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Private Water Well Components

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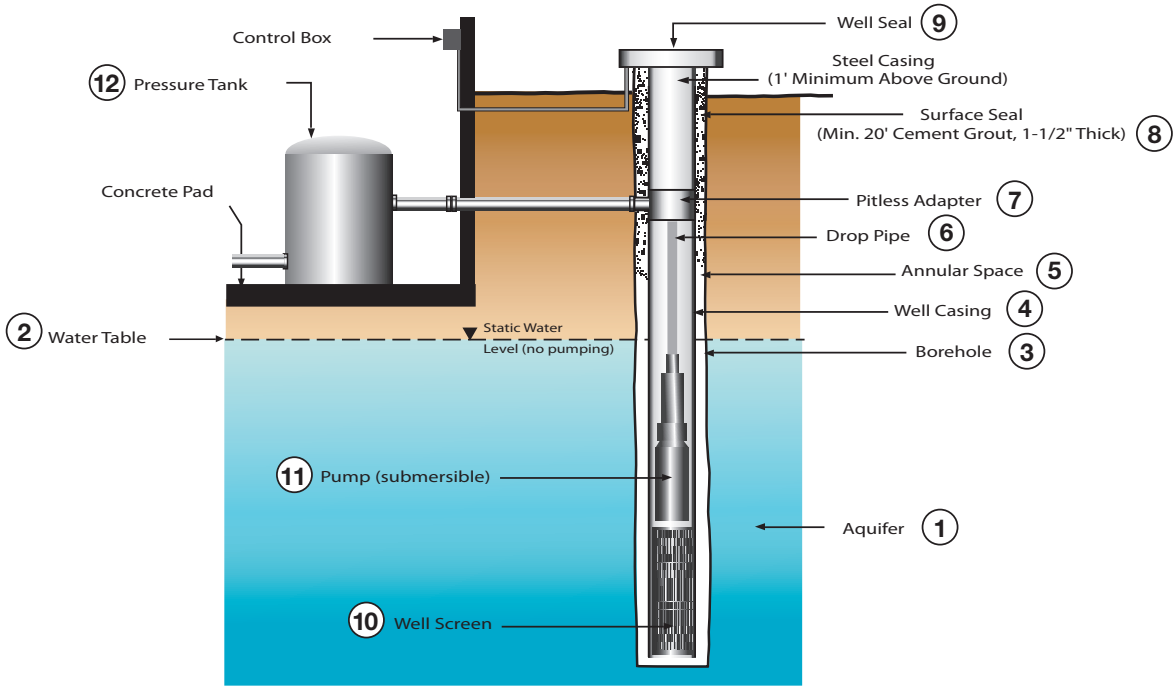
For proper maintenance of wells, it is important to have a basic understanding about the different materials that comprise your private well water supply system. The diagram below illustrates a typical domestic well system with a list of the key components and a short description of how they work. Please note that the numbers for the descriptions below match the numbers in the diagram. Where possible, standard definitions from the Arizona Administrative Code are used for consistency with Arizona Department of Water Resource (ADWR) materials.

1. **Aquifer:** underground formation capable of yielding or transmitting usable quantities of water.
2. **Water table:** point where groundwater is located. The well must extend below the water table level to operate effectively.
3. **Borehole:** hole created to access the aquifer.
4. **Well casing:** steel or plastic (PVC) tubing or pipe installed in the borehole during or after drilling to support the sides of the well and prevent caving. More information is given below.
5. **Annular space:** space between the borehole and the well casing.
6. **Drop pipe:** pipe by which water travels to the surface.
7. **Pitless adapter:** device that connects your pump underground (below the frost line) to the service line to your house. More information is given on page 2.
8. **Surface seal:** consists of steel casing (with 1 foot extending above the ground surface) and cement grout placed between the casing and the borehole to prevent contaminants from entering the well system from the land surface. More information is given on page 2.
9. **Well seal:** tamper-resistant, watertight cover steel plate of at least one-quarter inch thickness on the top of all inside and outside casings of a well to prevent anything from entering the well, including contaminants, animals, and small children. Alternatively, a well cap can be used in place of the well seal for abandoned wells or wells with no pumps. More information is given on page 2.
10. **Well screen:** perforations (series of openings in a casing, made either before or after installation of the casing) in the casing that allows water to enter the well while keeping sand and gravel from entering the pump. More information is given on pages 2 and 3.
11. **Pump:** located either above ground or submersed to draw water to the surface. More information is given on page 3.
12. **Pressure tank:** stores water above ground for household use. More information is given on page 3.



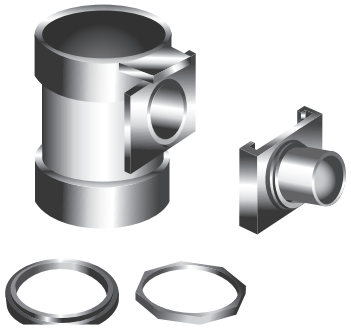
"Drawing not to scale"

Well Casing

A well casing is the tubing or pipe that "cases" or lines a borehole to maintain the well opening and contain the drop pipe and electrical wiring to the pump. Along with cement grout that seals the upper portion of the well to the surface casing, the well casing prevents mixing of multiple aquifer zones and may extend the full depth of the well. In rock aquifers, the well casing may only be a hundred feet or more through broken rock, leaving an open rock borehole as the well. The length of the well casing is specified by Arizona Statutes and Rules, as regulated by the Arizona Department of Water Resources (**http://www.azwater.gov/dwr/**).

The casing can be either steel or thermoplastic for all wells. The outermost casing in the top twenty feet of the well must be steel unless a variance is approved to use something else.

Pitless Adapter



Very rarely is the household well directly beneath the house; in most cases, the well is offset from the house. This offset is a problem in areas of Arizona that have freezing. The pitless adapter allows water to make a 90-degree turn below the frost line. Although there are three types of designs for pitless adapters, most are factory assembled and are threaded or compression-gasketed into the casing (see diagram above). A check valve may also be installed beneath the adapter in the drop line to prevent water from flowing back to the well. For more information, you can also consult *Arizona Well Owner's Guide to Water Supply* (AZ1485).

Surface Seal

Remember that well drillers use casings to keep drilled holes from collapsing. If only native soils are allowed to fill in around the casing, a path for contaminated water can form on the outside of the casing and into your well. To keep this from happening, a surface seal is used. The ADWR rules state that the surface seal be a combination of steel casing and cement grout placed in the space between the borehole and the steel casing in one continuous pour. When the well is drilled, the upper portion of the borehole must be at least three inches wider than the steel casing. Filling that space with proper materials (cement grout) is called "sealing." Arizona State well construction standards require a minimum of 20 feet of surface seal protection (1 foot of which must extend above the land surface) in all water supply wells. The final length of the surface seal casing is dependent on the local geology and may extend to a greater depth to seal the well from contact with a shallow aquifer. All wells are required to have a surface seal. If a pitless adapter is installed, the cement grout can stop at the bottom of the pitless adapter.

All driven wells are required to have cement grout placed in the annular space (and is required to be 1.5 inches or more) for at least six feet from the ground surface. All hand-dug wells are required to have watertight curbing extending, at a minimum, from one foot above the natural ground level to the static water level or into the confining formation if the aquifer is artesian. The curbing consists of poured cement grout or casing surrounded by cement grout (concrete block with cement grout and rock with cement grout can also be used). Hand-dug wells are required to be sealed at the surface with a watertight, tamper-resistant cover to prevent contaminants from entering the well.

Well Seal and Well Cap

A well seal is used to cover the top of the well casing pipe to prevent surface runoff from entering the well. It consists of a vented steel plate (at least one-quarter inch thick) with a compressible watertight gasket that is attached to the well casing pipe. Venting is necessary to allow pressure equalization and should be screened so contaminants such as debris, insects, and small animals don't get into your private water well system.

When a well is not abandoned and is not equipped with a pump, the well must be capped. A well cap is required to be tamper-resistant, watertight and is attached to the top of all inside and outside casings of a well. It should fit tight enough so that contaminants as well as small children don't get into your private water well system.

Well Screen and Gravel Pack

Well screens are filtering devices used to prevent excess sediment from entering the well. Attached to the bottom of the well casing, the screens allow water to move through the well while keeping out most sand and gravel. The most common screens are slotted or perforated pipe.

Perforated pipe is a length of casing that has holes or slots drilled into the pipe. A continuous slot screen is made of wire or plastic wrapped around a series of vertical rods, whereas slotted pipe features machine-cut slots into steel or plastic at set distances.

Well screens are manufactured with specified openings and hole diameters to match the screen filtering capability to the geologic conditions. Well screens are designed to be placed only within the saturated portion of the aquifer because if the groundwater elevation drops and air is allowed to enter the well screen, the well may be damaged by oxygen-induced metal corrosion.

During well design and installation, a gravel pack is typically placed in the annular space (the space between the well casing and the wall of the drilled hole) outside the screen casing but within the drilled borehole. The gravel pack consists of sand or gravel that has been designed with a grain size finer than the adjacent soils or unconsolidated aquifer material, but larger than the screen slot size. The gravel pack acts as a filter to prevent sediment from entering the well, and also to manage the velocity of the water passing through the aquifer and into the well. High-speed water velocity, due to excessive pumping or improperly sized gravel pack, may result in erosion of the aquifer as sediment is pulled into the well. Above the gravel pack and the well screen, the annular space between the well casing and borehole wall is backfilled with grout and/or concrete to prevent surface

water from draining into the aquifer. It is common for wells developed in hard, stable bedrock to remain as open boreholes. In these cases, a screen or gravel pack is not necessary. This is because groundwater entering an open borehole in a bedrock well typically travels through narrow cracks and fissures; thus, no sediment filter is necessary.

Pump

The type and size of the pump selected for a particular situation depend on the required capacity, location, operating conditions, and total head (pressure) for the system. After the needed characteristics of the pump have been determined, carefully select your pump using the recommendations of the manufacture representative or an engineer.

The most common pumps used for private wells are centrifugal pumps. Centrifugal pumps raise water by creating centrifugal force with a spinning wheel, referred to as an impeller, inside a tight casing. Vertical turbine pumps are a type of centrifugal pump which have a motor mounted at the casing top with a line shaft and column pipe which supports the pump section submersed in the well. The long pump shaft rotates inside the pipe and drives the pump rotating impellers. A deep well turbine pump is a combination of several stages of centrifugal impellers connected in series to a common shaft. Correct alignment of the motor, shaft, and the pump are important for long life and good performance.

Submersible pumps are also centrifugal pumps but have their motor mounted directly below the bowl assembly which houses the pump intake and impellers. Maintenance is minimal because there is no line shaft or oil tube requiring operator attention. These are commonly used in moderately deep to very deep wells.

Many times the pump will have a check valve located on the intake side of the pump. However, ADEQ requires a non-threaded sample tap to be installed just after a check valve on the discharge side of the well pump for all new drinking water well installations (Frech, 2010).

Pressure Tank

Pressure tanks, or hydro pneumatic pressure tanks, can be used successfully to maintain pressure throughout household distribution systems. Tank sizes can range from 40-gallons to 21,000-gallons or more.

In a conventional pressure tank, pressure is developed by pumping water into the tank until the air in the tank is compressed to a pre-set pressure—usually 40, 50, or 60 pounds per square inch (psi). An air compressor is used to ensure adequate air pressure is maintained. When the pre-set pressure is obtained, the pump shuts off and water demand in the system can draw on the stored water.

When the valve is opened in your system, such as a kitchen tap, air pressure in the tank forces the water to flow out of the tank and into the pipes. The pressure falls as the water flows out of the tank. When it drops to the start-up setting of the pressure switch, usually 20, 30, or 40 psi, the pump starts again until the tank is filled.

All pressure tanks should be installed with a pressure relief valve and some means to replace air in the tank. Maintenance of these tanks includes inspection of the exterior surface for signs of corrosion or other damage, checking the adequacy and operability of the air-charge system, verifying that the pump cut-in and cut-out pressures are adequate to meet system needs within the safety limits of the tank, and checking the operability of the pressure gauge.

Concrete Apron

The term "concrete apron" is commonly used as a synonym for the pad of concrete that surrounds the wellhead at the land surface and is sloped away from the pipe, so as to reduce the potential for standing water to pool at the wellhead. There are really two choices for homeowners to protect the wellhead from standing water: berming the soil up against the well and sloping the soil away from the well or pouring a concrete pad. A private water well is not required to have a concrete pad, but a well that is part of a water company regulated under the safe drinking water program through ADEQ is required to have a concrete pad or apron.

For Additional Information

Arizona Cooperative Extension (ACE) bulletins contain a variety of information about water, water quality, safe drinking water, and private wells. They are available through your county Extension office or from CALSmart Distribution Center, located in Tucson, at 4101 N. Campbell Avenue; (877) 763-531; (520) 795-8508 FAX; or visit **http://ag.arizona.edu/pubs/**

Sources

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This information has been reviewed by University faculty.
cals.arizona.edu/pubs/water/az1486b.pdf

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