Long Lake Groundwater Testing Project

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Groundwater Basics

Groundwater is not the mysterious subject that some people believe it to be. Groundwater is simply water contained in the empty spaces between soil particles and rock materials below the surface of the earth. If you dig a hole and find the point at which all of the empty spaces between the soil and rock are filled with water, you have hit the water table. The saturated areas below the water table make up our groundwater resources. Wisconsin's groundwater is related to all other water on earth through a process called the hydrologic cycle, or the water cycle. In the water cycle, water is transported from the earth by the processes of evaporation and transpiration to form clouds and eventually falls back to the earth as precipitation. Some precipitation runs off into surface water. Some soaks into the ground to be used by plants. Water that soaks past the plant root zone to the saturation zone becomes groundwater.

Groundwater is contained in what we call aquifers, water bearing geological formations that transmit and store water. An aquifer can be thought of as a kind of underground sponge. In the Long Lake watershed, sand, gravel, silt and clay deposited by the glaciers is the primary groundwater storage unit and the aquifer most utilized as a source of water for private wells.

What many people do not realize is that groundwater is always moving. It moves very slowly through the small pores or cracks found in the soil and bedrock. Typically groundwater may only move a few inches to a few feet per day. In Wisconsin's shallow aquifers, groundwater flows only short distances, a few thousand feet to a few miles, from recharge areas (areas where water infiltrates into the ground), to discharge areas (lower points on the landscape where water exits the ground). Examples of discharge areas include streams, rivers, lakes and wetlands. Groundwater is an integral component of most Wisconsin lakes and rivers. Groundwater traveling in shallow flowpaths has been in the groundwater system only a few years or decades; most private well water is supplied by these shallow flowpaths. Deeper in the aquifer where the groundwater flowpaths are much longer, water may be in the groundwater system decades or maybe even hundreds of years.

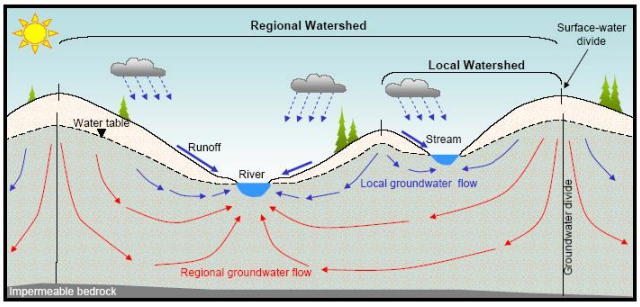

Figure 1. Generalized watershed groundwater flow diagram showing watershed boundaries.

Since groundwater generally discharges to the landscape at surface water bodies, we use the concept of a watershed to determine the area of recharge for lakes and rivers (Figure 1). Any water that falls within a watershed has the potential to end up in that watersheds discharge area. Most precipitation that isn't taken up by plants or doesn't evaporate will eventually find its way into Long Lake, some through direct runoff over the land surface and much of it through infiltration and groundwater flow.

Groundwater Quality

Water under natural conditions is never just H_2O or pure hydrogen and oxygen atoms. Water is often referred to as the universal solvent because it has the ability to dissolve many different types of materials. Just because water is not pure water does not necessarily mean that it is contaminated. Groundwater will naturally contain certain solutes depending on the type of soils and minerals the water has contacted. Some common minerals and elements found in groundwater include calcium, magnesium, iron, and manganese.

Humans also have a significant impact on what is in our groundwater. While many people know that a leaking landfill or a chemical spill are sources of contamination, everyday activities such as fertilizing your lawns/crops or salting roads can also contaminate groundwater supplies. Depending on what land-uses are allowed to take place and how careful we are about carrying out these activities ultimately determines whether these chemicals eventually end up in our water.

While the majority of wells in Wisconsin provide a clean and dependable supply of drinking water, there are a number of contaminants found in groundwater that can negatively impact health. Contaminants in drinking water are always a cause for concern. While municipal wells are regularly tested to ensure they meet safe drinking water standards, private wells are not. It is up to the individual homeowner to determine what tests to perform and how often. If water quality problems are detected, the homeowner is not required to treat the water; it is the individual's responsibility to determine what the risks are and whether those risks are great

enough to correct the problem or find an alternative source of drinking water.

While test results may vary locally within the watershed, results from over 50 private well samples submitted by homeowners in the Long Lake Watershed test program indicate very good groundwater quality. The mean pH was 7.7. The mean total hardness was 119 mg/L CaCO3. Hardness less than 150 mg/L $CaCO_3$ is considered to be soft water and may be slightly corrosive to household plumbing. Many participants reported concerns with taste and odor of their water. These concerns are most likely related to naturally high iron and manganese caused by reducing conditions within the aquifer.

Nitrate and chloride can be used to indicate the impact of local land-use on groundwater quality. The mean nitrate-N (NO_3-N) concentration reported was 0.3 mg/L NO_3-N (min. = < 0.1, max = 1.5). *Less than 1 mg/L is generally considered to be natural or background levels of NO_3-N.* The mean chloride level was 3.5 mg/L (min. = 1.0, max. = 24.5). *Less than 10 mg/L is generally considered to be natural or background levels of chloride.*

Only 9% of participants tested positive for coliform bacteria. Coliform bacteria are very common microorganisms found in surface water, soil and in human and animal waste. All wells that supply drinking water should be absent of bacteria including coliform bacteria. Coliform bacteria do not usually cause disease themselves, however; their presence indicates a potential pathway for fecal coliform and other pathogenic (disease-causing) organisms such as *E. coli* to enter the well.

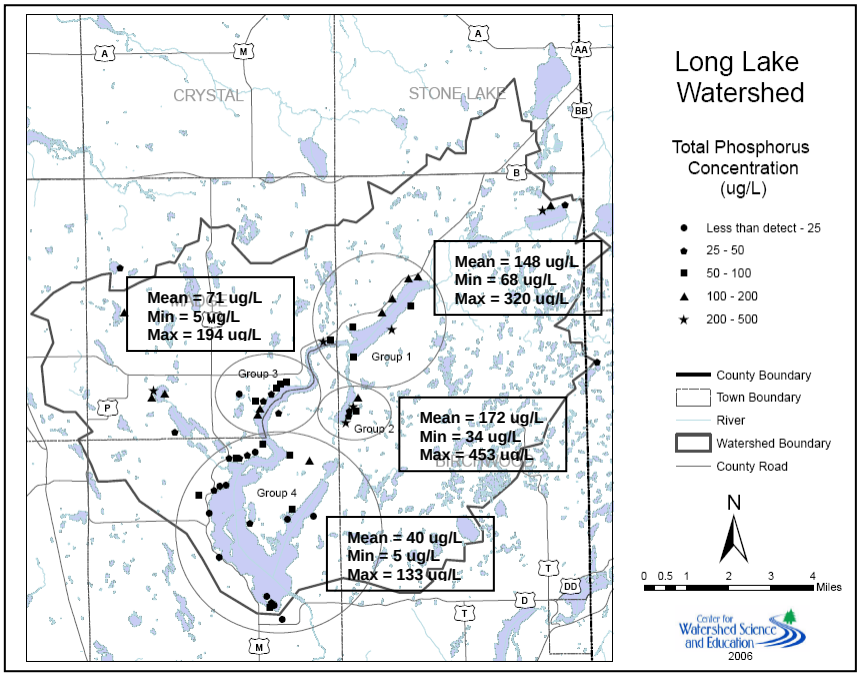

Figure 2. Total phosphorus concentrations from private well testing in the Long Lake Watershed.

Groundwater Surface Water Connection

Because groundwater provides water to surface water such as lakes, people should also be concerned about the effects of groundwater quality on surface water resources. Phosphorus is an essential nutrient for plant growth. Because it is often the limiting nutrient in freshwater aquatic ecosystems, increasing the amount of phosphorus leads to increases in plant productivity and rates of lake eutrophication. Concentrations of total phosphorus exceeding 100 ug/L may represent a threat to surface waters (MPCA, 1999).

Groundwater concentrations of phosphorus are generally low and the phosphorus load from groundwater is often ignored when creating phosphorus budgets for lakes. A past study has shown that elevated levels of phosphorus have been found in areas of Northwestern Wisconsin (Muldoon et al., 1990). Water quality data collected last summer from groundwater discharge features within the Long Lake Watershed also revealed elevated levels of phosphorus and suggest that naturally occurring phosphorus in groundwater may be a source of concern for the Long Lake Watershed (Hudak, 2006).

In conjunction with the well water testing program, the Long Lake Preservation Association also asked homeowners to sample their wells for total phosphorus. The hope is that results from well water tests will help indicate whether groundwater phosphorus may be an important component of phosphorus loading to Long Lake.

Concentrations of total phosphorus sampled through the groundwater testing program did reveal elevated levels of phosphorus in the groundwater (Figure 2). Concentrations of total phosphorus were greatest in the wells sampled in the northern half of the watershed along Mud Lake and the northernmost section of Long Lake. Concentrations in the southern half of the watershed, although lower, were still higher on average than typical groundwater phosphorus in other parts of Wisconsin. This data suggests that groundwater phosphorus likely constitutes a significant portion of the total phosphorus inputs into the lake.

References:

Muldoon, M.A., F.W. Madison, and M.D. Johnson. 1990. Soils, Geologic and Hydrogeologic Influences on Lake Water Qaulity in Northwestern Wisconsin. WGNHS.

Minnesota Pollution Control Agency. 1999. Phosphorus in Minnesota's Groundwater. MPCA.

Hudak, A. 2006. Assessing Lake Productivity in the Long Lake Watershed. UWSP/LLPA.