

Optimizing a Monitoring Network Using Water Quality and Environmental Factors in the Glacial Aquifer System, United States

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Abstract

A framework for developing a monitoring network for comparison of ground-water quality across the glacial aquifer system was developed based on two primary characteristics of the system: intrinsic susceptibility and vulnerability. Intrinsic susceptibility, a measure of how easily water enters and moves through aquifer material, is represented by the spatial distribution and physical setting of fine- or coarse-grained material at the land surface. Vulnerability, a function of intrinsic susceptibility and the proximity and characteristics of contaminants, includes natural and anthropogenic sources. The framework divides this aquifer system into areas with similar environmental factors for which ground-water quality can be compared. Water-quality data collected between 1991 and 2001 and various related environmental factors were used to optimize the selection and addition of sampling sites for a monitoring network in the glacial aquifer system within the framework context.

As part of the U.S. Geological Survey's National Water-Quality Assessment Program, ground-water-quality data were collected at over 1,700 domestic, public, and monitoring wells from representative parts of the glacial aquifer system. Sites with similar water quality, based on major ions and alkalinity, were categorized into five groups using cluster analysis (a statistical method that groups data to maximize between-group variability and minimize within-group variability). Regression-tree analysis identified 17 environmental factors that contribute to the spatial variability of water quality in the glacial aquifer system based on the five water-quality groups. All of the identified factors were related to how long water is in contact with the aquifer materials and indicated a statistically significant relation to the framework characteristics used to design the monitoring network for the glacial aquifer system. Understanding water-quality differences in the glacial aquifer system and knowing environmental factors that affect the spatial variability in water quality will help optimize the ground-water quality monitoring network as new sites are added.