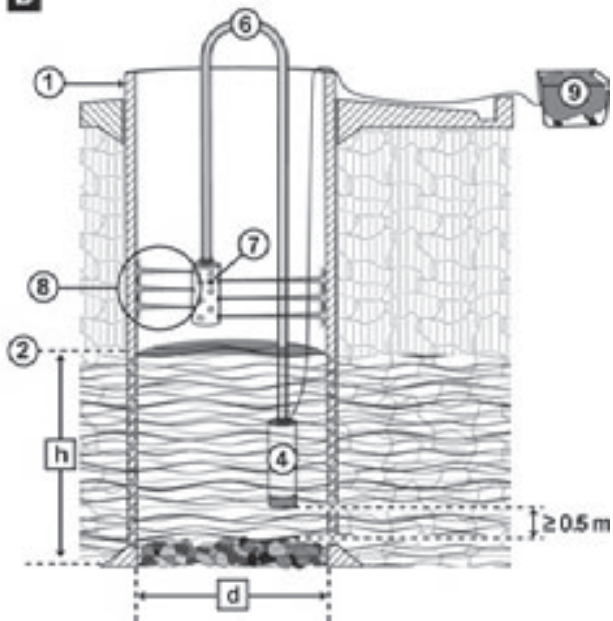
- Empty the well by means of a pump. Be aware that the well depth can't exceed 7 m (at sea level) if a surface pump (e.g. motor pump) is used. If the water table is deeper, a dewatering pump will be needed (T.B. 2.25). The sludge can potentially be removed by putting the "suction" pipe / dewatering pump very close to the bottom of the well and swirl the groundwater to put the mud in suspension.
- Remove all the potential debris that has entered the well (after an accidental event like a flood), using a strong metal bucket lifted by means of a winch and tripod. Make sure to follow all the safety prescriptions (see hereunder). Deepen the well in case of a massive influx of sludge.
- Prepare a 0.05% chlorine solution (T.B. 2.20). The amount of chlorine solution needed will depend on the total surface of the wellhead, shaft and intake.
- Scrub the complete lining with the chlorine solution, following the safety prescriptions (see hereunder).
- Wait at least ½ hour during which the well refills.
- Pump the water carefully out of the well again, while measuring the turbidity (T.B. 2.13) and the Free Residual Chlorine (FRC) concentration (T.B. 2.22). The pump can be stopped when the turbidity is lower than 5 NTU and the FRC concentration lower than 0.5 mg/l.

#### Technique B.

If it is not possible to empty the well completely, this method is the most effective.

- Try to remove as much sludge and debris as possible (after an accidental event like a flood) by means of a surface pump (if the water table < 7 m deep) or a dewatering pump (water table even > 7 m deep).
- Prepare a 0.05% chlorine solution (T.B. 2.20). The amount of chlorine solution needed will depend on the surface of the lining above the water table, including the wellhead.
- Scrub the lining above the water level with the 0.05% chlorine solution according to the safety prescriptions (see hereunder).
- Determine the volume of water inside the well: **volume = (π x d<sup>2</sup>/4) x h**  
with π = 3.14; d = inner diameter of the well; h = depth between the water table and the well bottom
- Prepare a 1% chlorine mother solution (T.B. 2.20). The amount of chlorine solution needed will depend on the water volume in the well.
- Add 10 l of the 1% solution per m<sup>3</sup> of well water, mix and leave the well closed for at least 12 hours.
- Pump the water carefully out of the well after this period, while measuring the turbidity (T.B. 2.13) and the FRC concentration (T.B. 2.22). The pump can be stopped when the turbidity is lower than 5 NTU and the FRC concentration lower than 0.5 mg/l.

Key	Input
A. Well cleaning of shallow well with motor pump (technique C)	
B. Well cleaning of well with dewatering pump (technique C)	
1. Lining	-Chlorination kit with a chlorine-generating product
2. Water level	-Scrubbing brushes (short and long handled)
3. Surface (motor) pump	-Extension for the handle of the scrubbing brush
4. Dewatering pump	-Hoses and disinfection tube (pierced sleeve)
5. Suction pipe	-Ropes, buckets
6. Delivery pipe	-Pump kit (motor or dewatering pump)
7. Sleeve with small diameter holes	-Tripod and winch
8. Water jets	-Harness / seat
9. Generator	-Mask
	-Goggles or face shield
	-Heavy duty gloves
d = diameter of the well	-Overall
h = depth between water table and bottom	-Temporary fencing material

**A****B**

### Technique C.

If a lot of wells need to be cleaned and disinfected in a short period (e.g. after a big flood), this method is preferred because it's the fastest, but it's also the least effective.

- Try to remove as much sludge and debris as possible by means of a surface pump (only if the water table < 7 m deep) or a dewatering pump (even for a water table > 7 m deep).
- Determine the volume of water inside the well: **volume =  $(\pi \times d^2/4) \times h$**   
with  $\pi = 3.14$ ; d = diameter of the well; h = depth between the water table and the well bottom
- Prepare a 1% chlorine mother solution (T.B. 2.20). The amount of chlorine solution needed will depend on the water volume in the well.
- Add 100 l of 1% chlorine solution per m<sup>3</sup> of well water, mix and leave the well closed for 30 minutes.
- Equip the delivery hose of the pump with a disinfection tube, which is a pierced sleeve (small holes of 4 - 6 mm diameter), closed at one extremity. The highly chlorinated well water being pumped through the small holes of the disinfection tube will result in strong jets, permitting the cleaning and disinfection of the well lining above the water table.
- Start the pump and move the disinfection tube up and down for at least 15 minutes, in order to spray thoroughly the shaft and the wellhead (T.B. 2.02) with a high flow of the highly chlorinated well water. When the well is completely cleaned, wait 30 minutes for the chlorine to act.
- Pump the water carefully out of the well after this period, while measuring the turbidity (T.B. 2.13) and the FRC concentration (T.B. 2.22). The pump can be stopped when the turbidity is lower than 5 NTU and the FRC concentration lower than 0.5 mg/l.

### Safety prescriptions

Safety measures must seriously be considered before starting the cleaning of a well. This includes the safety of the workers and the equipment, but also the surroundings of the working area:

- The working area should be fenced all the time, with no access to people other than the authorised personnel.
- Supervised by a competent and trained team leader, there must be a minimum of three trained workers per well. Two workers should be at the surface, one operating the winch and the other watching the third person inside the well. All three workers should rotate, every 15 minutes ideally. A clear and simple system of communication must be used between the person inside the well and the workers remaining at the surface.
- All workers should wear a helmet, an overall, heavy duty gloves and boots. When manipulating chlorine products, goggles or a face shield, a respirator and rubber gloves should be added.
- The staff should be trained to use the material correctly, including the safety equipment present on site like the lifting apparatus with harness and the first aid kit.
- Chlorine is a dangerous product that must be stored and handled with great care (T.B. 2.19). The manual disinfection (scrubbing) of the lining should be done as much as possible with the staff being outside of the well, by means of long handled hard brushes.
- All tools and safety equipment should be checked daily and replaced when necessary.
- Electric dewatering pumps can be used to empty a well before cleaning. However, a dewatering pump should be stopped and disconnected from its electricity source before people enter the well, as faulty equipment could cause electrocution.
- A generator used to provide power to electric pumps, should always be earthed.
- Generators and motor pumps should be located as far as possible away from the well to avoid exhaust gases entering, potentially causing asphyxia of people working inside. For the same reason should motor pumps never be lowered inside a well.



## Remarks

- The cleaning techniques described above are meant for lined wells. The cleaning and disinfection of an unlined well is not very useful, except perhaps after being flooded. Unlined wells should not be entered, especially not after they have been flooded because they might collapse. In such a case, it can be tried to remove the sludge by pumping, although it will be impossible to take out the potential big debris. The dirt layer on the unlined walls can be removed by technique C, but care should be taken not to erode the walls (any further), as this could lead to (partial) collapse.
- In general, a properly protected well (T.B. 2.04) is considered as being non-polluted. Nevertheless, a biyearly maintenance before and after the rainy season, including cleaning and disinfection is strongly recommended.
- The described types of cleaning / disinfection do not have any permanent effect. These kinds of interventions are effective on punctual contamination linked to maintenance or construction works, or accidental pollution (e.g. floods), but not for unprotected wells. If the source of contamination is not removed, water taken out of the well will not be disinfected due to the very temporary impact of chlorine.
- In any case, possible contamination sources must be searched and corrective measures applied before the disinfection of the well can occur.
- Microbiological contamination of a well through the ground by latrines or cattle is quite rare, unless the contamination source is located at a short distance from the well (the minimum recommended distance for latrines is set at 30 m, and 10 m for cattle). If the contamination really occurs through the ground, it could be necessary to close the well or to eliminate the source of contamination (e.g. latrines), knowing that it will take a minimum of 60 days before the adverse microbiological effects have disappeared. If the well is the only water source, implementation of bucket chlorination (T.B. 2.23) can be considered to reduce the risks and to give time to seek and implement an alternative solution.
- Potential damages to the outside (T.B. 2.04) and the inside lining of the well, discovered during or after the cleaning, should always be repaired. The repaired patches should be disinfected before the well is put back into function.
- When a well has to be emptied, the first (non-disinfected) water pumped out of the well should preferably be disposed of via a soak away pit (T.B. 4.06) or infiltration trenches (T.B. 4.07).
- In case a well has to be emptied during of a cholera outbreak, it is strongly recommended to hyperchlorinate the well water before, because of the environmental contamination risk by the potentially polluted groundwater. Per m<sup>3</sup> of well water, 100 l of 1% chlorine solution should be added.
- Since this chlorination method does not guarantee a continuous disinfection, it is strongly recommended to implement controlled bucket chlorination (T.B. 2.23) as long as the well is not properly protected or if there is a strong suspicion that the well is the origin of infection of several people.
- Debris and sand inside a tube well (borehole) can't be removed manually, but can be blown out by means of a compressor. Other techniques exist but fall out of the scope of these guidelines. Contact your technical referent for more information when required.
- The disinfection of a tube well (borehole) can be done by pouring 10 l of 1% chlorine solution per m<sup>3</sup> of water within the well (as described for technique B). For the whole casing to be disinfected, it is advised to pour the chlorine mother solution over the whole circumference of the tube well. Pump the water carefully out of the tube well after a minimum period of 12 h while measuring the FRC concentration (T.B. 2.22). The pump can be stopped when this concentration is lower than 0.5 mg/l. Do not forget to pour an abundant amount of potable water afterwards in the tube well to rinse stagnant chlorine solution on the couplings of the raising main.

## T.B. 2.25 Centrifugal pumps

Most motorized (combustion engine or electric) water pumps used by aid-agencies are centrifugal types. The principle of a centrifugal pump is that its spinning impellor (rotor) throws the water outwards and the empty space that is created at the centre of the impellor is filled via the “suction pipe” by new water, which is actually pushed in by the atmospheric air pressure. This new water will be thrown outwards again by the impellor, creating again an empty space at its centre and so on continuously until the pump is stopped. The velocity of the water thrown out of the impeller is partly transformed within the pump’s snail house (stator with a specific form) into pressure, thus the water can be transported at a certain flow over a certain height.

### Types of centrifugal pumps mainly used by aid-agencies

#### Surface pumps

They will most of the time be situated above the water surface and will “suck up” the water to deliver it at higher grounds. Whatever the kind or the power of the motor driving the pump, its maximum suction height (head) is about 7 m at sea level, and decreases as the altitude rises.

- Low pressure *motor pumps* (e.g. maximum pressure of about 300 kPa or 3 bar), driven by a petrol or diesel engine, are often used in emergencies. As motor pumps are designed to work at construction sites, they can deal with very turbid water that contains small solid particles.
- Most *high pressure pumps* (e.g. > 600 kPa or 6 bar) aren’t conceived to pump turbid water.
- *Trash pumps* (T.B. 3.13) are able to pump turbid water containing solids up to 20 – 30 mm (e.g. small debris, faeces) without clogging. Their impellor blades often have sharp edges to shred soft particles.

#### Submersible pumps

They need to be completely submerged in the water, otherwise they stop or even break down after a short period of use. As they are completely submerged, these pumps don’t “suck up” the water, they only have to deliver (push) it. They are specifically interesting for (tube) wells that have their water level (a lot) deeper than 7 m under the surface. The flow and pressure that can be delivered, depend on the size of the pump and on the power of its electric motor (most often combined in one piece of equipment). Submersible pumps are designed to lift non-turbid water, thus solid particles in suspension will damage their impellers and pump house.

#### Dewatering pumps

They combine to a certain extent features of the commonly used motor pumps and the submersible pumps. Dewatering pumps that are driven by electric motors, can be completely submerged or nearly completely out of the water (as long as the impeller part stays submerged). Some high quality models exist that have their electric motor cooled by the pumped water, so the motor part can stay out of the water for prolonged periods. As their inlet has to be under the water level, dewatering pumps can only deliver water, but at (relatively) high flow rates. As these pumps are designed for (very) dirty water, their delivery height is rather limited (certainly in comparison to submersible pumps in the same electric power range). Aid-agencies use them mainly to dewater hand dug wells rapidly, before the works within can start. They can also be used during well cleaning (T.B. 2.03) or to remove the sludge from assisted sedimentation reservoirs (T.B. 2.16). They can also be employed to deliver potable water from hand dug wells that are more than 7 m deep.

### Pump characteristics

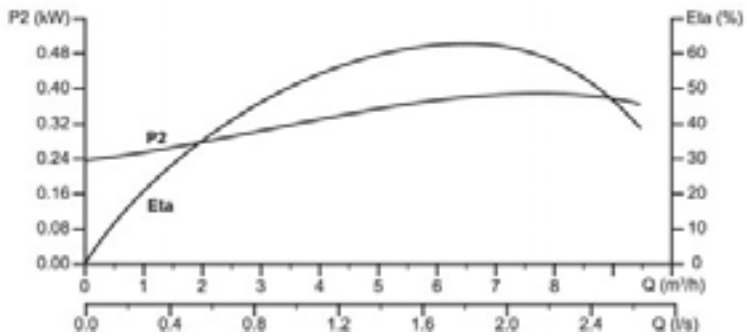
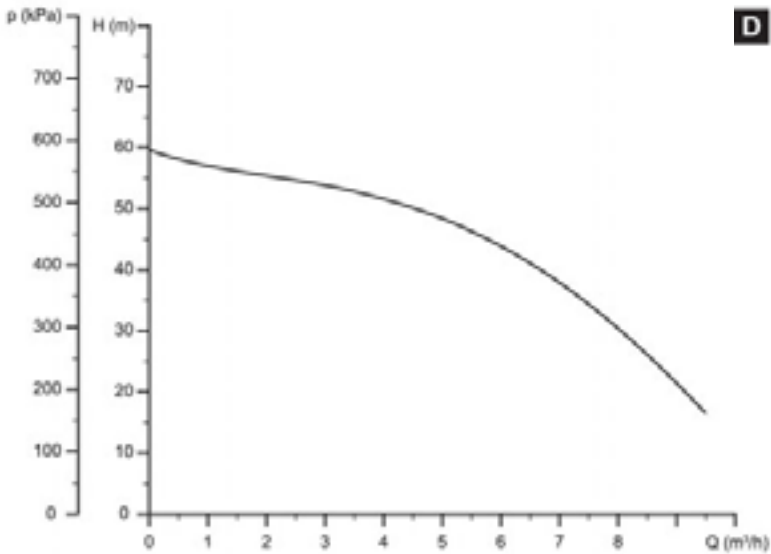
#### Identification plate

Every centrifugal pump should have an identification plate indicating at least two working points:

- The maximum Total Manometric Head (TMH) it can reach (at zero flow); expressed in kPa, bar, meter Water Column (mWC).
- The maximum flow it can reach (theoretical working point at TMH zero); expressed in l/s, l/min, m<sup>3</sup>/h.

**A****B****C****Key**

- A. Motor pump
- B. Submersible pump
- C. Dewatering pump
- D. Pump graph (centrifugal pumps)



### Characteristics curves (graphs)

- ***pQ (upper part of the graph)***: The pQ curve of a centrifugal pump is the relationship between the pressure (p) and the flow (Q) it delivers (for a motor pump at the maximum regulated speed of the combustion engine). The curve determines the capacity of the pump over its working range. Note that at maximum pressure, the flow is zero. Often, a part of the curve is printed in bold. This is the range at which the pump should function to have a high efficiency. The actual working point (the specific pressure and flow at which the pump will function) is determined by the height difference and the head losses in the pipe system that the pump has to overcome (T.B. 2.31; 2.32).
- ***Pump efficiency and power requirements (lower part of the graph)***: Some manufacturers of (electric) centrifugal pumps also provide curves indicating the efficiency (Eta) and the power requirement (P2) of a specific pump. The efficiency is the relation between the power transmitted to the water and the power delivered by the motor. Every pump has its own efficiency curve, which will vary according its flow. The maximum efficiency is where most of the power of the motor is transferred to the water as shown on the curve. The power curve also shows that a centrifugal pump needs the least power when the flow is zero. So if a generator has difficulties to deliver the starting current of an electric centrifugal pump, it's recommended to start it with its gate valve closed (Q = 0, p = max.), because this requires the least power, thus also the least starting current.

### Remarks

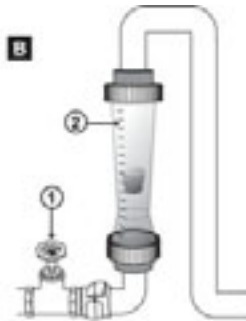
- Always read the owner's manual before using a pump.
- Motor pumps and generators should never be lowered inside or put directly next to a well to avoid their toxic exhaust gasses accumulating within.
- Dewatering pumps should be stopped and disconnected from their electricity source before people enter the well.
- When a generator is used to supply power to an electric pump, make sure it is earthed.
- Not all surface centrifugal pumps are self-priming; thus not only their pump house has to be filled completely with water before the pump is started, but also their "suction" pipe. In case of doubt if a pump is self-priming, always fill its "suction" pipe with water.
- Some high capacity surface pumps can't "suck up" the water and need to have the water level at the same height as the pump axis, or even above (check the owner's manual).
- Not all centrifugal pumps are capable of pumping turbid water. The possible presence of large quantities of sand or other solid particles in the water may damage the moving parts of the pump.
- The installation of a strainer is compulsory, even for pumps which are specifically manufactured to deal with water that contains solid particles.
- The presence of salty or brackish water may corrode the pump rapidly.
- Some electric pumps have electronic features that start their motor slowly and thus require a lower starting current (consequently also less starting power). It is therefore not necessary to start this kind of pumps with a closed gate valve.
- Be aware that 10 meter Water Column (mWC) is about equal to 100 kPa or 1 bar (with bar and mWC being the unities most commonly used by technicians).

## T.B. 2.27 Determination of the maximum pumping rate of a well

In order to verify if a hand dug well or a tube well (borehole) can cover the water demand, it's important to determine its maximum pumping rate via a pumping test. The maximum pumping rate is also important to identify an appropriate pump for the well. The pumping test consists of recording the evolution of the water drawdown inside the well at increasing flow rates. The dynamic water level related to the maximum pumping rate, together with the depth at which the slotted tube well casing starts also determine at what depth the pump should be installed.

### Procedure

- Check the well's logbook for following information: total depth, static water level, dynamic water level at maximum pumping rate and depth where the slotted part of the tube well starts. If the logbook isn't available, all the above mentioned data have to be determined before a pump can be chosen and/or installed. Information on neighbouring wells can provide an estimation of the well depth and the static water level in the area.
- Determine the total depth of the well. This can be done by introducing a disinfected heavy weight (e.g. a stone) on a long rope into the well. Once the weight can't be felt anymore, the bottom is reached. The length of the inserted rope, starting from the ground surface (e.g. the edge of the wellhead / the casing aboveground) until the bottom can be measured, and therefore indicates the total depth of the well.
- Determine the static water level of the well by means of a dipper. A dipper is a probe connected to a long measuring tape that will give a light and/or sound signal when it comes in contact with water. To obtain correct data, the static water level measurement should only be done when the well hasn't been used for at least 24 hours.
- Estimate, in case of a borehole, the depth where the slotted casing starts, based on its total depth and the static water level. A properly designed borehole often has 1 to 3 lengths of slotted casing of 4 to 6 m length each, depending on the extent (thickness) of the underground aquifer. It's important to consider that a correctly designed borehole can never have its static water level lower than the slotted part of the casing.
- Install a motorized centrifugal pump (T.B. 2.25). For shallow wells (static water level less than 6 m deep at sea level), a motor pump can be used. For hand dug wells with a deeper static water level, a dewatering or a submersible pump will have to be used. For deep tube wells a submersible pump will need to be installed, at least 1 m above the slotted casing (T.B. 2.29). A gate valve should be foreseen on the delivery pipe to regulate the pump's flow accurately.
- Start the pump with the gate valve closed, open it slowly and regulate the flow "Q" at 0.5 m<sup>3</sup>/h by means of the valve. The flow can be determined by measuring the time needed to fill a recipient of known volume (e.g. 20 - 30 l), or a lot easier by an instant flow meter.
- Measure the drawdown "s" (in meter) with the dipper, and follow up until the dynamic water level has stabilized (drawdown < 1 cm/minute) at this specific flow rate. Often a stabilization period of 2 hours is taken, but in acute emergencies, it can be tried to reduce this period.
- Plot the measured figures on a flow (abscissa) / drawdown (ordinate) graph to indicate the working point. A straight line can also be drawn from the graphs zero point (flow = 0, drawdown = 0) across the first flow (Q = 0.5 m<sup>3</sup>/h) / drawdown (s) working point, representing more or less the linear head losses within the aquifer (as the non-linear head losses will mostly still be low for such a low flow).
- Measure also the turbidity of the well water by means of a turbidity tube (T.B. 2.13). The turbidity should preferably be less than 5 (N)TU, and certainly not above 20 (N)TU.
- Increase the flow to 1 m<sup>3</sup>/h by opening the gate valve a little more, and whilst monitoring the turbidity, follow the drawdown over the same period as for the flow of 0.5 m<sup>3</sup>/h.
- Plot the new working point on the graph and interconnect the different working points to form the well curve, representing the linear and non-linear head losses during pumping (as per figure C).
- Keep adding a step of 1 m<sup>3</sup>/h to the flow rate while measuring the drawdown, and keep on plotting the results on the graph, until the non-linear head losses have become equal to the linear head losses, or until the well curve bends significantly away from the linear head losses line. These phenomena indicate that the critical flow is reached. The critical flow is also reached when the turbidity of the pumped up water starts to rise drastically. In case these phenomena don't occur, the flow rate can be increased until the maximum possible drawdown is reached, meaning that the dynamic water level is still at least 1 m above the pump (or the strainer if a surface pump is used).



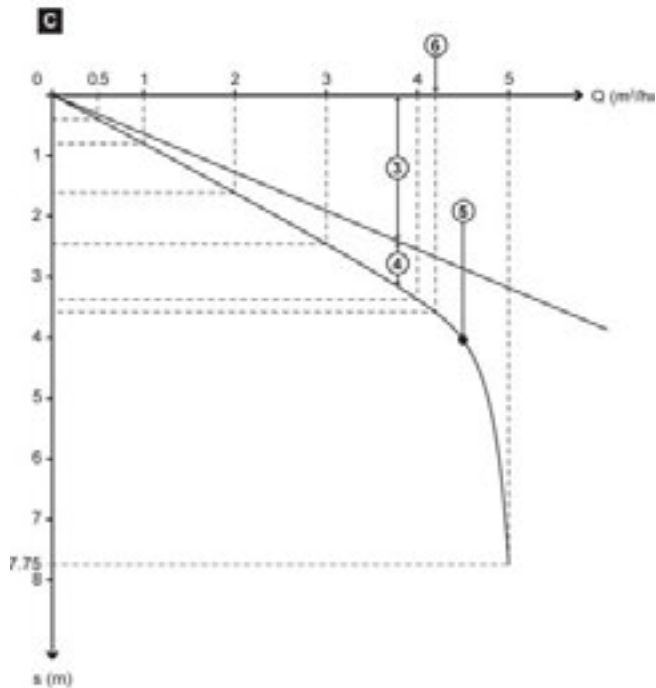
**Key**

**Input**

- A. Dipper
- B. Instant flow meter with gate valve
- C. Flow (Q) – drawdown (s) graph

1. Gate valve
2. Instant flow meter (Rota meter)
3. Linear head-losses
4. Non-linear head-losses (turbulence)
5. Critical flow
6. Maximum pumping rate

- Logbook
- Rope and disinfected weight (e.g. spanner)
- Dipper
- Recipient and watch or instant flow meter
- Gate valve
- Pump kit (motor, dewatering or submersible)
- Turbidity tube
- Squared / graph paper, ruler and pen



## Interpretation of the results

- When a well is being over-pumped beyond its critical flow, it can result in the well curve bending significantly away from the linear head losses line. This is caused by:
  - important turbulence and thus heavy non-linear head losses within the gravel pack and the slotted casing of a tube well, or
  - the dewatering of a particular productive aquifer.
- In any case, over-pumping should be avoided. This means that the maximum pumping rate should be below the critical flow. In practice, and to play on the safe side, the pump flow rate of the last step before the critical flow is reached, can be considered as the practical maximum pumping rate.
- A serious increase of the turbidity also indicates that the (tube) well is over-pumped. The maximum pumping rate should then be regulated at the flow delivering water with a turbidity of less than 5 (N)TU (maximum 20 (N)TU during acute emergencies).
- In case the critical flow isn't reached, nor the turbidity has risen, the maximum pumping rate should be set at the flow at which the dynamic water level in the well is at least 1 m above the pump / strainer.
- Based on all the results, a logbook with all the available information should be made and archived for future use.

## Remarks

- This simplified pumping test provides the possibility to determine rapidly an approximation of the most essential parameters that are needed to exploit safely an existing well. However, the approximations made above do not guarantee any long-term results for the tested well. Other more sophisticated methods exist (e.g. Porchet) and can be found in specific literature (section 2.5 Further reading).
- The following data are important factors for the exploitation of a well:
  - Total depth: in practice the depth from the edge of the wellhead or from the casing aboveground, until the bottom of the well.
  - Static water level: water level before pumping starts (not having been pumped for at least 24 hours).
  - Dynamic water level: water level at a certain pumping rate, preferably at the well's maximum pumping rate (but certainly not above).
  - Maximum pumping rate: the maximum water flow that the well can deliver without having important non-linear head losses, too high turbidity of the water or being sucked dry.
  - Depth where the slotted part of the casing starts: the part where the water enters the tube well.
- Even if the logbook of the well is available, it can be interesting to verify all its data, at least if time permits.
- When determining the total depth of the (tube) well, make sure there aren't any obstacles blocking the free passage of the weight and rope (e.g. a pump).
- An appropriate submersible pump should be installed with its bottom at least 1 m above the slotted casing of the tube well, in order to avoid:
  - erosion of the soil at the level of the pump inlet, and
  - insufficient cooling of the pump motor (T.B. 2.29).
- A dewatering pump or the strainer of a motor pump's "suction" pipe should never be less than 0.5 m away from the bottom of a hand dug well. This is to avoid that settled dirt particles would be pumped up, which would increase the turbidity drastically from the start.
- If the turbidity of the well water is already high before the pumping test starts, it can be an indicator that the well hasn't been designed correctly (e.g. no lining for a hand dug well) and/or developed properly (no slow pumping during prolonged periods). Another possibility is that the well has been over-pumped previously.
- Where water is scarce, avoid wastage during the pumping test by collecting the water in a reservoir.
- The distance in between the well curve and the linear head losses line indicates the non-linear head losses, created by the turbulent flow inside the gravel pack and the slotted casing of the tube well.
- If time is available, it is preferable to increase the flow in steps of 0.5 m<sup>3</sup>/h, instead of 1 m<sup>3</sup>/h.
- It is also possible to do a pumping test with a flow in between the two measures where the critical flow appeared, in order to determine the maximum pumping rate more precisely. This is recommended if the "initially obtained" maximum pumping rate is too low in comparison with the desired flow (and thus not covering the water demand).
- After the maximum pumping rate has been determined, it's recommended to pump at this rate for 24 hours, in order to verify the capacity and the stability of the well.