

## **Nitrate Exposure and Infant Risk Study (NEXIR)**

### **2002 Update**

The Nitrate Exposure and Infant Risk Study (NEXIR) was performed by the Minnesota Department of Health (MDH), Division of Environmental Health, with support from the Minnesota Future Resources Fund as recommended by the Legislative Commission on Minnesota Resources (LCMR). The study investigated the occurrence of nitrate and bacteria in private drinking water wells and the potential health impact that exposure may have on young children.

### **Background**

Nitrate (NO<sub>3</sub>) is a common groundwater contaminant throughout Minnesota. Nitrate occurs naturally in our environment and is important in natural processes such as decomposition and plant growth. Natural levels of nitrate in groundwater are rarely high enough to be dangerous to humans who drink the water. However, when it becomes highly concentrated in groundwater, nitrate can be toxic. Significant sources of nitrate contamination include fertilizers, animal wastes, and human sewage. Nitrate may contaminate a private drinking water well if the well is shallow, poorly maintained, old, and/or near a source of contamination. These situations also favor contamination by disease-causing bacteria. Disease-causing bacteria such as fecal coliform, or *E. coli*, may worsen the health effects of nitrate if ingested.

Infants under six months of age are at the most danger from elevated levels of nitrates in drinking water. A baby fed water high in nitrates (or fed formula made with high-nitrate water) may develop a condition called “methemoglobinemia” or “blue baby syndrome.” In this condition, the baby’s blood is unable to properly carry oxygen. As a result, the baby’s skin turns a blue color, particularly around the eyes, nose, and mouth. Death may follow, if oxygen deprivation is severe and lengthy enough. Susceptibility to blue baby syndrome increases if fecal coliform bacteria are also present in the baby’s drinking water. Fecal coliform bacteria cause diarrhea and interfere with digestion, intensifying nitrate’s effects on the body.

Any water nitrate-nitrogen level over 10 mg/L is considered too high for safe drinking by babies under six months of age. This 10 mg/L nitrate-nitrogen limit is the Maximum Contaminant Level set up by the U.S. Environmental Protection Agency. Almost all adults may drink water with nitrate-nitrogen levels higher than 10 mg/L. However, some hereditary disorders render a few adults susceptible to methemoglobinemia. Also, women who are pregnant should not drink water high in nitrates.

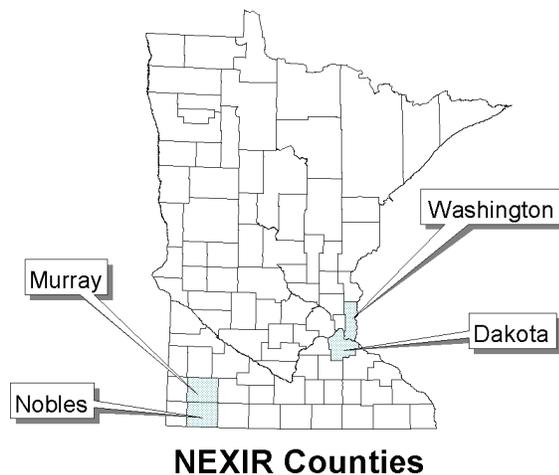
NEXIR was designed to examine how infants in Minnesota may be exposed to nitrate from private drinking water wells. NEXIR was a population-based study; that is, its findings characterize a cross-section of Minnesota residents who use private well water. The objectives of NEXIR were to:

- Investigate nitrate and bacteria occurrence in drinking water among private well users;
- Investigate history of water use, and exposure to nitrate and bacteria in young children, as related to indications of methemoglobinemia or diarrhea;
- Assess existing knowledge among caregivers of young children about risks of nitrate exposure; and
- Assess the need for further education for caregivers and physicians.

## NEXIR Methodology

NEXIR took place in four counties in two different study areas (see map, below). Region I comprised Washington and Dakota counties in east-central Minnesota, representing the Twin Cities suburban area. Region II comprised Murray and Nobles counties in southwestern Minnesota, representing a rural, highly-agricultural area.

NEXIR households were randomly selected from lists of all properties not using public water. Property owners or residents were called, screened for eligibility, and invited to participate. A property was considered eligible for NEXIR if: (1) at least one person lived there more than 30 days per year; (2) the household had no access to a city or rural water supply; and (3) a private well was present, and was or could be used for drinking water.



Field staff visited a total of 710 eligible properties throughout the two study areas. Nitrate samples were collected from well water both indoors and at the wellhead. Samples were also collected to test for presence of total and fecal coliform bacteria. Family members completed a household questionnaire with questions on well water use, drinking water habits, and demographics. Additional questionnaires for caregivers of children under the age of six inquired about children's water use, children's health, and caregivers' knowledge of nitrates.

## NEXIR Results

Preliminary analysis of water samples shows that nitrate and bacterial contamination differed between regions. *Nitrate-nitrogen* levels from the wellhead were over 10 mg/L in about 6% of Region I samples, and in about 23% of Region II samples. *Total coliform bacteria* were present in 19% of Region I samples and in about 66% of Region II samples. *Fecal coliform bacteria* were present in just under 1% of Region I samples and in about 17% of Region II samples. In Region I, 96% of household members drank the tap water versus 77% in Region II. Thirty percent of household members were children, with 6% below the age of 6.

A final report of NEXIR results is expected in 2003, when results will be presented to the LCMR.

## NEXIR Advice to Participants

All participants were sent a letter with individual nitrate and bacteria results, along with MDH recommendations, within two months of their household visit. MDH recommendations for nitrate and coliform bacteria are shown on the following pages.

*Advice to NEXIR Participants for Nitrate Results*

<b>NITRATE RESULT</b>	<b>MDH RECOMMENDATION</b>
<b>&gt; 10 mg/L</b>	<p>The nitrate levels measured in a sample from your well water (outdoor tap) exceed the health limit of 10 mg/L. The presence of nitrate in the water indicates that surface contamination of the well is occurring. Do not give water from this well to any infant under six months of age, either directly or in formula. Do not boil to “treat” high nitrate water. Boiling actually concentrates the nitrate, due to evaporation of the water. Commercially bottled water is required to meet the nitrate standard, and can be given to infants. Pregnant women should avoid drinking well water known to contain high levels of nitrate.</p> <p>Our health recommendations are based on levels of nitrate found in the well (outdoor tap). Your indoor drinking water tap was also sampled and tested for nitrate. Levels of nitrate from the indoor tap may be lower than levels tested from the well outdoors, if the tap is being effectively treated with a treatment system in the home. Please be aware that treatment systems can and do fail over time, and they require ongoing maintenance. For that reason, home water treatment units are not recommended for treating high nitrate well water that will be given to infants.</p>
<b>≥ 3 and ≤ 10 mg/L</b>	<p>Nitrate has been measured in a sample collected from your well (outdoor tap) at a low level, between 3 and 10 mg/L, that does not exceed the health limit of 10 mg/L. Although this level of nitrate is considered safe for drinking, the presence of greater than 3 mg/L nitrate in the water indicates that surface contamination of the well is occurring. Frequent testing of the water, at least once per year, is recommended because nitrate levels can change over time, particularly in older wells.</p> <p>Our health recommendations are based on levels of nitrate found in the well (outdoor tap). Your indoor tap was also sampled and tested for nitrate. Levels of nitrate from the indoor tap may be different from nitrate levels found in the well outdoors, if the indoor tap is being effectively treated in the home. Please be aware that treatment systems can and do fail over time, and require ongoing maintenance. For that reason, home water treatment units are not recommended for treating high nitrate well water, which will be given to infants.</p>
<b>&lt; 3 mg/L</b>	<p>Nitrate was not detected or is at very low levels (&lt;3 mg/L) in the sample collected from your well (outdoor tap), indicating that the well water is safe from nitrate contamination. We do recommend that private well owners routinely test their drinking water every 2-3 years to ensure that the water remains safe from nitrate. Nitrate levels can change over time, particularly in older wells.</p> <p>Our health recommendations are based on levels of nitrate found in the well (outdoor tap). Your indoor tap was also sampled and tested for nitrate. Levels of nitrate from the indoor tap may be different from levels tested from the well outdoors, if the indoor tap is being effectively treated with a home water treatment system. Your indoor nitrate result also may be different from the well sample result if your indoor tap is connected to a different water source.</p>

*Advice to NEXIR Participants for Bacteria Results*

<b>BACTERIA TEST RESULT</b>	<b>MDH RECOMMENDATIONS</b>
Total Coliform: Absent <i>and</i> Fecal Coliform: Absent	Your well tested negative for total coliform and for fecal coliform bacteria. This finding indicates that the water was safe from contamination by disease-causing bacteria at the time of the test. Because bacteria contamination can vary over time, it is recommended that you continue to test the well every 2-3 years for bacteria contamination. Spring is usually the best time to test.
Total Coliform: Present <i>and</i> Fecal Coliform: Absent	Your well tested positive for total coliform and negative for fecal coliform bacteria. This finding indicates that surface contamination has gotten into the water. There is potential for disease-causing bacteria to be present in the drinking water also. It is recommended that the well be tested at least once a year for bacterial safety. Spring is usually the best time to test.
Total Coliform: Present <i>and</i> Fecal Coliform: Present	Your well tested positive for total coliform and for fecal coliform bacteria. This finding indicates that surface contamination has gotten into your well water and that unsafe levels of disease-causing fecal bacteria are present. It is recommended that: the water not be used for drinking or for food preparation unless it is boiled for at least three minutes at a full, rolling boil; and the well be disinfected and retested clean (or uncontaminated) before drinking unboiled water.

**Questions?**

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