WELL REPLACEMENT DECISIONS

When is it time to replace a well? Part 1

By Michael Schnieders, PG, PH-GW, and Ned Marks, PG

Wells foul, age, and degrade for a number of reasons. With increased limitations placed on new wells, higher energy costs for operation of existing wells, and ever increasing regulatory oversight, well owners are demanding more from their well systems.

Each well is unique, and as such is a reflection of the sum of its components, the setting, and the way it has been maintained. While certain things can be used to extend the longevity of the system, there are many issues that impact the well's lifespan.

Let's look at well degradation and some of the factors that impact the decision of well replacement.

Well failure comes down to an issue of production, produced water quality, quality of construction, and those areas outside of our control (Murphy's Law and an affinity for bad luck). As such, the main categories of well failures are:

1. Poor design, construction, development, and maintenance
2. Contamination (of the well and/or the aquifer)
3. Natural fouling as a result of chemical, biological, or formation influence on the well
4. Aquifer depletion.

Starting on Day One

Many consider well design as an off-the-shelf issue, something left to last minute designs or the availability of materials. But without a design and construction plan tailored to the site, problems often start on day one.

Many of the aspects of well failure with regards to this subset are the result of cost-cutting measures enacted early on in the design process. For example, it is a common practice in the Midwest to place stainless steel screens with carbon steel casings in an effort to reduce project costs. The initial savings (15% to 25% estimate) is quickly lost, though, in the increased maintenance efforts, cost of iron removal or secondary water treatment methods, and general degradation of the well structure due to corrosion.

In a similar sense, well development is often reduced as it falls at the end of well construction when many projects are already running over budget and off schedule.

A poorly developed well can limit well efficiency and impact produced water quality for the entire life of the well. Mistakes made during construction of the well can impact the well, its capacity, water quality, and cost of operation for its entire life.

The groundwater industry continues to be hindered by a "run to failure" attitude. In the eye of the contractor, new well construction is more lucrative. In the mind of the engineer, new wells are more exciting. For the owner, when faced with reviving a well reduced to 15% of original capacity, a new well may just be more economical.

Part of this attitude is wells by their very nature are out of sight, and as such not always found at the top of the maintenance list (or "out of mind"). As long as the well has continued to produce, maintenance is often held off. But as well replacement has become more difficult and expensive, some owners are starting to look closer at their wells and taking steps to be more proactive with maintenance.

Although the United States enjoys a fairly safe groundwater supply, aquifers are still susceptible to contamination through naturally occurring chemicals and minerals (such as arsenic), poorly maintained private and public wastewater treatment systems, regional land use practices, industrial releases, and other sources.

Impacting More Than One System

The contamination of private well systems not only compromises the household directly served by the well, but also nearby residences and municipalities depending on the same aquifer. Contamination, whether the result of a contaminant entering the watershed and aquifer or direct impaction of the well, can dramatically affect the use and the longevity of the well.

> As the drought continues across many parts of the U.S., surface water bodies and areas of groundwater recharge are becoming increasingly impacted, with long-term implications on regional water supplies.

One additional source of contamination for consideration is the impact of regulatory changes imposed on water quality standards for existing wells. Systems that were under the limit when constructed can find themselves no longer in compliance, with no change in actual water quality occurring.

Natural fouling itself can be divided into three categories: chemical, biological, and mechanical. However, more often than not, a fouled well is experiencing a combination of the three. Biological fouling—or "biofouling"—is often the result of a specific bacterial occurrence such as coliforms or the buildup over time of significant amounts of biofilm.

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Heavy corrosion including pitting and degradation is visible on the column pipe. Damage to the structure is significant and reflected additional corrosion occurring on the well casing.

Tired and well-used municipal pump scheduled for replacement. Damage and corrosion are evident throughout the pump and column pipe assembly. Sometimes, corrosion can be minimized with material selection.

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Chemical fouling accounts for the precipitation and the accumulation of mineral scale, which typically reflects the contributing aquifer water chemistry.

Mechanical fouling is generally accepted as the accumulation of fine-grained sediments that have migrated towards the well and are mechanically blocking producing zones.

Corrosion within the well system is generally a result of some level of interaction between each of these areas and the well's design. Aggressive water chemistry, dissimilar metals, stray current, and microbial induced corrosion are all types of corrosion that can quietly impact the well's structure and produced water quality over time.

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In the same category as natural fouling are the unintended consequences of poor maintenance and overly aggressive well rehabilitation in response to these issues. Methods ranging from excessive chemical use to ground freezing to explosives have been used on wells, often with little regards to identifying the problem or condition of the well.

Just as dangerous as the potential for overreacting are the results of procrastination, resulting in attempts to restore capacity losses in excess of 70 percent on an aged well structure.

Source aquifer depletion is a growing concern throughout the world. In the United States, with much of the country impacted by drought in the past few years, the effects are being felt at an alarming rate at times.

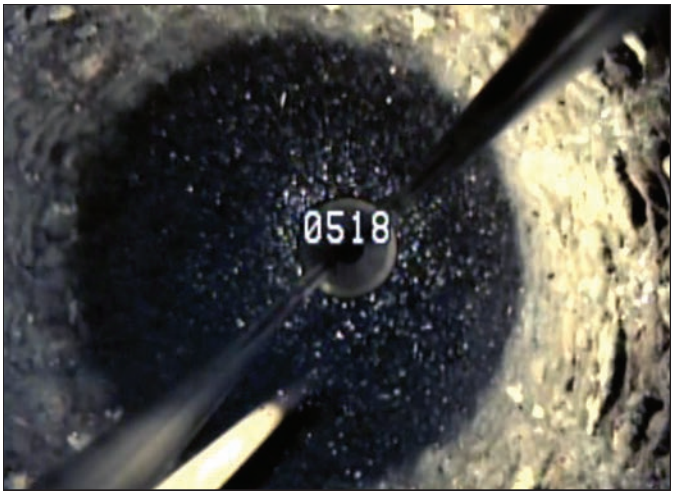
Groundwater levels decline as a result of supply and demand. With decreased recharge and increased demand, the storage available in our aquifers declines. As greater demands are placed on surface water management and as weather patterns change, millions of gallons of potential recharge have been redirected away from our aquifers. With no lessening of demand, many regional groundwater sources are being impacted significantly.

Many people don't realize the connection between surface water and groundwater also works in reverse. As aquifer levels are recharged—springs, streams, and other surface water bodies are recharged as well. The reverse is evident during periods of overpumping when streams and lakes within the watershed will experience a declining level.

The Growing Concern

Aquifer depletion impacts well systems by lowering the water table, increasing aeration and turbulent flow, increasing zones of influence, instigating localized subsidence, changing the produced water quality, and stressing water systems components such as pumps and water treatment equipment.

With rising energy costs, a number of municipalities are paying closer attention to well efficiency and the cost to operate their wells. Poorly neglected wells impacted with scale or biomass plugging can result in the pump having to work harder and longer to move the same volume of water, resulting in higher operation costs and increased wear on the pump and motor.



Downward-facing image from a potable well video survey. Mineral scale and biomass accumulation is significant, with heavy fouling of the louver screen completion evident. Although water quality remained stable, significant impaction of the well's capacity and efficiency had occurred.

In a similar manner, poorly designed wells or wells located in aquifers with significantly impacted water levels can see decreasing levels of efficiency.

Expecting a replacement well to achieve historical pumping rates with less saturated thickness is unreasonable. The specific capacity may not change but overall yield will.

Another driving consideration is the rising cost of replacement. While costs have impacted all facets of the industry, new well construction remains an expensive endeavor. Look at all the parts and pieces that are needed: casing, screen, gravel pack, column pipe, land, permitting, infrastructure, and access. Not to mention the cost to drill the well and complete it.

Typically more of an industrial mindset, many well owners are beginning to see regular monitoring and maintenance leads to increases in longevity and efficiency with far fewer costly repairs and extended downtimes.

As it is often said, the informed decision is the best decision. When evaluating whether to repair or replace a well, you need to assemble as much historical and current data as possible. This forensic review should include water quality data, pump performance data, construction, development methods, treatment history, power demand, and source water aquifer data.

Current information regarding the surrounding watershed and areas of recharge is valuable, as is a current assessment of land use and future development in and around the well site. In addition to historical data, you should get a current assessment of the well's condition, pumping capability, and its produced water quality.

You are likely envisioning a growing laundry list of information. Sadly, much of this information is often lost or scattered, having been a victim of different operators, engineers, and contractors who have worked on the well.

Even if a well is operating fine, well owners and operators are encouraged to begin accumulation and management of this data for each of their wells.

Armed with this information, you need to look at several major questions:

- Is the well structurally sound?
- Has the water quality changed, and if so, are our treatment methods adequate?
- At what level of capacity and efficiency is the well operating?
- If returned to full capacity, can the well meet our current or future demands?
- Is the well and area of recharge vulnerable to contamination, altered land use, or changing weather patterns?

Water Well Journal will feature Part 2 of this two-part series next month, looking at the decision process involved in determining repair or replacement of potable well systems. WWJ

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