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## **Water quality of the glacial aquifer system, United States—an emphasis on nutrient concentrations in domestic wells**

by Kelly L. Warner

The unconsolidated material within the glaciated area of the United States is referred to as the glacial aquifer system, and it is the largest principal aquifer in area and is the most heavily pumped aquifer used for drinking-water supply in the United States. According to a recent U.S. Geological Survey study, the total withdrawals from the glacial aquifer system were 3,560 million gallons per day in 2000, which constitutes almost 5 percent of total withdrawals from all aquifers in the United States. Approximately 45 million people relied on the glacial aquifer system for domestic supply in 2000. The U.S. Geological Survey National Water-Quality Assessment (NAWQA) program began assessing the glacial aquifer system in 1991. A framework for interpreting water quality across the glacial aquifer system has been developed based on two primary characteristics: aquifer intrinsic susceptibility and vulnerability. Water quality in areas of similar intrinsic susceptibility and vulnerability is being compared. In addition, areas of similar water chemistry, based on major ion chemistry data collected from 1991 to 2004, have been delineated within the glacial aquifer system using cluster analysis and principal component analysis.

Drinking-water use in rural agricultural areas, of which an estimated 90 percent is ground water from domestic wells, is most vulnerable to nutrient contamination because of the surrounding agricultural land use. Water-quality data for the glacial aquifer system collected by the NAWQA program include analyses of 469 domestic wells, 99 public water supplies, and 1,116 shallow monitoring wells across the aquifer system extent. Non-parametric survival analysis is being used to compare domestic well-water quality among well types (public and private). The median nitrate concentration (measured as dissolved nitrate and nitrite) in ground water from domestic and public-supply wells is 0.1 mg/L, and 0.6 mg/L, respectively. These median concentrations differ appreciably from the median concentration for the monitoring wells (1.2 mg/L), which assess recently recharged ground water. Comparison of ground water from domestic, public, and

monitoring wells to a nitrate screening level of 1, 4, and 10 mg/L show increasing differences by well type with the higher screening levels. Differences in nutrient concentrations and detections by water use, well characteristics, and chemical concentrations are being explored within the context of the framework based on aquifer intrinsic susceptibility and vulnerability.