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● What is a well?

A well is a hole in the earth from which fluid is withdrawn. A water well is an artificial excavation or structure put down by any method such as digging, boring or drilling for the purposes of withdrawing water.

Well water may be drawn via mechanical pump (such as an electric submersible pump) from a source below the surface of the earth, or drawn using containers, such as buckets, that are raised mechanically, or by hand. Wells can vary greatly in depth, water volume and water quality. Well water typically contains more minerals in solution than surface water and may require treatment to soften the water.

Although water wells are the most common type, oil, gas, and mining wells also exist. A well is made by reaching the water table. Wells can be made in a variety of ways: digging, driving, boring, or drilling.

Wells draw water up from the ground, called ground water. Ground water is stored naturally below the earth's surface. Most ground water originates as rain or snow that seeps into the ground and collects as underground aquifers.

● What is an aquifer?

An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well. The study of water flow in aquifers and the characterization of aquifers is called hydrogeology.

Two broad classes of drilled-well types may be distinguished based on the type of aquifer which the well is completed in:

Shallow or unconfined wells are completed in the uppermost saturated aquifer at that location (the upper unconfined aquifer); or deep or confined wells, which are sunk through an impermeable stratum down into an aquifer which is sandwiched between two impermeable strata (aquitards or aquicludes). The majority of confined aquifers are classified as artesian because the hydraulic head in a confined well is higher than the level of the top of the aquifer. If the hydraulic head in a confined well is higher than the land surface it is a "flowing" artesian well (named after Artois in France).

There clearly are many cases that fall in between these two end-members; often unconfined wells may be very deep (what is often called a *shallow* well can be over 150 m deep) and many times wells are completed across all aquifers from their top to their bottom (especially agricultural or industrial wells), being open to both unconfined and confined aquifers.

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● What is Groundwater?

Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of geologic formations. A formation of rock or soil is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces become fully saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology.

Ground water does not stay in one place. Gravity causes ground water to flow downward and outward. Porosity-the size and number of void spaces in the formation-determines how much water can be stored in an aquifer. Permeability-the ability of water to move through void spaces-indicates how quickly the water will travel through the aquifer.

Unconsolidated aquifers usually transmit water more efficiently than bedrock aquifers. Ground water flows easily through the spaces between loose sand and gravel particles. Water wells drilled into sand and gravel aquifers are often very productive.

Water flows out of pores and through fractures in consolidated bedrock aquifers. Productive water wells drilled into bedrock penetrate aquifers in fractured limestone or shale, or porous sandstone.

There are two basic types of wells.

1. Dug Wells
2. Drilled Wells

Until recent centuries, all artificial wells were pumpless dug wells. Such primitive dug wells were excavations with diameters large enough to accommodate muscle-powered digging to below the water table. Relatively formal versions tended to be lined with laid stones or brick; extending this lining into a wall around the well presumably served to reduce both contamination and injuries by falling into the well. The iconic American farm well features a peaked roof above the wall, reducing airborne contamination, and a cranked windlass, mounted between the two roof-supporting members, for raising and lowering a bucket to obtain water. More modern dug wells may be hand-pumped, especially in undeveloped and third-world countries.

Note that the term "shallow well" is not a synonym for dug well, and may actually be quite deep.

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Drilled Wells

Drilled wells can access water from a much deeper level by mechanical drilling.

Drilled wells with electric pumps are currently used throughout the world, mainly in developing and developed countries, typically in rural or sparsely populated areas, though many urban areas are supplied partly by Municipal wells.

Drilled wells are typically created using either top-head rotary style, table rotary, or cable tool drilling machines, all of which use drilling stems that are turned to create a cutting action in the formation, hence the term 'drilling'. Most shallow well drilling machines are mounted on large trucks, trailers, or tracked vehicle carriages. Water wells typically range from 20 to 600 feet, but in some areas can go deeper than 3,000 feet.

The oldest form of drilling machinery is the Cable Tool, still used today. Specifically designed to raise & lower a bit into the bore hole, the 'spudding' of the drill cause the bit to be raised & dropped onto the bottom of the hole, and the design of the cable causes the bit to twist at approximately 1/4 revolution per drop, thereby creating a drilling action. Unlike rotary drilling, cable tool drilling requires the drilling action to be stopped so that the bore hole can be bailed or emptied of drilled cuttings.

Drilled wells are typically cased with a factory made pipe, typically steel (in air rotary or cable tool drilling) or plastic/PVC (in mud rotary wells, also present in wells drilled into solid rock). The casing is constructed by welding, either chemically or thermodynamically, segments of casing together. If the casing is installed during the drilling, most drills will drive the casing into the ground as the bore hole advances, while some newer machines will actually allow for the casing to be rotated & drilled into the formation in a similar manner as the bit advancing just below.

● Well Pumps

Well pumps are the modern day equivalent of windmills, which were used to move water from one place to another over 100 years ago.

There are three basic types of well pumps.

1. Horizontal Shallow-well Pump
2. Vertical Line-shaft Pump
3. Vertical Submersible Pump

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● Horizontal Shallow-well Pump

The most common pump for a shallow well is a horizontal jet pump. Jet pumps are mounted above the well, either in the home or in a well house, and draw the water up from the well through suction.

Because suction is involved, atmospheric pressure is what's really doing the work. Think of the system as a long straw. As you suck on the straw, you create a vacuum in the straw above the water. Once the vacuum is there, the weight of the air, or atmospheric pressure, pushes the water up the straw. Consequently, the height that you can lift the water with a shallow-well jet pump relates to the weight of the air. While air pressure varies with elevation, it's common to limit the depth of a jet-pump-operated shallow well to about 25 ft. Because shallow-well jet pumps use water to draw water, they generally need to be primed—filled with water—before they'll work. To keep water in the pump and plumbing system from flowing back down into the well, a 1-way check valve is installed in the feed line to the pump.

● Vertical Line-shaft Pump

This type of vertical pump is commonly installed in a drilled and cased well. Its function is to lift liquid (usually water) from the water level in the well to the surface and provide a specified discharge pressure at the surface. The pumping element consists of a single or multistage bowl assembly and is located below the lowest liquid level. The bowl bearings are usually lubricated by the pumped liquid. The column pipe and line shaft assembly is either an open type product lubricated assembly or enclosed type oil or external liquid lubricated assembly. The column pipe is supported at the surface by a discharge head. The discharge head directs the water from vertical to horizontal flow and also supports a driver. A shaft sealing arrangement is contained within the discharge head. This type of pump is self-priming.

● Vertical Submersible Pump

A submersible pump is a pump which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The advantage of this type of pump is that it can provide a significant lifting force as it does not rely on external air pressure to lift the fluid. A system of mechanical seals are used to prevent the fluid being pumped entering the motor and causing a short circuit. Submersible pumps are found in many applications, single stage pumps are used for drainage, sewage pumping, general industrial pumping and slurry pumping. Multiple stage submersible pumps are typically lowered down a borehole and used for water abstraction or in water wells. While submersible pumps are more efficient than jet pumps in delivering more water for the same size motor, pump or motor problems will necessitate pulling the unit from the well casing—a job that's best left to a pro. However, submersibles are known for their reliability and often perform their role 20 to 25 years without servicing. Submersible pumps may also be used in shallow wells. However, silt, sand, algae and other contaminants can shorten the pump's life.