WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

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WRD's Safe Drinking Water Program and Well Profiling Program: Improving Water Quality

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There are currently over 500 groundwater production wells in the Central and West Coast Basins operated by 110 entities delivering water for municipal, industrial, and agricultural use to the nearly 4 million people in 43 cities overlying the basins. The groundwater is extracted from sand and gravel Pleistocene aquifers ranging in depth from 50 feet (ft) to over 2,000 ft. The aquifers are separated by clay and silt aquitards creating both unconfined and confined conditions. Most of the wells are screened across multiple aquifers to maximize groundwater production (**Figure 1**).

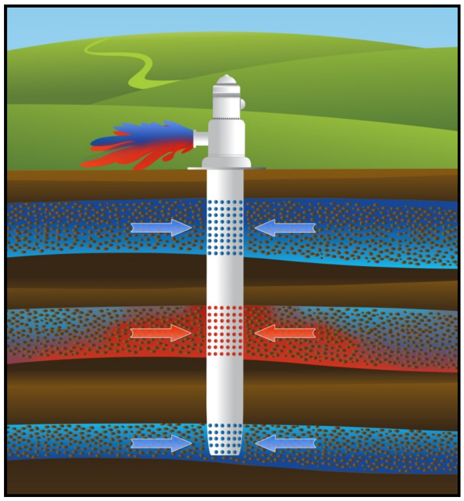

Figure 1: Water well screened across multiple aquifers. The water quality at the wellhead is a blend of the aquifers tapped.

Although many of the production wells extract high quality groundwater that needs little to no treatment before serving, some wells do face water quality issues that require action before the water can be used. Both natural and anthropogenic contamination can occur from a variety of sources, including the inherent aquifer characteristics and human-related activities such as leaking underground storage tanks, dry cleaners, metal shops, junk yards and others. WRD Technical Bulletin, Volume 15, provides details of the groundwater quality in the Central and West Coast Basins and identifies the most prevalent natural contaminants (arsenic, total dissolved solids, manganese, and odor) and human-caused contaminants (perchloroethylene and trichloroethylene) found in water wells throughout the basins.

Figure 2: GAC Water Treatment System

Safe Drinking Water Program: One common solution to removing contaminants from groundwater is through wellhead treatment. In this process, the water from the well is run through filtering and cleaning devices to remove the contaminants before being sent into the distribution system. Granular activated carbon (GAC) is a common water treatment technology to remove volatile organic contaminants (**Figure 2**). For iron and manganese removal, the simplest process is through direct filtration using an oxidizing media such as manganese greensand.

To assist water purveyors with their wellhead treatment projects, WRD has a Safe Drinking Water Program. Since 1991, this Program has provided financial assistance (grants or loans) to construct wellhead treatment projects at 19 wells throughout the District, restoring over 30,000 acre-feet per year of groundwater to beneficial use. However, because wellhead treatment systems can be very expensive in capital and long-term operational and maintenance costs, WRD has been exploring alternatives.

Well Profiling is one technology that shows promise as an alternative or beneficial supplement to wellhead treatment. This technology has been around for years but advances in equipment miniaturization are making it more available and reducing overall costs. As **Figure 1** shows, wells can tap multiple aquifers that may have different water qualities. The quality of the water produced at the wellhead will be a blend of the various water qualities tapped by the well.

The water entering a well may not be distributed equally across the screened intervals, but instead be highly variable based on the transmissivity of the aquifers, the depth of the pump intake, the pumping rate, and whether any perforations are sealed off due to physical, chemical, or biological plugging. It cannot be assumed, for example, that a well pumping 1,000 gallons per minute (gpm) with 100 feet of screen is producing 10 gpm from each foot of screen. More likely, one-third to two-thirds of the screen length is providing most of the water with the remaining screen relatively stagnant.

Well profiling is a method to determine where the water entering the well is coming from and what the water qualities are. This is done by raising and lowering measurement tools inside the well during pumping and non-pumping conditions to determine flow characteristics across the screen intervals and by collecting numerous depth-specific water quality samples. After analyzing the data, a profile can be completed to show the flow contributions and water quality information in the well (**Figure 3**). If a poor water quality zone is identified, it can possibly be sealed off so that the well produces higher quality water from the other zones. Conversely, in a remediation project, the contaminated zone(s) can be isolated for extraction without pulling out the cleaner groundwater.

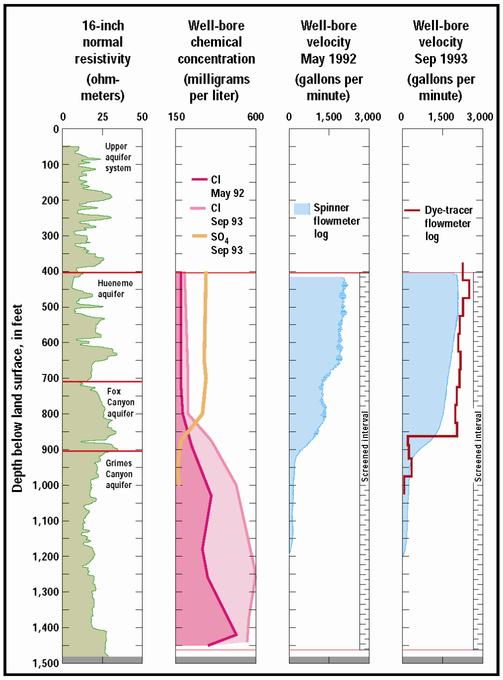

Figure 3: Well Profiling including Water Quality and Flow measurements (USGS, 1999)

A Case Study: WRD has a Well Profiling Program to assist pumpers with investigating the source and quality of groundwater entering their wells. To date, 6 wells have been successfully profiled and two have been retrofitted to improve water quality.

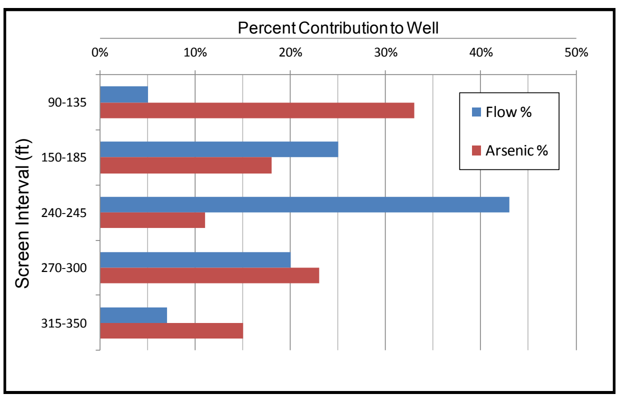

Figure 4: Arsenic and Flow Contributions to a local well

For example, one well in the District was producing arsenic at concentrations between 8 and 24 parts per billion (ppb). In January 2006, the Federal maximum contaminant level (MCL) for arsenic was reduced from 50 ppb to 10 ppb, rendering this well in potential violation of the standard. Well profiling was performed and determined the following: 1) The pumping rate was 1,200 gpm and the pump intake was set at 190 ft; 2) there are 5 screened intervals in the well; 3) profiling showed the highest arsenic contribution was coming from the shallowest screened interval, (90 ft—135 ft), but this interval was not contributing much water to the well (**Figure 4**). The lowest arsenic contribution and the highest flow rate was coming from the screened interval from 240 ft to 245 ft.

Based on the results, the well was equipped with a rubber inflatable packer lowered to 200 feet to seal off the upper two screen intervals and eliminate their flow and arsenic contributions to the well. A pump suction was extended through the packer to a depth of 260 feet so that the well only produced water from the lower three intervals. When the well was turned back on, arsenic concentrations steadily decreased to less than 5 ppb. The well is now in compliance with the arsenic MCL and no wellhead treatment is required. And, pumping capacity was not lost from the well as the high transmissivity of the lower aquifers made up for the loss of the shallower screen intervals.

Total cost for the well profiling and screen sealing were about 10% of the cost for an full arsenic treatment system, proving the value of the upfront work. For more information on WRD's Safe Drinking Water Program and Well Profiling Program, please contact Ted Johnson.

References:

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