GROUNDWATER – A VIABLE ALTERNATIVE?

ACCESSING GROUNDWATER RESOURCES DURING CALIFORNIA'S DROUGHT

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The year 2013 was the driest year in recorded history for many areas of California, according to the State Department of Water resources (DWR). Also, according to the High Plains Regional Climate Center (HPRCC), the southern half of California is generally below average precipitation for the period from February 1 through March 2, 2014. 2014! California just experienced one of the larger storms on record, and we are still below average? As shown on the HPRCC precipitation map (Figure 1), the region in southeastern California from roughly Calexico to Yuma is currently as low as a mere 2% of normal precipitation.

Percent of Normal Precipitation (%)
2/4/2014 – 3/5/2014

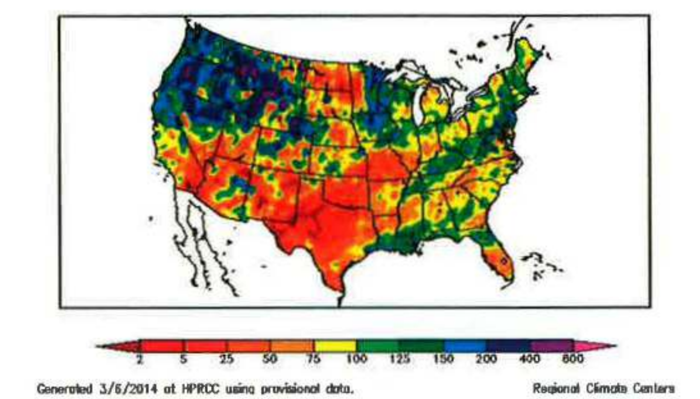

Figure 1
From High Plains Regional Climate Center

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At first thought, this does not seem critical. This is an area that really doesn't typically get much rain. The water for this region comes primarily from the Colorado River. But wait! Look back at the map now, but let your eyes wander a little to the northeast...to Colorado. By my rough estimate, this map shows that roughly three fourths of the state of Colorado is below normal precipitation, and portions of the deficit area are below 50% of normal! This is one of the sources of that water Southern California depends on!

Accessing groundwater may be an important key to maintaining our water supply as DWR is predicting precipitation deficit (drought) conditions at least through September 2014. Even if we experience another "Miracle March" type event (for those who remember March 1991 in Southern California), drought conditions and water supply concerns are a part of living in the "Great American Southwest." California will continue to experience periodic droughts and the water shortages that go with them.

Groundwater, Groundwater Everywhere?

So what about groundwater? Well, it is pretty much everywhere. It can be as shallow as a few feet, or as deep as 500 feet or deeper. It may occur in sandy material, or in fractures in hard bedrock. The question, typically, is not "will we find it?" but rather "will there be enough?" and "what will the quality be?" This is where the hydrogeologist comes in. Armed with the right information, a hydrogeologist's evaluation may help inform a water supplier's decision to pursue groundwater or increase utilization of groundwater in water supply. Some of the tasks a hydrogeologist does are:

- Research existing groundwater usage in the vicinity of a project site, and the potential viability of initiating/increasing groundwater use for a particular supplier or user.
- Geologic/hydrogeologic mapping and evaluation of potential well sites.
- Borehole logging and data collection during drilling of test wells. The information obtained from this task supports an informed decision whether or not to put forth the expense to install a full-scale groundwater supply well.
- Aquifer testing to evaluate the "safe yield" of a new well and whether use of that well should be limited to avoid possible effects on others (more on this later).
- The hydrogeologist performs these tasks to attempt to eliminate questions (is there enough good quality water?) and reduce risk (will pumping a well deplete the aquifer or impact other groundwater supply wells?) so that a water supplier or user, once these questions are answered favorably, may proceed with accessing a resource that reduces the concern that the surface water supply may eventually run out.

A Case in Point

A small Community Services District (CSD) serves approximately 200 connections in a small town in San Diego County. A challenge to developing water resources in this community is locating "cool" groundwater. The town was a premier resort location in the early 1900's due to the presence of thermal wells and hot springs, which reportedly drew as many as 5,000 visitors a weekend in its heyday. The problem is not finding groundwater, but finding groundwater that is not 95 degrees Fahrenheit with a strong sulfur odor- that's just not refreshing on a hot summer day!

Initially, geologic research and mapping of the community revealed the hot springs and thermal wells are generally located just west of a fault line running through the center of town (no worries, there is no indication that this is an "active" fault). The project began with drilling test wells to evaluate groundwater quality and quantity at possible supply well sites. Once a test well was installed, it was sampled and analyzed for a suite of constituents pursuant to requirements for community supply wells. Where water quality met the standards, wells were test pumped and pumping/drawdown data evaluated for possible well yield.

The first test well, located well to the east of the fault, demonstrated good water quality upon initial sampling, and subsequent aquifer testing demonstrated favorable results for available water quantity. However, re-sampling after the aquifer test showed low concentrations of aromatic petroleum hydrocarbons. The test well was maintained for possible future use, and additional potential well sites evaluated. The Department of Environmental Health (DEH) was also contacted, informed of the contaminants detected in the well, and asked to "look into it."

A second test well site, upon sampling, showed unusually high concentrations of aluminum. Aluminum? Really? After some research, this result stumped even the experienced hydrogeologist, and the well was abandoned in favor of a third potential well site. Upon drilling the third test well, located far to the west of the fault and hopefully out of the "hot" zone, water quality was found to be acceptable. This well was located in an area underlain by shallow (approximately 30 feet deep) weathered crystalline rock, raising the concern that insufficient water quantity would be available. The decision was made to proceed with drilling deeper test borings. Before drilling, a fracture trace analysis was conducted in the region around the proposed well sites. The area was found to be highly fractured, with preferred orientations striking northwest and dipping southwest. Regional topography was also consistent with the primary fracture orientation, and drilling proceeded with the assumption that sufficient water-bearing fractures would be encountered to make the wells potentially viable for community supply.

Two test borings were drilled and aquifer yield was found to be not only adequate, but exceptional for fractured crystalline rock wells. Subsequent water quality testing of the deeper borings also showed good quality groundwater. The two "hard rock" test borings were completed as groundwater supply wells.

A Rough Analysis

The cost of exploring groundwater supply options and installing production wells can be expensive, but also cost-effective in the longer term. Suppose a water user, say a golf course, is spending approximately $80,000 per month on municipal water supplied by the local city. The cost to drill and install a supply well, including the initial research, may equal as little as 1 to 2 months of those big water payments, and in one case in the author's experience, one new well was capable of producing approximately one third of the golf course's water needs. If the well is used to only produce one fourth of the needs, that equates to $20,000 per month savings and the well is paid off in.....well, you get the picture. I've avoided many hard facts in this analysis because many other factors also come into play when deciding to use groundwater for the first time. How the extracted groundwater is stored and conveyed is a major consideration, as is the potential cost of electricity or fuel to power the well pump(s). But even with these economic considerations, groundwater has the potential to augment, if not replace, municipal water use, as well as reduce costs paid for water supply...

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Accessing Groundwater Resources during California's Drought continued

Groundwater Dependent Communities

...unless you are a community that is already dependent on groundwater as the source of water. Droughts can impose a different set of challenges to such a community. Reduced rainfall reduces water input to the aquifer used for water supply. Reduced water to the aquifer causes groundwater storage to decrease (groundwater levels drop) and may result in wells "drying up" and becoming unusable. Options include adding more and/or deeper wells. Again, here the hydrogeologist might really be a help. Hopefully, the research and mapping has provided a clear picture of the distribution and depth of groundwater use in the area. Perhaps installing a deeper well or wells would supply the needs. Perhaps just adding additional wells, at about the same depth as the existing well or wells, will be the best option. Either way, a careful hydrogeologist will help the water user make an informed decision about the best way to maintain adequate water supply. Now back to that statement about effects on others. In the State of California, a land owner is entitled to use the groundwater beneath his/her property. However, he/she is not entitled to take water from beneath other people's properties without permission. In a groundwater dependent community where surrounding lands also depend on groundwater, obtaining such permission is unlikely. Detailed aquifer testing and a careful evaluation of the data generated are used to evaluate connectivity between wells and whether installing and pumping a well might deplete groundwater storage for the neighbors.

Sustainability

That brings us to the concept of sustainability; will using groundwater for our project be sustainable? The hydrogeologist will attempt to answer this question using the data collected during hydrogeologic assessment and aquifer testing. But once an initial answer is obtained, it MUST be revisited virtually for the life of the project. Groundwater is not an unlimited resource. Recharge to an aquifer does not happen quickly. A major rainfall event or even an above average rainy season may take weeks, months, even years or more to reach the aquifer. Conversely, a drought also may not affect the aquifer for some time.

The concern is not just whether groundwater levels drop below "normal" levels (over draft of the aquifer) over time. Simply reducing groundwater usage would allow the water levels to recover, one might think. However, as groundwater levels drop below normal in an aquifer, the aquifer may compress, reducing potential storage once water levels do rise again. Once an aquifer compresses, it will NOT un-compress. The amount of groundwater storage in the aquifer is forever depleted, it will never be the same.

A significant case in point is the Ogallala aquifer beneath the Great Plains of the United States. It underlies portions of South Dakota, Wyoming, Nebraska, Kansas, Colorado, Oklahoma, New Mexico, and Texas. It is one of the world's largest aquifers at approximately 174,000 square miles. According to Wikipedia, approximately 27 percent of the irrigated land in the United States overlies the aquifer which yields about 30 percent of the groundwater used for irrigation in the United States. Since 1950, the saturated volume of the aquifer has been reduced an estimated 9 percent. Some aquifer zones are now empty of water and it has been estimated that these zone will take over 100,000 years to replenish naturally through rainfall!

Agricultural areas of California, dependent on extensive groundwater pumping for irrigation, are facing similar issues with declining groundwater levels and compressing aquifers. So the sustainability of groundwater use must be evaluated far beyond just drilling a well, pumping it for a few days, and seeing how much draw down occurs and whether other wells are affected. A program of on-going groundwater monitoring and evaluation of basin-wide data will help to reduce the possibility that the groundwater resource is over used, particularly to the point of causing irreparable damage.

Summary

Properly drilling a groundwater supply well or evaluating/testing an existing system is a multi-faceted endeavor that needs to consider basic water quality trends, assess aquifer characteristics, estimate water production, evaluate impacts groundwater supply wells have on each other within a particular basin, recognize cultural and political allotments, and continue these evaluations over time as groundwater is used. Hydrogeology can be applied to accurately assess groundwater quantity and quality, and can yield valuable information to evaluate potential water supply and sustainability.

For communities that depend on imported water, groundwater use can relieve the challenges of an ever-dwindling supply and ever-increasing demand. In groundwater-dependent communities, as the natural groundwater resource diminishes, it becomes necessary to explore ways to increase groundwater use without impacting the neighbors or over drafting the aquifer. The hydrogeologist can assist the water supplier or water user to determine the best course of action to sustain adequate water supply. The practice of hydrogeology in such cases involves assessment of numerous aspects of the aquifer to effectively evaluate potential water resources. Even so, when the assessment is complete and all data taken into account, there will still be that sense of anticipation when the drill bit begins turning and the test borings progress: will we find enough water today? ■