When Your Customer's Water Well Can't Keep Up —

A New Look at an Old Problem

By J. Andrew Reid

Summary: *This article will discuss groundwater systems and steps well drillers can take to provide the performance customers expect, even when the well appears inadequate. Water treatment dealers may also take note as this could serve to expand their product services.*

Approximately 42 million people in the United States obtain water from their own private drinking water supplies,[1] and more than 15 million homes rely on private groundwater wells.[2] Many of the people who live in these homes know less about their well than they know about the city water system that probably serviced their last home. The key difference is this: There was a water authority to administer their previous system and now they must administer this one. For homeowners new to well water, learning to understand and adapt to its idiosyncrasies is an often daunting task that can cause anyone—desperate for fast solutions—to throw good money after bad.

The tradespeople whom homeowners hire to maintain and upgrade their water supply system include well drillers, pump installers, plumbers and water treatment firms. Today, these are specialties and, though there are strict training and licensing requirements in each discipline, any one group often has only minimal knowledge of the principles governing the others.

Given this situation, is it any wonder that so many homeowners are unhappy with the performance they get from plumbing connected to their private well water system? Contractors who know how to deliver performance to these customers will have their undying gratitude as well as benefit from word-of-mouth advertising. Those that disappoint will be remembered in a less flattering way.

Nature's infrastructure

City water comes from a reservoir, a river, canal, or a number of wells. Distribution systems contain miles of pipe and are designed to meet demand with contingencies for occasional high use such as a fire on your block.

When a new house is under construction, the builder simply applies for a water service pipe and meter adequate to meet the peak demand flow requirements of the plumbing system designed for the house. State, federal and local governments determine terms of service and minimum acceptable standards in quantity and quality of water delivered. The limitation with this system is you can only get water where there's a water main in the street.

When there's no water main, the only available supplier is Mother Nature. The choices offered there are a well, spring, surface water or rainwater. In most areas of the United States, the groundwater well is the method of choice and often the only one permitted by law.

Nature's infrastructure is instantly expandable. Groundwater comes from an aquifer that you can tap into almost anywhere. Even the Sahara Desert has water beneath it. An aquifer can cover many square miles and is composed of spaces filled with water in the various layers of material beneath the ground. In one area, there may be sand or gravel deposits. In others, the shale may contain many fractures. Still, others have dense rock that may have relatively few fractures. These cracks and voids fill with the water that soaks down through the ground and form a water-bearing stratum called an aquifer.

The price of admission is the cost of constructing a groundwater well that's basically a specially constructed excavation, deep enough to be in the water table into which water from the surrounding aquifer will seep. The quantity and quality of the water provided through this connection is governed by local geology, and the terms of service are subject to change without notice.

Well yield

The expected well yield—the rate at which water enters the well from the surrounding aquifer—can be estimated

based on the yield realized from other wells in the immediate area. Still, actual yield can vary significantly from one well to the next, and it's possible for the well hole to be bone dry. A well's sustainable yield is the amount of water that can be withdrawn continually without depleting the aquifer.

A well is said to be low yield if it isn't adequate to supply the peak demand flow rate necessary for proper operation of the plumbing system by pumping directly from the well. For example, it's common for a modern home to have a one-inch main water line to supply a flow rate of 20 gallons per minute (gpm), but the yield of many wells fall considerably below that.

Learn to compromise

When there's a large difference between the well capability and the flow requirement of the building, the selection of the well pump must be guided by a compromise between the two. If the pump is large enough to pump 20 gpm and the well yield is 5 gpm, the well may be pumped dry and the homeowner will be out of water quickly. If the well pump is chosen based solely on well yield, it will be impossible to pump the well down and run out of water, but plumbing performance may be poor.

This is the reason low-yield well complaints are either: "My water pressure is terrible" or "I run out of water." Occasionally, someone tries to correct low-pressure complaints by installing a larger pump, only to discover that the solution has caused a new problem—the customer is now running out of water.

Pressure tanks

Often, several pressure tanks are installed (see *Figure 1*). This is a good indication of a low-yield well. Pressurized storage was added in an attempt to overcome problems with plumbing performance. The complaint from this homeowner was that other plumbing couldn't be used when someone was in the master bath shower.

Figure 1. Mutiple pressure tank installation

The pressure tanks installed represent about 100 gallons of usable water. There's no way to schedule when the 100 gallons will be exhausted, and the well pump will not come on to replace any of the water used from storage until nearly all the stored water is used. If 75 gallons is missing when the homeowners turn in for the night, there will only be 25 gallons available for showers in the morning before the well pump comes on. Once that happens, the old problem will return because they will be trying to supply peak demand directly from the low-yield well using a pump that's too small for the job.

When the well pump does come on, there must be at least 100 gallons of water in the well to refill the tanks plus enough to cover any ongoing use. If there isn't, it will not be possible to satisfy the pressure switch and the well pump will run until it overheats and the motor fails. Adding pressure tanks doesn't cure low-yield well problems; it simply delays them.

Well dynamics

Once a well fills to its static level, the level at which water in the well is the same as that in the ground around it, no more water will come in. If no water is removed from the well, it will cease producing. If water is withdrawn from the well, more will come in. Most wells spend a majority of their lives in a non-productive state. The system in Figure 1, for example, would likely go the entire night without collecting a drop from the well. Two things limit the amount of water that a well can produce—time and well yield.

The water level in a well will vary depending on the rate and duration of pumping cycles. The well yield increases toward its maximum as the water level inside the well declines. The lower the level inside compared to that outside, the larger the pressure difference and the faster water will move in. The closer the level inside compared to that outside, the slower the well fill rate will be.

Low-yield wells pumped for long periods experience significant variations in water level. Pump performance in low-yield well installations varies with water level changes. Every pump has a finite amount of energy that it can spend to lift water and provide pressure. The more energy it must spend lifting water, the less is available with which to provide pressure. When supplying a building directly from a low-yield well, system performance often becomes poorer the longer the pump runs.

It's not difficult to supply a home requiring 20-gpm peak demand using a well with a 1-gpm yield or less if you separate collection and delivery. Collection must be based on well yield and arranged to keep the well producing while the delivery pump must be sized to supply the peak demand flow rate from atmospheric storage. If a well yields enough water in 24 hours to meet a family's daily needs (see *Table 1*), there's no reason that the plumbing performance for that house shouldn't be as good as or better than any home on a public water supply, if the right equipment is installed.

Table 1. Meeting the water needs of a household

Water needed based on 75-125 gallons per person per day		Daily availability based on well yield	
Number of people	Water needed (gallons)	Well yield (gpm)	Daily production (gallons)
1	75-125	0.1	144
2	150-250	0.25	360
3	225-375	0.5	720
4	300-500	0.75	1,080
5	375-625	1.0	1,440
6	450-750	1.5	2,160
7	525-875	2.0	2,880
8	600-750	2.5	3,600
9	675-1,125	3.0	4,320
10	750-1,250	4.0	5,760

Table 1 uses a figure of 75 to 125 gallons of water per person per day and clearly shows that a quart-per-minute well will supply the needs of a four-person household if you can collect all the water that the well produces.

Alternative systems

Well management systems are a recent arrival in the marketplace. They use time-based pump controls and make it possible to collect the entire output of a well. For instance, it's possible to collect 60 gallons per hour from a 1-gpm well

Figure 2. Well system with atmospheric storage

without pumping the well down because only production is withdrawn. If the well pump can deliver 10 gpm, it will be possible to run it for six minutes each hour without taking more water than the well can produce. Rather than collect for six minutes and once per hour, the control can be set to collect at any interval desired such as 20 gallons every 20 minutes. Set up in this way, collection is never far behind demand and, given adequate storage, a well can produce as long as necessary.

Figure 2 is a modern well management system with atmospheric storage. It can store 440 gallons of water on the same footprint occupied by the three pressure tanks in Figure 1. Collection from the well can begin as soon as a few gallons have been used from storage so there's always enough water to meet peak demand and there's less wasted time so well production is maximized. This type of system allows the installer to set up collection based on the well's yield and delivery based on the plumbing system's requirement for flow pressure.

Flow pressure is the pressure in the water supply pipe near the faucet or water outlet while it's open and flowing. Figure 3 shows flow pressure of 28 pounds per square inch (psi) at a shower head while it's the only fixture in the system that is on. Figure 4 shows 14 psi flow pressure at the same showerhead while two other showers are also running. Some codes suggest that satisfactory flow pressure is 15-to-20 psi. Many homeowners suffer with systems that deliver so little flow pressure that flow ceases from one outlet when others are in use.

It's important for water professionals to see the big picture. The customer wants performance. When water treatment equipment is installed, the goal must be treated water delivered at a flow rate that will permit the plumbing to function correctly. A four-bath house needs a larger water delivery system and treatment equipment with a higher flow rate than a two-bath house, even if there are only two people living there. A house with the capacity to sustain six people may one day have six people living in it. Once someone installs undersized equipment and others follow, it can be very costly to get the plumbing system functioning properly again.

Figure 3. Pressure at 28 psi as lone fixture

Figure 4. Pressure at 14 psi with two other showers running

Conclusion

There's an untapped opportunity for those in various water industries that work on homes with wells. In many cases, homeowners never get the plumbing performance they expected when they purchased their home because most people think of a well water supply in the same way they think of city water. Low-yield wells present problems not addressed by pressure tank water systems. Understanding the limitations of pressure tank systems, and the alternatives presented by well management equipment with atmospheric storage, makes it possible to offer well owners the pressure, volume and quality they want using their previously inadequate well.

References

1. http://www.epa.gov/OGWDW/pwells1.html
2. National Groundwater Association, "US Wells in Place, by State and End Use," April 8, 1996.

About the author

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