Low-Flow Purging Reduces Management of Contaminated Groundwater

Keith E. Schilling

Purging a monitoring well prior to sampling removes stagnant water in the well casing and ensures collection of groundwater samples representative of formation water. Traditionally, a number of well casing volumes are removed (from three to five) and water stabilization parameters are monitored during removal of the casing volumes*.* Temperature, pH and specific conductance are routinely monitored during purging to determine when a sufficient volume of water has been removed from the well. When these parameters exhibit stabilized readings with a specified range of values (i.e., plus or minus 10 percent over consecutive measurements), the water sample is considered representative of formation water. For deeper wells, purging a well in this manner can generate a large volume of contaminated groundwater, which requires proper handling and disposal. In addition, the amount of time purging multiple casing volumes can often be excessive for sites with many wells.

Now there is an alternative to purging multiple well volumes. This new approach focuses on pumping a well from the well screen at a flow rate below the recharge capacity of the formation. The specific rate of pumping is generally aquiferdependant, but typically does not exceed one liter per minute (or equivalently, 0.26 gallons per minute). By purging at low flow rates, only ground water that enters through the well screen is purged from the well. Because stagnant water located above the pump intake in the well casing is not drawn into the pump, the casing volume would not have to be purged from the well prior to sampling.

Water samples are generally collected during low-flow purging as soon as formation water is determined to be flowing from the well. Therefore it is important recognize the difference between formation water and stagnant casing water during the low-flow purging process. Water stabilization parameters are monitored in-line from the wellhead by sampling discharge to recognized quickly when formation water is present. In this manner, the amount of water purged from a well is dependent solely on formation water stabilization rather than on predetermined well volumes. Measuring turbidity, reduction/oxidation potential (redox) and dissolved oxygen during purging is recommended to gauge the degree of water stabilization.

The low-flow purging approach can effectively reduce the volume of contaminated water generated during purging and the time spent performing the task. The following example illustrates how the low-flow purging approach is reducing costs associated with long-term monitoring at a contaminated ground water site.

Purging Equipment and Procedures

Dedicated bladder pumps were installed in monitoring wells at the site to preform quarterly groundwater sampling of 15 bedrock wells ranging in depth from 60 to 350 feet. At each well, a bladder pump was installed at a depth approximately 20 feet below the static water surface. In addition a drop tube from the pump to the well screen was used to purge and sample ground water from the middle of the well screen. The cost to install the dedicated pumps and tubing in the wells averaged about $1,000 per well. A generator and controller unit to operate the pumps in all of the wells at the site cost an additional $4,000.

A multiprobe water analyzer was used to measure water stabilization parameters inline from the pump to discharge. Purge water was directed through a flow cell containing measurement probes for temperature, pH, specific conductance, dissolved oxygen, redox and turbidity. The parameter data were visually displayed and recorded on a portable computer at a rate of one set of readings every 20 seconds. This interval was selected to coincide with the approximate pulse pumping associated with the bladder pumps. Purging generally continued at the site until the parameters stabilized to within 10 percent over two consecutive minutes of pumping.

Discharge from the flow cell unit was typically directed to a graduated bucket where the flow rate and total volume of purge water removed from the well could be measured. The contaminated was subsequently placed in 55-gallon drums or equivalent containers for disposal.

The cost of the multiparameter flow cell was about $5,000. The unit can be operated with any MS-DOS portable computer equipped with communications software.

Purge Volumes

Low-flow purging with the dedicated bladder pumps has greatly reduced the amount of water generated during purging of monitoring wells. The average volume of contaminated water generated per well (4.1 gallons) was significantly less than the traditional three volume approach (49.5 gallons). A summary of purge volume and purge time for the low-flow approach and a comparison with the traditional three-volumes approach is presented in Table 1

Each well was purged at an average rate of 0.31 gallons per minute (gpm) for an average duration of 13 minutes. Based on records from previous sampling activities at the site, an average of 50 minutes per well was needed to purge three casing volumes from each well. the total time required to purge three volumes in this manner (12.5 hours) is nearly four times greater than the time needed for low-flow purging (3.25 hours). Based upon an estimated consulting fee for a two-person sampling crew at $150 per hour, the cost difference in sampling time between the two methods is nearly $1,400 per sampling event.

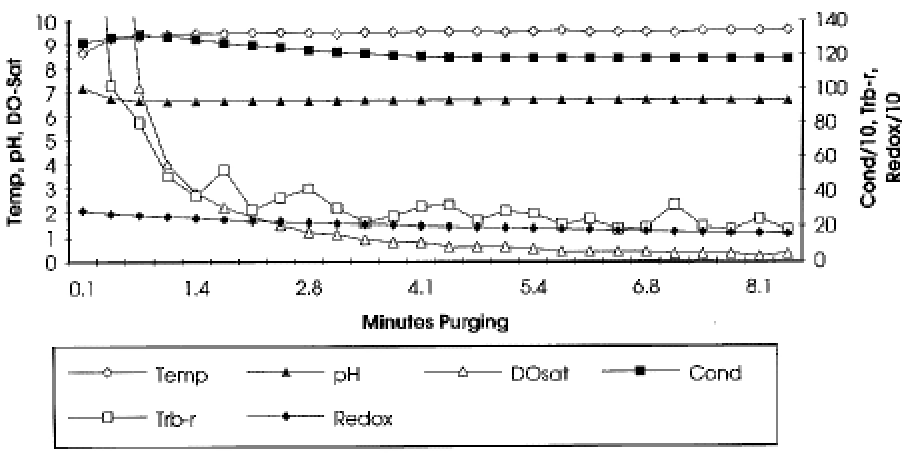

Figure 1. Water stabilization measurements collected during purging of a 60-foot deep monitoring well. Parameter readings include: temperature (C), pH, dissolved oxygan (% saturation), specific conductance divided by 10 (millimhos/cm), turbidity (NTU) and redox divided by 10 (oxidation-reduction potential in millivolts).

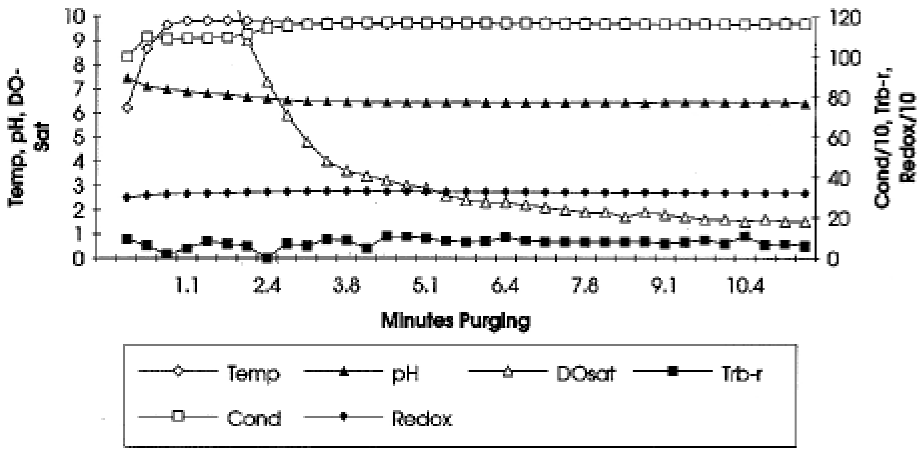

Figure 2. Water stabilization measurements collected during purging of a 250-foot deep monitoring well (parameter units same as Figure 1).

Stabilization Parameters

Stabilization data were visually displayed and and recorded by a portable computer in the field, which was used for viewing, archiving and plotting purposes. Typical stabilization methods recorded during purging at two well locations are shown in figures 1 and 2. These measurements are indicative of the overall water stabilization trends observed in other wells sampled at the site. Figures 1 and 2 represent parameter measurements collected during the purging of wells 60 feet deep and 250 feet in depth, respectively.

The measurement of dissolved oxygen (DO) was the most sensitive parameter used during the purging activity at the site, with DO stabilization occurring within four to eight minutes of low-flow pumping. Stabilized DO readings occurred with less purging time in the shallow well (Figure 1) than in the deep well (Figure 2) because of additional time needed to purge standing water from the pump and drop tube in the deep well.

Testing turbidity (Figure 1) and redox also has proven useful in judging the stabilization of purged water. Turbidity has been noted to fluctuate on occasion in some wells, although this parameter is compromised by ambient light infiltration into the flow cell. The traditional parameters of pH, temperature and specific conductance stabilized very quickly during purging and have not been useful as indicator parameters.

Economic Analysis

Table 1 also compares the cost associated with purging three volumes from wells vs. low-flow purging over a 30 year life of the project. Considering only the time needed to purge the wells and the costs associated with the disposal of the contaminated water, the low-flow purging approach will reduce the costs at the study site by aproximately two thirds compared to traditional methods of purging wells. Based on this analysis, the capital costs of about $20,000 associated with installing the dedicated sampling system for 15 wells can be saved in as little as six quarters of sampling.

Other factors that increase the disparity in costs between low-flow purging and traditional methods include: costs for transporting and staging purge water from the site, analytical costs associated with sampling the purge water for disposal purposes, and additional professional time needed for managing the process.

Conclusions

Low-flow purging of wells at environmental sites can lessen the costs associated with long-term monitoring programs. Installing dedicated low-flow pumps in wells and measuring DO, turbidity and redox indicator parameters can greatly reduce the volume of water purged from monitoring wells. In the case study highlighted above, low-flow purging procedures reduced the volume of contaminated water generated by more than 90 percent compared with the traditional method of purging three well volumes, and reduced the costs associated with management and disposal of the contaminated groundwater by two-thirds. Over 30 years of ground water monitoring at a site, the potential savings offered by using a dedicated low-flow purging system can be very attractive.

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Table 1

Comparison of Low-Flow and Three-Well Volume Approach		
Purging Analysis	**Low-Flow Purging**	**Three Well Volumes**
Volume of Water Purged *(15 wells)*	61.2 gallons	743.1 gallons
Average Volume Purged	4.1 gallons	49.5 gallons
Average Pumping Rate	0.31 gpm	2-5gpm
Average Purging Time per Well	13 minutes	50 minutes
Total purging time *(15 wells)*	3.25 hours	12.5 hours
Economic Analysis	**Low-Flow Purging**	**Three Well Volumes**
Time for Purging Wells *(a)*	$500	$1,875
Disposal Costs *(b)*	$1,300	$3,750
Cost per Sampling Event	$1,800	$5,625
Sampling costs for Year *(quarterly)*	$7,200	$22,500
Sampling Costs for 30 Years	$216,000	$675,000
(a) Assumes two person crew at $150/hour.		
(b) Assumes cost to dispose one drum equals $1,000; $300 for additional drums (one drum = 55 gallons).		

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