



## **Introduction**

A borehole can be regarded as a well or a borehole. Typically, a borehole is thin in diameter and drilled. All wells are artificial pits or tunnels that are either drilled, dug, driven or jetted into the ground to a depth through which groundwater may flow or be pumped to the surface. Exploiting groundwater is arguably the most complicated water source, as the water is hidden at an unknown depth, in an unknown volume. The engineer needs to be sure about boreholes or wells and ask three questions before presenting to a community, as a water supply option.

1. Is there an available source of water below ground level (known as an aquifer).

*Fully answering the first question may be an expensive exercise, in terms of a groundwater survey, and the answer may still be incomplete. One would hope that existing wells within the village and local knowledge, could provide some clues as to water depths and volumes*

2. What type of conduit for routing the water to the surface, is appropriate (known as casing)

*Drilling companies are expensive, while local well digging experts are good value for shallow depths. Care needs to be taken digging wells by hand, as ground collapse is common in some soils.*

3. How will the water be extracted.

*The answer to this question must always come from the community, because maintenance of hand pumps is notoriously high. It is necessary to have a community participatory selection process in choosing the correct pump.*

## **Installation and Operation**

**Drilling Operations** and drilling methods vary widely and range from digging by hand-augars, to the use of technical and expensive drilling rigs. The rig is set up over the prospective well location and drilling continues until desired depths are reached.

**Installing the Casing Screen** is done during drilling, or when the desired depth of borehole has been reached. Casing can be made of different materials, e.g. steel, plastic or ferro cement, and comes in various diameters and lengths. Screens have slots or holes to allow ingress of water and keep foreign materials out. Well screens are usually attached to the first piece of casing to be put into the borehole and successive pieces of

casing are then added until the entire length of the borehole has been screened and / or cased.

**Installing an Artificial Filter Pack** around the screen is necessary for some well designs. This operation takes place before grouting or sealing the well. The filter pack consists of graded sand or gravel, which is placed around the well screen. The filter pack removes or filters unwanted fine particles from the formation that would otherwise find a way into the well. Fine particles could cause the well water to appear cloudy.

**Grouting the Well** involves filling the space between the casing and borehole wall with a slurry of cement or clay. This seals the area between the casing and borehole wall, preventing downward contamination leakage from the surface, also preventing mixing of ground water between other water-bearing zones encountered while drilling. Grouting is accomplished in several ways, and involves the mixing and placement of either a bentonite clay slurry or a neat cement slurry in the space between the borehole and the casing. Neat cement is a common type of grout. The section of the borehole to be grouted varies according to geological conditions, the type of water well being constructed, and water well codes. After grouting, the well is ready to be developed.

**Developing the Well** maximizes the well yield. Damage to the formation or aquifer occurs when the drill bit cuts through the rock or sediment leaving behind small pieces of rock or sediment that may plug the well screen and reduce the yield of the well. Also, during the drilling operation, different fluids may have been introduced to the borehole to remove cuttings and prevent collapse. There are three main reasons for well development: (1) repair damage done to the formation during drilling, and to remove unwanted fluids, so that the natural properties of the aquifer are restored; and (2) change the physical properties (porosity and permeability) of the aquifer near the borehole so that water will flow more freely into the well; and (3) determine the maximum flow. A variety of techniques are used to develop wells. Some are as simple as bailing the well by hand or by engine pump, and others may involve a complex operation of high capacity pumping and jetting. The screened area of the well, or the uncased unscreened portion of a borehole, is where the development takes place because this is the area where water will enter the well. All of the techniques have their advantages and achieve the same goal of increasing the amount of water that can be delivered to the



surface for use. With development complete, a permanent pump can be installed if necessary, and the well can be put to use.

### **Concluding Comments**

A well shall be located so that adequate access to the well for use, inspection, maintenance, repair, renovation, treatment, and testing is provided. A well shall be located where it is not subject to seasonal flooding or surface water contamination, or it shall be constructed in such a manner that seasonal floodwater cannot enter the well. A well should be located up gradient of any potential or known source of contamination unless property boundaries, site topography, location of structures and accessibility require a different location. The minimum horizontal separation distances from potential sources of contamination shall approximately be 25 - 50m or more, depending on the depth of the well and soil composition. The ground surface immediately surrounding a well casing shall be graded to divert surface water away from the well. Concrete shall not be used for grading purposes. Before deciding on the use of groundwater as the water supply option it is essential to seek expert opinion and advice. Supervision of works should not be carried out by inexperienced engineers, and great care should be taken in drawing up the contract with specialist well-drillers, as there are no absolute certainties that water will be found below ground.

### **Glossary**

**Annular space** – the space between the casing or screen in a well and the wall of the borehole.

**Aquifer** – a body of the rock or sediment that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs.

**Artificial filter pack** - artificially graded material surrounding the well screen in a water well.

**Bailing** - the repeated lowering, filling, raising and emptying of a bailer to remove fluid from a well. A bailer is a cylindrical tube fitted with a valve at the bottom.

**Bentonite** - a clay material used in the water well industry as a drilling mud and as a well sealing material to slow or stop water movement.

**Borehole** - a circular hole made by boring or drilling to access a particular geologic unit.

**Casing** - a pipe lowered into a bore hole during or after drilling and grouted into place.

**Formation** - a body of rock identified by certain geologic characteristics; term applied by drillers to a rock or sediment that can be described by certain drilling characteristics.

**Geologic** - pertaining to or related to geology, which is the study of the planet Earth.

**Ground water** - all subsurface water.

**Grouting** - the process of placing a cement or clay slurry to fill or seal fractures or spaces.

**Jetting** - the process of loosening and flushing cuttings or loosely consolidated materials from a borehole or well, by using a directed forceful stream (jet) of air or water.

**Neat cement** - a mixture of portland cement and water, in a certain proportion, used for grouting wells.

**Permeability** - the capacity of a rock or sediment to transmit a fluid.

**Porosity** - the ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

**Water well** - an artificial pit, hole, or tunnel, drilled, dug, driven, or jetted into the ground to a depth that penetrates a water-yielding formation to allow water to flow or to be pumped to the surface.

**Water well codes** - a set of regulations or standards to be followed and enforced for the construction of water wells.

**Well development** - the act of repairing damage to the formation caused by drilling procedures and increasing the porosity and permeability of the materials surrounding the intake portion of the well.

**Well screen** - a section of well casing which has been perforated or slotted to allow inflow of water and to keep unwanted materials from entering the well.

**Well yield** - the amount of water that can be withdrawn from a well per unit time

### **References**

Glossary terms are adapted from Bates, R.L., and Jackson, J.A., 1987, *Glossary of Geology*, American Geological Institute, Alexandria, Virginia, and from Driscoll, F.G., 1986, *Groundwater and Wells*, St. Paul, Minnesota, Johnson Division, Second edition, 1,089 p.  
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