Effects of Septic Systems on Ground Water Quality - Baxter, Minnesota

Individual sewage treatment systems (ISTS or septic systems) have the potential to impact ground water with chemicals such as nitrate, chloride, and phosphorus. Once in ground water, these chemicals have the potential to move and spread.

In 1998, the Minnesota Pollution Control Agency's Ground Water Monitoring and Assessment Program (GWMAP) began studying impacts of septic systems on ground and surface water quality. The purpose of these studies is to provide MPCA and local government staff with information useful for assessing potential impacts from septic systems. This information can be used in land use planning.

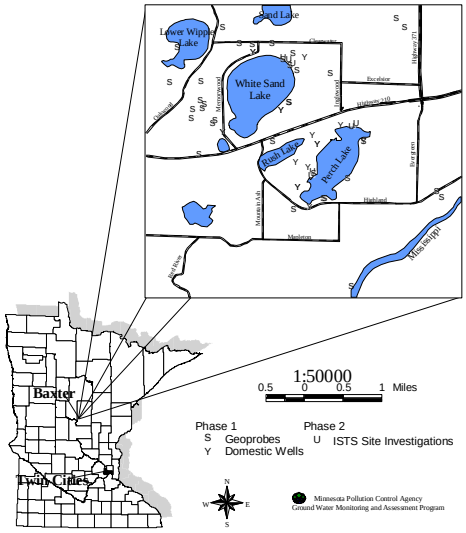
Baxter Study Objectives

In 1998, we conducted a ground water study in Baxter, Minnesota. The Baxter-Branierd area has experienced rapid growth in recent years, including residential development with septic systems (unsewered areas). We chose Baxter because of these changes in land use and because there are numerous recreational lakes in the area that could be impacted by discharges from septic systems. The objectives of the study were to

- compare ground water quality beneath sewered and unsewered residential areas; and
- evaluate ground water quality within individual septic plumes.

Study Design

Figure 1 illustrates the location of the study area. The study area encompasses approximately 10 square miles. To compare water quality beneath sewered and unsewered areas, we sampled 40 domestic and 12 temporary wells at a variety of depths within the aquifer underlying the study area. Sampling was primarily for nitrate, but included other chemicals such as chloride, phosphorus, and sodium.



The septic systems studied did not meet the 3-foot vertical separation distance from the bottom of the drainfield to the seasonally high water table. This separation distance is necessary to provide treatment of most contaminants. Due to the seasonal nature of the water table it is not know what percent of the time the system is compliant with the separation distance. It is also

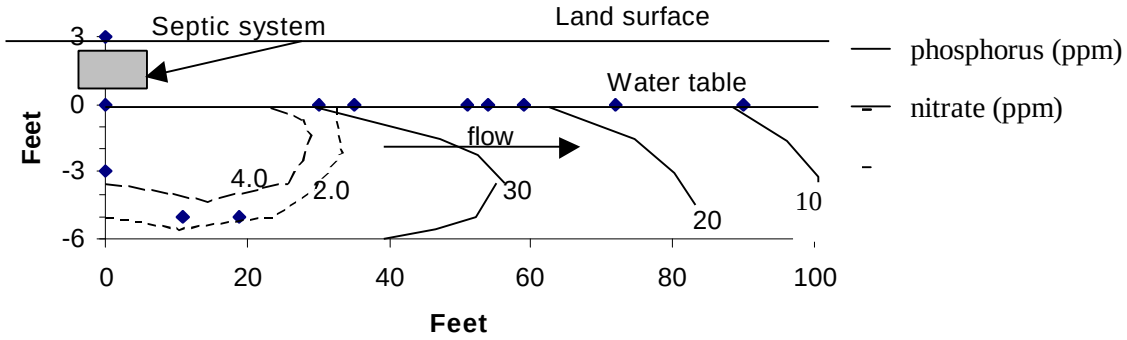
unknown how seasonal variation of the water table affected the characteristics of the plumes studied.

For the second part of the study, we selected seven septic systems. These were sites located on lakes (See Figure 1). We drilled 15 to 25 holes at each site to define the horizontal and vertical extent of plumes originating from each septic system. We sampled for Volatile Organic Compounds (VOCs), bacteria, and a wide variety of inorganic chemicals.

What did we find?

Concentrations of nitrate were higher in unsewered areas (2.0 mg/L or parts per million) than in sewered areas (0.78 mg/L). There were three exceedances of the drinking water standard (10 mg/L) in shallow wells under unsewered areas, but only one exceedance in a domestic well. Concentrations of most other chemicals were statistically equal between the two areas.

Chemical concentrations in septic effluent and within septic plumes were similar to concentrations found in other studies in the literature. Septic effluent is characterized by concentrations of ammonia, chloride, phosphorus, sodium, potassium, boron, VOCs, and bacteria that are higher than background concentrations in ground water. These chemicals can reach ground water beneath the drainfield, except for ammonia, which is converted to nitrate in the soil zone. Within a septic plume, concentrations of phosphorus, bacteria, and VOCs decreased rapidly and rarely traveled more than 30 feet from the drainfield. Chloride, nitrate, sodium, and boron traveled much further, from about 30 to over 500 feet. Nitrate concentrations within the plume exceeded the drinking water standard throughout much of the plume. No plume extended to an adjacent lake. A typical plume is shown in Figure 2.



Conclusions and Recommendations

Both non-complying and complying septic systems can impact ground water quality. Within individual plumes, concentrations of nitrate exceeded the drinking water standard. Concentrations of phosphorus and bacteria decreased rapidly within the plume.

Caution should be exercised when applying the results for Baxter to other areas. The Baxter area may not be typical of many unsewered areas in Minnesota. Additional studies should be conducted in older, larger subdivisions, and adjacent to lakes that are more sensitive to nitrate contamination than the lakes in the Baxter area.

What is next?

We will attempt to replicate these studies in other areas of the state, so that we can develop a better understanding of septic impacts on water quality in a variety of different settings. In 1999, we will conduct septic system studies near St. Cloud and in Washington County.