Ambient Groundwater Quality Monitoring Network

Background

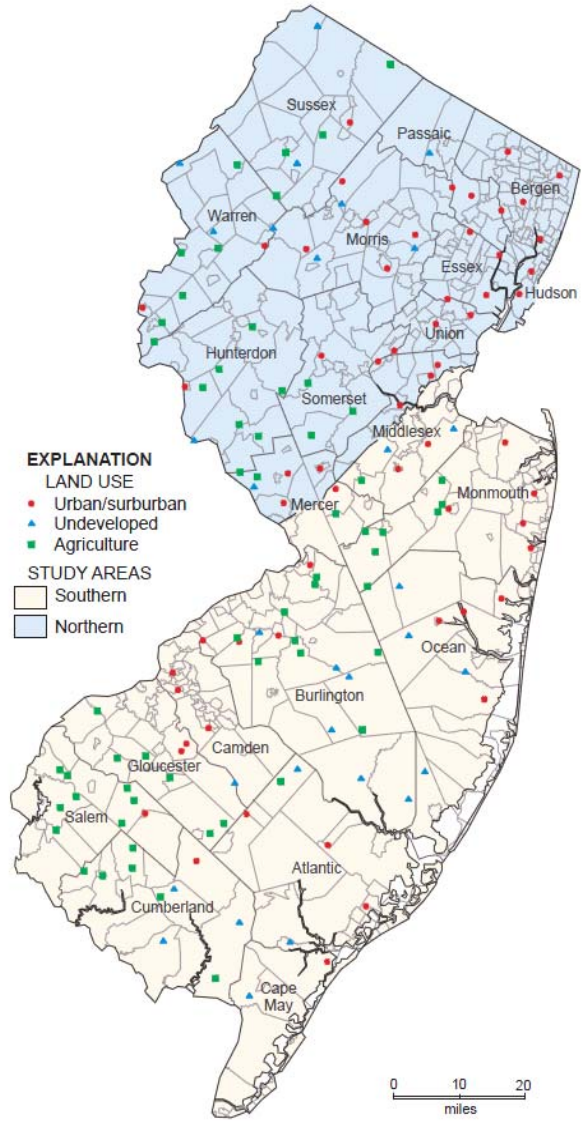
The quality of shallow groundwater is important because it is the water that recharges deeper aquifers and provides base flow to local streams and wetlands. The NJDEP, in partnership with US Geological Survey, monitors ground-water quality with its Ambient Ground Water Quality Monitoring Network (AGWQMN). The goals of the AGWQMN are to: (1) assess ground-water quality status, (2) assess ground-water quality trends, (3) evaluate contaminant sources, and (4) identify emerging water quality issues. The network consists of 150 shallow wells that are sampled at the rate of 30 per year on a five-year cycle. Chemical and physical parameters analyzed in each well-water sample include pH, specific conductivity, dissolved oxygen, temperature, alkalinity, major ions, trace elements, nutrients, gross-alpha particle activity, volatile organic compounds (VOC), and pesticides. The first sampling cycle was performed between 1999 and 2003, and a second sampling cycle was performed between 2004 and 2009.

The final distribution of wells as a function of land use is 60 in agricultural areas, 60 in urban/suburban areas, and 30 in undeveloped land use areas. Land-use designations were determined using 1986 and 1995 land use coverages, 1995 aerial photographs, site visits, and estimations of ground-water-flow directions based on the local geologic framework and site specific topographic controls to ensure the well is down-gradient of the desired land use.[1,2]

Network wells are screened just below the water table, and the sample water is therefore expected to be relatively young groundwater. Monitoring younger ground water rather than the older groundwater in deeper systems permits a better assessment of how current land use activities are affecting ground-water quality.

Well locations, along with the delineation of the northern and southern study areas and the land use category of each well location, are pictured in the figure “Ambient Ground Water Quality Monitoring Network Well Locations.”

Ambient Ground Water Quality Monitoring Network Well Locations



Status and Trends

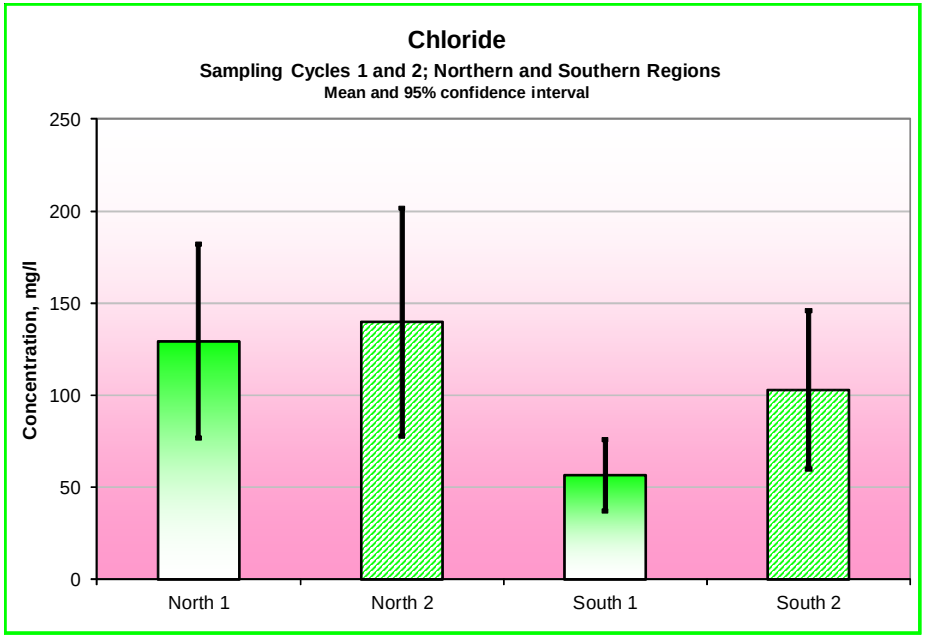
Two different sampling cycles have provided two data points for each well. Two data points are not generally considered enough to establish a trend. However, review of the data collected so far does indicate differences in concentration patterns of some parameters that are related to land use and/or geology. Changes in some parameters over the two time periods have been observed. Some of the most noticeable patterns and changes are noted below.

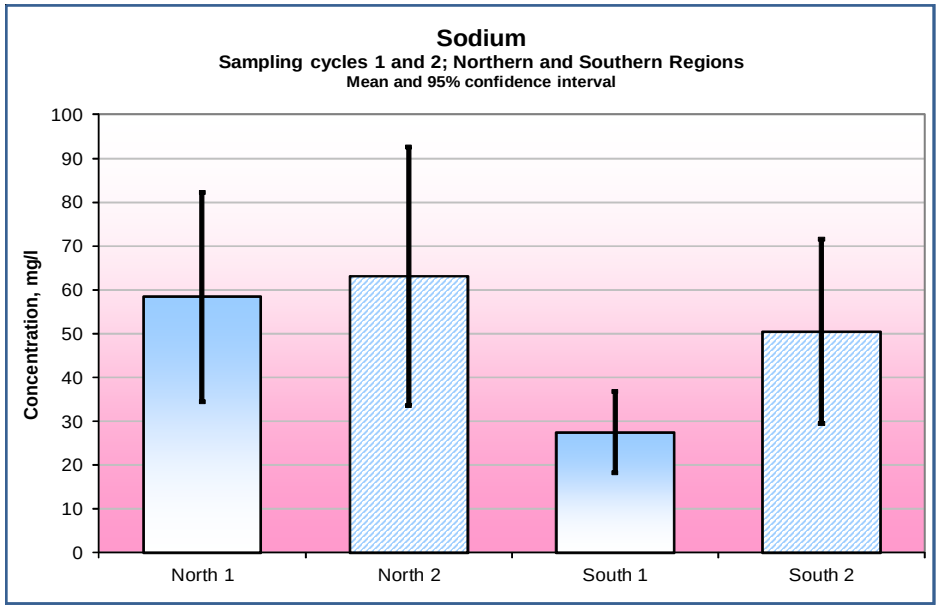
There are distinctive differences in natural ground water quality between southern and northern New Jersey. The groundwater in the southern part of the state generally has a lower pH and lower total dissolved solids (TDS) levels, which reflects the acidic sandy soils of the coastal plain. Groundwater in northern New Jersey has a higher pH, due to that region's bedrock geology, and has a lower temperature, which reflects the regional difference in climate.

Dissolved oxygen (DO) levels are typically lower in groundwater from urban land use areas than in groundwater from undeveloped areas, and TDS levels are higher. In the second sampling cycle, DO levels were also generally lower in agricultural areas than in undeveloped areas. Reasons for lower DO levels in urban areas include relatively large amounts of impervious surfaces, which limit exchange of air with groundwater. Substances in wastewater, which is present in urban and agricultural areas, also deplete oxygen, lowering DO levels. Road salt and application of lawn care and agricultural chemicals are the likely factors causing higher TDS values observed in agricultural and urban land use areas.

Concentrations of calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride, and silica ions are generally higher in the northern part of the state than in the southern part due to the regional geology.

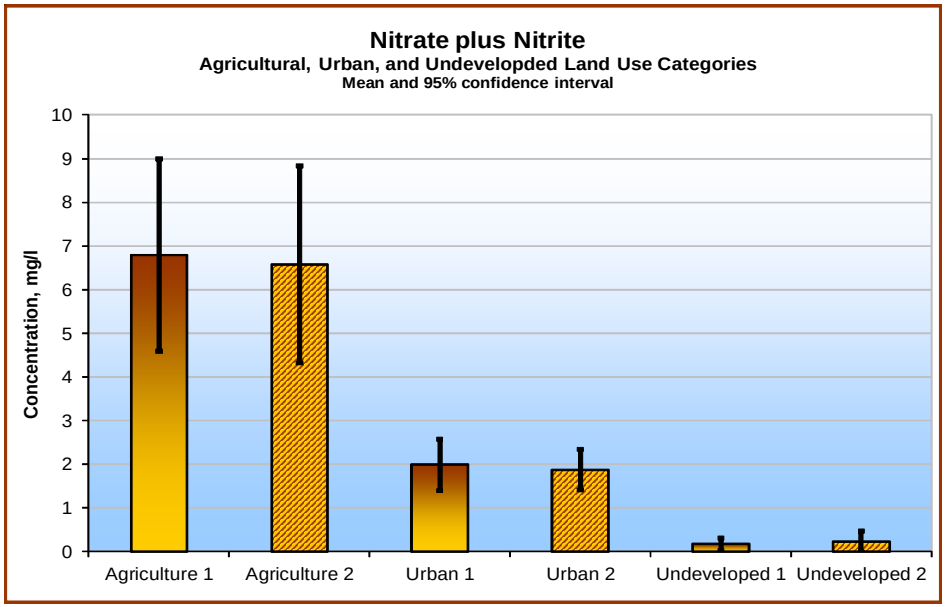
In southern New Jersey, both chloride and sodium increased from the first to the second sampling cycle. The increase in chloride concentration, as determined with a statistical test (Wilcoxon matched-pairs signed-ranks), was extremely significant (i.e., highly unlikely that this observation is a random event), with a p value of 0.0006. The increase in sodium concentration was also extremely significant, with a p value of 0.0005. One possible explanation for this increase could be use of road salt for deicing of roadways.[3] See the figures "Chloride" and "Sodium."

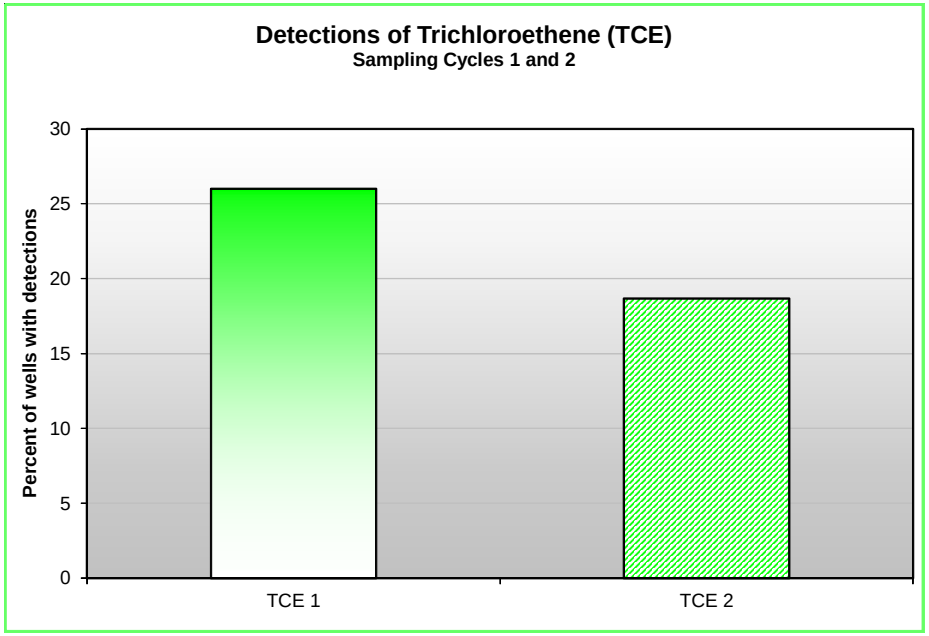




Agricultural and urban areas in both southern and northern New Jersey have higher concentrations of nutrients, especially nitrite plus nitrate, than undeveloped areas. The origin of the nitrite plus nitrate is believed to be primarily fertilizers and releases from manure management,[4] although septic systems and leaking sewer systems likely contribute as well. See the figure "Nitrate plus Nitrite." The health standard for nitrate is 10 mg/l.

Statewide, 74 of the 150 (49%) monitoring wells had detections for pesticides in both sampling cycles. Urban and agricultural lands had the greatest number of wells with pesticide detection. The combined agricultural and urban wells accounted for 97% and 96% of all the wells with pesticide detections, in the first sampling cycle and second cycle respectively. The most common chemicals observed were the herbicides atrazine, metolachlor, prometon, and the atrazine metabolite deethylatrazine.





Volatile organic compounds (VOCs) decreased from the first to the second sampling cycle in all land uses in both northern and southern New Jersey. An example is trichloroethylene (TCE). Of the 150 wells sampled in each cycle, there were 39 detections of TCE in the first sampling cycle but only 28 detections in the second cycle. The lower presence of VOCs in the second cycle probably reflects decreased use of many VOCs, due in part to both state and federal restrictions, better management of waste solvents, and waste clean-up efforts. See the figure "Detections of Trichloroethene (TCE)."

Unlike other VOCs, chloroform was observed in most of the monitoring wells in undeveloped areas in southern New Jersey. This likely reflects the natural origin of chloroform, which has been found to be produced by soil fungi and termites.[5,6]

Gross alpha-particle activity was generally higher in southern New Jersey than in the northern part of the state in both sampling cycles.

Outlook and Implications

In New Jersey, approximately 40% of drinking water supply is ground water. Human activities are known to impact shallow ground-water quality, and protecting this resource is critical.

The AGWQMN work continues, and additional data will be available after the third round of sampling and analysis is complete. The value of these data will grow with each sampling cycle, and should provide insight for policy makers to assess current policies and to help shape future policies. It must be noted, however, that AGWQMN was designed to cover the entire state based on land use. Data to assess a localized or regional issue would require more monitoring wells to provide adequate coverage. Any new wells added to the network will have to be installed to the same rigorous criteria as the existing wells to ensure that the data are comparable.

More Information

http://www.state.nj.us/dep/wmm/bfbm/groundwater.html
http://www.state.nj.us/dep/wmm/bfbm/index.html

For more information on groundwater quality with respect to drinking water see Drinking Water Quality, in this Environmental Trends series.

References

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[4] Puckett, Larry J., Tesoriero, Anthony J., Dubrovsky, Neil M., 2011, Nitrogen Contamination of Surficial Aquifers-A Growing Legacy, *Environmental Science and Technology*,45, p. 839-844.

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