

Depth-Dependent Sampling to Determine Source Areas and Short-Circuit Pathways for Contaminants to Reach Public Supply Wells, High Plains Aquifer, York, Nebraska

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Biographical Sketches of Authors

Matt Landon has been a hydrologist with the U.S. Geological Survey since 1990. He has conducted studies of ground-water hydrology and ground-water quality in Minnesota, Nebraska, and California. He is currently working on studies of transport of anthropogenic and natural contaminants to public supply wells for the National Water-Quality Assessment Program and the California Ground water Ambient Monitoring and Assessment program.

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Allen Christensen has been a hydrologist with the USGS since 1991. He has conducted studies throughout the desert southwest using gravity, microgravity, well-bore flow analysis, and depth-dependent water-quality analyses in pumping wells to determine vertical differences in saturated and unsaturated flow and water chemistry.

Abstract

As part of the U.S. Geological Survey's National Water-Quality Assessment Program, an investigation of the processes controlling the transport of contaminants to public-supply wells was conducted in layered unconsolidated deposits of the High Plains aquifer near York, Nebraska. Analysis of samples collected from a public-supply well that integrate water from the entire screened interval within a confined sand aquifer revealed concentrations of PCE, TCE, and uranium that were below drinking-water standards but of concern as indicators of contamination. Samples also were collected from the supply well under typical pumping conditions at five depths in the 18-m long screen using a submersible bladder pump. The samples from the bottom half of the screen had oxygen and hydrogen isotopic values and concentrations of PCE, TCE, major ions, excess nitrogen gas, and uranium consistent with water derived from shallow recharge areas in the urban area mixed with relatively older native water from the confined aquifer. The presence of the unconfined-source water only at the bottom of the supply-well screen implies that wellbore leakage in the supply well itself was not the pathway for contaminant movement. Similar mixed water signatures were detected in a few monitoring wells screened in the confined aquifer along the zone of contribution. This non-uniform distribution of unconfined-source water implies that there are preferential flow paths that permit urban recharge water and contaminants to move across the confining unit. The primary pathway is probably downward leakage of water through well bores or annular spaces of irrigation or older supply wells that penetrate the confining unit.

The depth-dependent sampling, combined with monitoring-well data, provided an improved conceptualization of how contaminants enter the supply well. Results of a numerical solute

transport model are consistent with an interpretation that supply-well contamination is dependent upon preferential pathways and transient seasonal vertical-head gradients.