

**Title:** A Study of Detection of Fecal Indicators and Other Factors Impacting Water Quality in Private Wells in Door County, Wisconsin

**Project I.D.:** DNR Project #159

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**Background/Need:** The proposed Environmental Protection Agency (EPA) Groundwater Rule (GWR) will require public water systems to test their source water for fecal contamination. Systems that have been determined to contain fecal contamination in their water system will be required to eliminate the problem with some corrective action. In Door County, Wisconsin, the only solution for many small water systems to obtain consistently safe water is to install costly treatment devices. Prior testing for coliphage, one of the GWR proposed fecal indicators, suggested the majority of groundwater systems would be impacted.

While the GWR will apply to all public water systems in Wisconsin, Door County is an appropriate location for this study for two reasons:

- (1) The area has a large number of small privately owned public water systems.
- (2) The county is more susceptible to groundwater contamination than most other counties in the state due to the shallow soils and the vulnerable geology.

**Objectives:** Phase I – Monthly Testing Of 25 Wells  
The primary purpose of this study was to sample 25 wells monthly to obtain an average percentage of wells that would be impacted by fecal contamination based on positive detects in the three proposed GWR indicator tests. The indicators include *Escherichia coli* (*E.coli.*), *enterococci*, and coliphage. The EPA is considering use of these indicators to determine the water systems that would require treatment or a new water source to protect the health of the individuals these systems serve. Results for each test method were reviewed to identify similarities and differences in the detection of fecal contamination. Data collected from each individual study site were also studied to determine if any environmental factors were significant in explaining what wells were impacted.

Phase II – Gastrointestinal Illness and Drinking Water  
The study also attempted to gather data on linkages between gastrointestinal illness complaints and the primary water source consumed by the individual.

**Methods:** Private home wells were used as sampling sites in this study as a surrogate for small public water systems. The sites were selected from a pool of volunteers that responded to advertisements in local papers and fliers dispersed at meetings. Sites were required to be available year-round for sampling and have well depth information. Sites were selected to disperse them throughout the county. Water samples were collected by WDNR staff and submitted to the State Laboratory of Hygiene for analysis of fecal indicators and *coliform*.

Human illness cases were obtained by referral from the local hospital and contacts made directly to the WDNR.

**Results and Discussion:** This study provided a preview of the percentage of EPA proposed fecal indicator tests that may yield positive detects in small Door County public water systems. As was expected, the data show that there is some vulnerability for Door County wells to microbial contamination. For example, half of the wells had *coliform* detected in water samples collected in August.

However, the additional tests proposed in the GWR did not drastically increase the number of wells that would be considered unsafe. Prior coliphage indicator testing in Wisconsin had suggested 95% of the wells would be impacted (Janczy 1998). Only seven of the wells in this study (28%) were found to contain coliphage. This suggests that there are less microbially impacted wells than previously thought based upon the new coliphage testing data. The fact that viruses are detected in any drinking water samples is still not comforting.

It is disturbing that 40% of the wells did test positive for *coliform* and a fecal bacteriological indicator at some time during the year of testing. This suggests that fecal material is occasionally contaminating the aquifer from which these wells draw water.

The highest percentage of wells impacted with fecal bacterial indicators occurred in August at 32% for *enterococci*. The highest percentage of *E.coli* occurred in September at 20%. Coliphage was the detected at the same level.

**Recommendations:** The GWR implementation plan has not been finalized. A standard has not been defined to judge whether a well is considered contaminated with fecal material for regulatory purposes. This standard will depend on the final GWR and how states implement the rule. A well with one fecal indicator in one sample may not meet the regulatory definition of a fecally contaminated well. However, the fact that 40% of the wells in this study contained fecal material suggests that 40% of the approximately 400 TN wells in Door County are at a high risk of being classified as contaminated with fecal material.

The study did show some differences in occurrence between *E.coli* and *enterococci*. These differences may require additional study. Some studies have suggested that there is a stronger relationship between *enterococci* in water systems and human illness (Borchardt et. al. 2003). This suggests *enterococci* may be a better indicator of pathogen contamination than *E.coli*. In the 25 well sites evaluated in this study *enterococci* was detected more often and had a stronger correlation with *coliform*. This suggests that *enterococci* testing would at least be a useful addition to diagnosis of water systems susceptible to fecal contamination that the current *E.coli* testing does not identify.

The GWR will rely on individual water sampling data for each well to evaluate possible upgrades or treatment options that may be needed at specific wells. This study shows site specific information is important. The water quality varied greatly in the study wells despite the majority of the wells being constructed in the fractured dolostone aquifer. Additional site specific studies may be beneficial in defining water systems at risk and improving well construction requirements to protect wells from microbial contamination.

**References:** Borchardt, Mark A. and others. 2003. "Septic System Density and Infectious Diarrhea in a Defined Population of Children". Environmental Health Perspectives – Journal of the National Institute of Environmental Health Sciences, Doi:10.1289/ehp.5914.

Janczy, Joe. 1998. "Wisconsin Migrant Worker Camp Drinking Water Quality Study" USEPA Region V Safe Drinking Water Branch, p.1-10.

**Key Words:** Coliform, Coliphage, E.coli, Enterococci, Door County Well Groundwater

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**Final Report:** A final thesis report is available at UW-Green Bay 920-465-2303 or Water Resources Institute Library, UW-Madison 608-262-3069