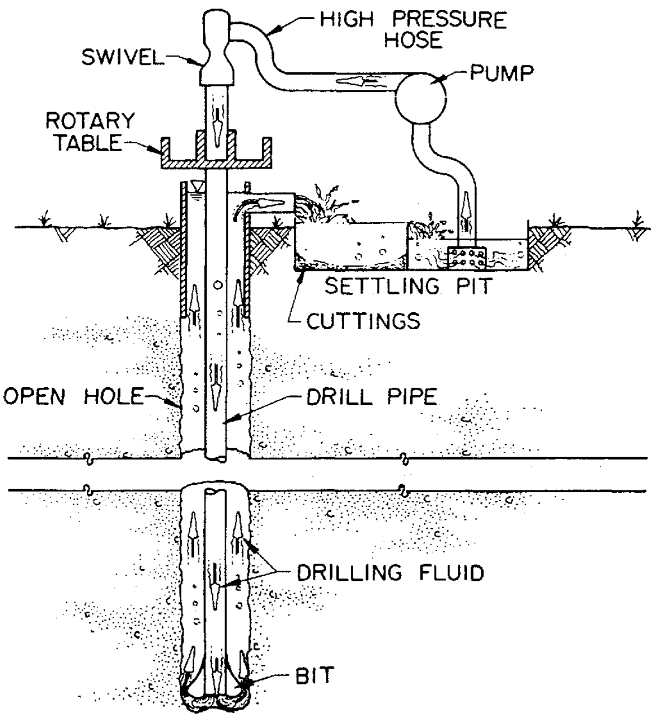
Well, Well, Well

by John Voytek Jr.



The construction of a typical water well.

There are several ways to drill a well, but all drilling methods have one thing in common—they bore a hole into the ground. During the drilling process, the well contractor examines the material that is removed from the hole, looking for samples of the local aquifers, and noting the material on a driller's log. (The driller's log documents what the contractor finds and becomes the "as built" set of plans for the well to be constructed.)

Using past experience as a guide, the well contractor can estimate how far down to drill to find water. But it is only an estimate; in some areas, two or more test holes must be drilled to find an aquifer capable of supplying an adequate supply of water.

The actual well-construction method is determined after the aquifer is located, taking into account the local geology and the soils at the particular site. If the aquifer consists of loose sand and gravel, a screen or intake will be installed to hold back the material and ensure that only clean groundwater can enter the well. If the aquifer is solid rock, no intake is needed; the rock will stand by itself, and groundwater will flow into the well through tiny cracks and crevices in the rock.

If the rock doesn't have enough cracks and crevices or if the soils are discovered to be fine and full of clay, the quantity of groundwater may be limited.

Testing the Well

After the well is constructed according to local regulations and construction codes, the contractor cleans, disinfects and finally tests the well for yield. Testing the well involves pumping the well for about four hours at a constant rate, then measuring the water level in the well.

Ideally, the yield will be sufficient to stabilize the water level so that the level will not continually drop while the well is pumped—in other words, the groundwater will enter the well as fast as it is pumped out. If the well does not have an adequate yield, the water level will continue to drop until it reaches the pump in the well, and at that point the pump will stop operating.

After the pumping test, the contractor may take water samples to determine whether the quality of the groundwater meets local health standards. If coliform bacteria are present, it indicates that surface water somehow is getting into the well. This could be fatal if septic tanks or hazardous chemicals are stored nearby.

The contractor, well owner or builder also can have a series of chemical tests performed on the groundwater. These tests are becoming increasingly popular because of public concern over hazardous chemicals in water supplies. Depending on the type of chemicals analyzed, the cost of such a test can range from $20 to more than $1,500. [See article on page 24.]

The cost of a private well is difficult to predict because of all the variables involved, but the national average is about $2,500. Depending on the nature of the rock and the type of equipment required to drill a well at any one site, of course, this figure can vary.

Pumping Systems

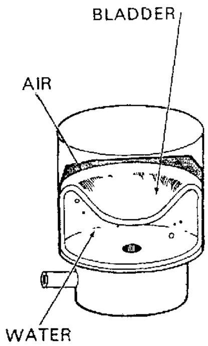
After the well is drilled and the water is tested for quality and quantity, the builder's attention turns to the water system. The first item here is the pump and pumping system that will be used.

Submersible pumps are more common than other types. As the name implies, they are submersed in the well, eliminating the need for a protective cover over the well to protect the well and the pump from freezing.

The submersible pump is lowered to a point in the well at which the water level will (or should) never fall. (The proper depth is determined by the contractor's initial pump test.) If the water level ever reaches the pump, the water-supply system will not operate.

The water pumped from the well is transferred to the house through a series of pipes buried underground to protect them from freezing. The water pipe exits out of the side of the well casing about three to four feet below the ground through a pitless adaptor that connects the pump to the house.

The water usually enters directly into a pressure tank in the house. Water is pumped into the tank to maintain an adequate pressure within the water system. One type of common pressure tank is a rubber-bladder tank that fills up with water, causing the bladder to expand. When water is used in the house, it is forced out by the rubber bladder exerting pressure on the stored supply. When the water pressure in the tank falls to a predetermined level, the pump turns on in the well and replenishes the pressure tank.



In this manner, the home is provided with fresh, clear water for years to come. (Well, almost.) Periodic maintenance of the well, pump and water system is a must to forestall any catastrophic failure of the system.

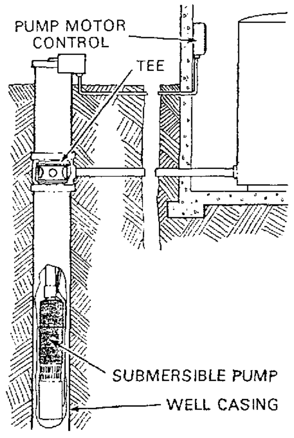
Avoiding Problems

If the quality of the groundwater is less than desirable—if it contains high amounts of iron, calcium and other common, non-harmful minerals that make the water unpleasant to use—home water-treatment systems can be installed to treat and remove unwanted chemicals. Water softeners, iron filters and other treatment schemes commonly are added just after the water leaves the pressure tank and before it enters the plumbing system.

There's no easy cure for at least one problem—low yield from the well—and there is no choice but to live with the situation. The average person generally uses about 100 gallons of water a day; an entire family uses somewhat less than 100 gallons for each person. The industry standard, meanwhile, is 150 gallons of water per day for each bedroom that is served.

Periods of high use—in the morning and during the early evening hours, which are when more than 90 percent of the day's water is used—are what place a strain on the low-yielding water systems. Wells that can pump only one gallon of water each minute can provide more than 1,400 gallons of water in a 24-hour period, but they can supply this water at a rate of only one gallon a minute.

Low-yielding wells can be tolerated by installing temporary storage tanks that can hold 100 to 400 gallons of water from the well until it is needed by the system.



Water supplies serving six or more families or dwellings are regulated under the Safe Drinking Water Act of 1979 but federal standards for private water systems do not exist—and no such laws are on the horizon. Instead, lawmakers are concentrating their efforts on regulating and protecting the sources of our drinking water from pollution.

Groundwater is all the water trapped or held by soil rock or sand grains or found in cracks and crevices of hard rock. It provides more than 95 percent of our drinking water. In the US an estimated 14 million water wells are in place, of which 13 million provide drinking water to private homes. The remaining wells serve as municipal water supplies or provide water for irrigation and industry.

Finding groundwater is not always easy, however. In some areas of the country locating suffcient supplies can be difficult and expensive. In other areas finding good-quality groundwater has become more difficult and expensive because of pollution and overuse. ■

Low-yielding wells can be tolerated by installing temporary storage tanks that can hold 100 to 400 gallons of water from the well until it is needed by the system. If the system demands 200 gallons in the morning, water could be available immediately from the storage tank, and the well then could refill the storage tank at a rate of one gallon a minute over the next several hours.

Despite such inconveniences as these, millions of Americans have found that a properly installed and maintained well is an efficient and cost-effective way to meet their water needs. ■

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Common Questions About Water Wells

Q. *Once a well is in place, is there any way to test the effectiveness and integrity of the grout seal?*

A. It is very difficult to test the effectiveness of a grout seal once it has been installed. An acoustic-sonic log can be run in the borehole, testing the presence and quality of a cement grout seal. However, these logs are very expensive, and the results are not always 100 percent reliable. If a different type of grout seal is used in the well, other methods also are available.

If the cement has not fully hardened in the well, a temperature log can be run in the well, showing the contractor the areas of higher temperature. The higher temperature is a result of the heat that is produced by the cement during the hardening process.

A dye test is a fairly simple way to determine the integrity of a seal around the casing. In this method, the contractor digs a small pit around the casing and fills the pit with a special, nontoxic dye. The pit is then flooded several times with water, allowing the dyed water to seep into the ground around the well. If the seal around the casing is inadequate, the dye will appear in the water supply. The time it takes for the dye to enter the well can be anywhere from one hour to four days, depending on the type of dye, the local geology and the depth of the well. The dye test can also be used to test septic systems, noting their impact on the local groundwater.

Q. *There is a lot of concern with pollution of our groundwater. Can a carbon filter help?*

A. Carbon filters can remove a certain percentage of some—but not all—organic chemicals present in the water supply.

Unfortunately, the carbon filters themselves can harbor or promote bacterial growth. If water tests indicate a bacterial problem, the entire water system should be checked for an in-line carbon filter. Generally, these filters are installed and then forgotten; the home owner does not maintain the filter, so bacterial growth in the filter itself may be causing the problem. By removing the carbon filter and disinfecting the well and system with chlorine, the bacterial problem should disappear unless the bacteria are from another source.

Q. *Our local groundwater contains a lot of dissolved gases that cause problems with the pump system. What can be done?*

A. Many groundwater supplies contain dissolved natural gas and other gases that generally are not harmful, but that pose an interesting problem when the contractor tries to design the pumping system.

The first thing the contractor must determine is where the gas is coming from. If the bubbles are from cascading water, the pump can be lowered in the well to eliminate the problem.

If the bubbles are coming from the expansion of naturally dissolved gas in the groundwater, the entire pump or ejector of the jet pump should be placed in a "bucket," and the entire pump-and-bucket assembly placed in the well. As water is being pumped, the gas bubbles begin to rise.

A pump "bucket" may not work in all cases, but it has proved successful in many gas-producing wells.

Q. *How deep can I set four-inch Schedule 40 PVC casing?*

A. Plastic casing is rated by SDR numbers and schedule numbers. Water-well contractors should be sure that they buy water-well casing—not water pipe—and that the casing conforms to the ASTM Standard F-480. This information is printed in blue ink directly on each piece of casing.

Schedule numbers refer to the casing's minimum wall thickness regardless of the diameter. Thus, the larger the casing, the weaker the Schedule 40 casing becomes. (Wall thickness stays about the same.)

SDR numbers refer to the minimum amount of hydrostatic strength the casing can tolerate. A four-inch Schedule 40 casing is rated at about 125 to 150 pounds per square inch (p.s.i.) collapse pressure. A four-inch Schedule 17 casing is rated at about 175 to 225 p.s.i.

If the diameter is six inches, the six-inch Schedule 40 PVC casing would be rated at about 60 to 75 p.s.i., whereas the six-inch Schedule 17 casing still would be rated at 175 to 225 p.s.i.

By using the SDR numbers rather than the schedule numbers for plastic casing, contractors can be assured that the casing will always meet the minimum requirements of their area regardless of the casing diameter.

Q. *In our area, scale and incrustation build up very quickly. Sometimes, pumps get stuck in four-inch wells, and the pump might not break free. What can be done to stop this from happening in future wells?*

A. In some areas, groundwater can form scale and incrustation in the entire water system in addition to the well-screen area. Occasionally the pump or the ejector of the jet pump gets cemented in place. If the pump has operated for a number of years without a problem, this scale can be very thick, making it difficult—or even impossible—to remove the pump. Two options to remove the pump are treating the well with acid or drilling out the pump and motor.

When acid-treating the well, the contractor ideally should use a dry, pelletized acid that can settle on top of the pump. As the dry acid dissolves, the acid will immediately begin dissolving the scale. Liquid acids tend to flow around or through the pump and settle in the bottom of the well, cleaning the screen but not the pump.

If the pump is still cemented in the well after one or more acid treatments, drilling the pump out or drilling a new well should be considered.

To eliminate this problem with new wells, the contractor must convince the home owner of the need for a larger well casing. The larger casing will slow the velocity of water, reducing the scale buildup around the pump. The pump or ejector should be centered in the well using centralizers. If scale does build up on the pump, there is ample room between the casing and the pump, adding years to the well's life.

In all cases, the home owner must be made aware of the need for a regular maintenance check of the well. The pump also should be cleaned periodically so the scale can't build up and cement the pump in place. ■

—John Voytek Jr.