Minnesota Pollution Control Agency

Environmental Outcomes Division

Ground Water Monitoring & Assessment Program

Quality of ground water under communities served by individual sewage treatment systems

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In 1998 and 1999, the Minnesota Pollution Control Agency (MPCA) conducted studies of ground water quality under three communities in Minnesota that are served by individual sewage treatment systems (ISTSs). The study areas differed in age of development, density of ISTSs and hydrogeologic setting. Each of the aquifers studied is vulnerable to contamination. We were primarily interested in the distribution of chemicals in ground water under areas served by ISTSs and made no effort to evaluate the performance of ISTSs, although this is an important factor affecting ground water quality.

Why is the MPCA studying communities with individual sewage treatment systems?

Research indicates that ground water under ISTSs contains higher concentrations of chemicals, such as nitrate, compared to ground water under undeveloped settings (such as forested land). Pathogens and phosphorus may may also represent water-quality concerns.

In Minnesota, approximately half a million ISTSs serve about one million people. Expansion of urban areas continues, and developments served by ISTSs continue to increase on urban fringes in many areas of the state. The objective of this study was to evaluate ground water quality under communities served by ISTSs. This information allows us to compare impacts from different human activities and set environmental priorities for Minnesota. Similar studies are being conducted under different land-use settings.

Description of the study

Figure 1 (next page) shows the locations of the three study areas. In each area, we sampled 40 to 60 monitoring and domestic wells for bacteria and inorganic chemicals. A report by MPCA (1998) describes our sampling procedures. The table below describes the study areas.

Characteristic	Site 1	Site 2	Site 3
Median age of system (years)	8	6	20
Median lot size (acres)	0.25	1.00	0.25 to 0.50
Conforming systems	60% have permit	50%	Unknown
Median depth to water (feet)	16	15	45
Aquifer type	Medium sand	Fine sand	Sand over limestone

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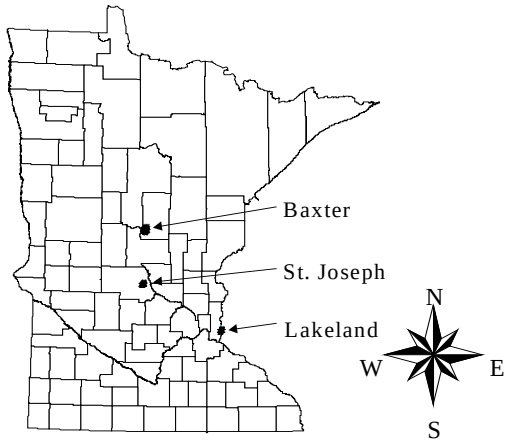

Figure 1

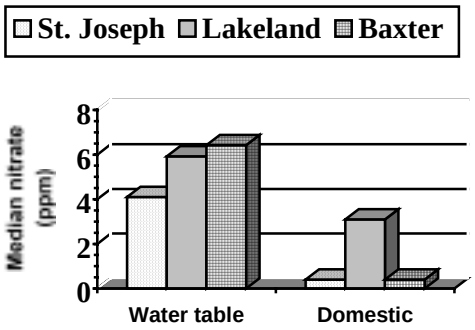

Figure 2

What did we find?

- The drinking water standard of 10 mg/l for nitrate was exceeded in 27 percent of the 33 samples collected at the water table, but in only one of the 100 sampled domestic wells. Median nitrate concentrations ranged from 4.1 to 6.4 mg/l at the water table.
- Nitrate concentrations decreased rapidly with depth at St. Joseph and Baxter and slowly with depth at Lakeland. Concentrations of nitrate were highest in older parts of each study area.
- Total coliform bacteria were detected in all 12 water table samples in Lakeland and St. Joseph, in 44 percent of domestic wells sampled in St. Joseph, and in 20 percent of domestic wells sampled in Lakeland. *E. coli* bacteria, considered a better indicator of fecal contamination than total coliform, were not detected in domestic wells. The high incidence of total coliform detection may be related to presence of noncompliant systems, which contribute to ground water contamination by bacteria and viruses.
- Concentrations of phosphorus are below levels of concern in the sampled communities.
- Chloride concentrations correlated with nitrate concentrations. Chloride serves as a potential indicator of ground water impacts from ISTSs.

Summary and recommendations

We observed similar patterns of water quality in the three study areas. The data are similar to information we have found in literature from other states. Age, compliance, and density of ISTS are likely to be important factors affecting shallow water quality, while aquifer characteristics affect water quality deeper in an aquifer. The effect of age may be related to gradual expansion of septic plumes over time and an increasing likelihood of noncompliant systems that contribute to bacterial contamination.

Our data indicate nitrate contamination of ground water from ISTSs. These concentrations are less than concentrations under irrigated row crop agriculture and higher than concentrations under communities served by municipal sewers. Ground water quality under sewered areas, however, is impacted by a variety of other chemicals (see reports from our land use studies: http://www.pca.state.mn.us/water/groundwater/gwmap/gw-landuse.html).

In aquifers that are not vulnerable to nitrate contamination, drilling wells deep into the aquifer is sufficient to minimize impacts from ISTSs. In vulnerable aquifers or areas where surface waters may be impacted through ground water discharge, a community may develop environmentally based land-use plans, ensure compliance of ISTSs to minimize bacterial and viral contamination, choose to install municipal sewer lines, ensure proper well construction, or install nitrogen-reduction systems, such as mounds or filter systems. Water conservation and regular system maintenance will have moderate impacts on water quality. Research needs include expanding sampling for bacteria and viruses under communities served by ISTSs.

Reference

Minnesota Pollution Control Agency. 1998. *GWMAP Field Guidance Manual*.

For more information

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