



Drinking Water Protection Series

Nitrogen Basics for Wellhead Protection Teams

Wellhead teams will probably discover that the challenges and eventual solutions for their Source Water Protection Area (SWPA) will be highly unique. However a number of Minnesota communities may share a similar contaminant... nitrate (NO₃). Found in both groundwater and surface water supplies, nitrate contamination is almost always man-induced. Common causative factors include over-application of fertilizers and animal manures and seepage from septic systems. MDH reports that 7% of the wells found in the County Well Index (private and community wells) exceed the NO₃-N health standard of 10 mg/L. Some regions of Minnesota are more susceptible due to geology and land use differences *Figure 1*.

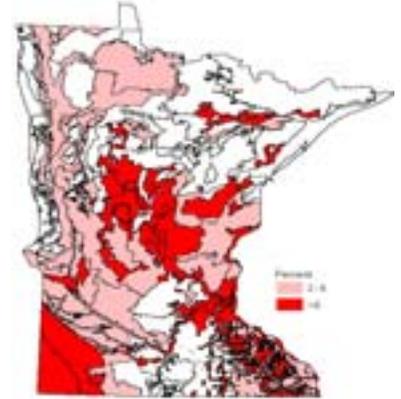
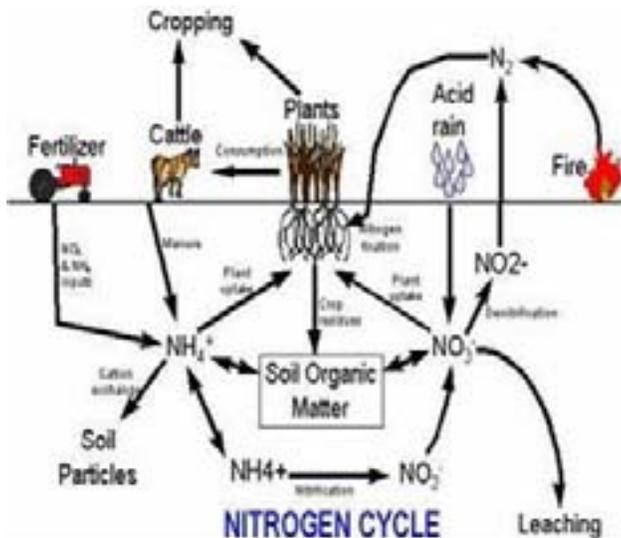


Figure 1. Percent of wells exceeding 3 mg/L. MDH County Well Index nitrate results summarized by agroecoregion. (Map courtesy of Dr. David Mulla, UM)

Public works staff and wellhead teams will be able to make informative decisions after mastering a basic understanding of nitrogen (N). The purpose of this fact sheet is to provide the reader with a brief description of the N cycle and some of the key sources typically encountered in Source Water Protection areas.

Understanding the “Nitrogen Cycle”



Nitrogen is the most abundant element in the atmosphere yet, ironically, it is the most yield limiting plant nutrient from a biological perspective. Nitrogen is the building block of proteins and nucleic acids; no other nutrient can be substituted. Farmers, gardeners, and lawn care enthusiasts know its value for maintaining healthy plant growth.

Nitrogen pathways and transformations are complex and beyond the scope of this fact sheet. A simplified version is illustrated in *Figure 2*. Don't be intimidated by the twists and turns.....the important things to keep in mind are: 1) There are multiple N sources; 2) Nitrogen in the nitrate form is highly mobile posing the greatest threat to drinking water supplies; 3) Nitrate leaching losses can be significantly minimized through a series of **Best Management Practices (BMPs)**. Generally BMPs can be implemented with minimal risk of reducing crop yields or turf grass quality.

Figure 2. A simplified illustration of the “Nitrogen Cycle”. (Courtesy of Dr. Terry Cooper, U of M)

Nitrogen Sources –Getting the “Big Picture”

Estimating the relative importance of the various N sources is an important step toward a successful implementation plan. Once accomplished, a more difficult task follows which is to estimate the relative impacts of these sources on the groundwater resources.

N Budgets in Four Minnesota Wellheads

(Perham, St. Peter, Hastings, and Cold Spring)

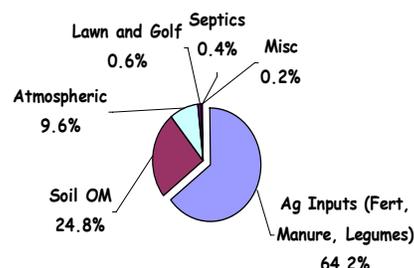


Figure 3. N contributions within four Minnesota SWPAs.

Previous work with the cities of Perham, St. Peter, Hastings and Cold Spring along with Lincoln-Pipestone Rural Water over the past decade has provided MDA and MDH with some valuable expertise in understanding nitrate contamination. In all of these cases, agricultural sources overshadowed other potential sources such as septic tanks or lawn care inputs *Figure 3*. Contributions in your SWPA could vary significantly.

Soil Organic Matter & Crop Residue

Most Minnesota soils contain between 2,000 to 6,000 lb/A of organic N in the “plow layer” (top 6-7”). Organic N decomposes very slowly typically releasing 25-75 lb/A each year. Climatic conditions such as temperature and moisture have a large influence on release rates. Types and frequency of tillage operations can slightly modify contributions. Contributions are significant (25% in *Figure 3*) but should be considered a natural process. These contributions are already factored into the University of Minnesota’s fertilizer recommendations for crops and turf grass.

Agricultural Inputs

Producers make fertilizer rate decisions on numerous factors which are based on economics, yield goal, previous crop, manure credits, soil texture, and organic matter. Nitrogen inputs need to be viewed as a complete management system. Over-application, regardless of whether N evolves from fertilizer, manure, or contributions from previous crops, will result in potential impacts on groundwater supplies. The general strategy should involve taking the proper credits for manures and legumes, and make up the difference with commercial N fertilizer following UM recommended application rates. Proper management of agricultural sources will have a profound impact on the future of many rural community water supplies.

Septic Systems

The average family of four can produce 40-60 pounds of N per year. Properly sited and well-maintained septic systems reduce nitrate problems and greatly lower the risk of ground water contamination. Septic systems should be designed and maintained according to local and state standards.

Lawn and Golf

Healthy vigorous turf grass can provide a good filtering mechanism to reduce nitrate leaching. The fibrous root system of turf grasses in combination with nitrogen uptake needs, generally contribute low levels of nitrates to the overall N budget. The primary objective in applying nitrogen fertilizer to a lawn is to add necessary nutrients **in the required amounts and at the proper time** to achieve desirable turf quality and plant health.

Atmospheric

Rainfall and snow contributes about 10-15 lb/acre annually through atmospheric deposition. Depositional numbers have increased over the last century due to increased number of internal combustion engines and emissions from concentrated livestock operations.

This fact sheet is the first in a series that will help wellhead teams identify potential nitrate sources in their SWPA’s and provide guidance on how to manage this contaminant.

“Drinking Water Protection Series”

1. **Nitrogen Basics for Wellhead Protection Teams**
2. **Nitrate Contamination—What is the Cost?**
3. **The Importance of Crop Selection and Management for Controlling Nitrogen Losses**
4. **Promoting the Right Nitrogen Rate**
5. **Effectiveness of Nitrogen Best Management Practices (BMPs)—Irrigated Sands**
6. **Effectiveness of Nitrogen Best Management Practices (BMPs)—South Central MN**
7. **Nutrient Management Planning Basics**

For more information:

Minnesota Department of Agriculture—www.mda.state.mn.us/appd/waterprotect.htm
Minnesota Department of Health— www.health.state.mn.us/divs/eh/water/index.html
Minnesota Rural Water Association—www.mrwa.com



Developed cooperatively between the Minnesota Department of Agriculture and the Minnesota Department of Health