GROUNDWATER AND ITS ROLE IN COMPREHENSIVE PLANNING

COMPREHENSIVE PLANNING AND GROUNDWATER FACT SHEET 1
WISCONSIN GROUNDWATER COORDINATING COUNCIL
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What is this groundwater? What does it have to do with comprehensive planning? If you're like most people in Wisconsin, you use groundwater for showering, cooking, drinking, watering your lawn, washing your clothes and many other activities that we take for granted. About 75% of us Wisconsinites get our household water from groundwater, either from a private well or a municipal well. Only a small number of communities in Wisconsin, located along Lakes Michigan, Superior or Winnebago, are supplied by surface water.

In addition, groundwater is used heavily by agriculture and industry. It also supplies most of the water in Wisconsin's many lakes, streams and wetlands. Protecting this valuable resource is critical for the long-term health and well being of your community. One of the ways you can do this for your community is through the comprehensive planning process, which is commonly called "Smart Growth." This fact sheet provides some background information on groundwater and discusses its relation to comprehensive planning.

The Hydrologic Cycle

Where does the groundwater that comes out of your tap or your showerhead come from?

As the word implies, groundwater is found underground and is part of the hydrologic or water cycle, kept in motion by solar energy and gravity. (Figure 1)

Groundwater begins as precipitation. Some precipitation (rain or snow) runs off into lakes, streams, rivers and wetlands. Some evaporates back into the atmosphere. Plants take some up. Groundwater is that water that makes it past the plants down into the subsurface soil and rock.

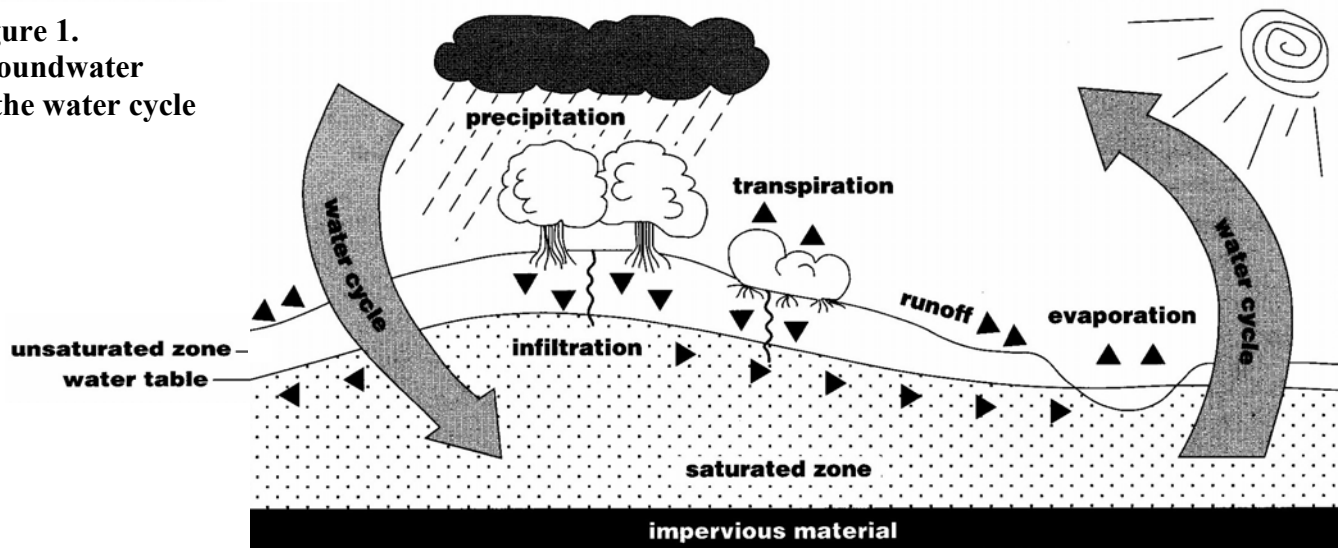
In Wisconsin, an average of 30-32 inches of precipitation fall each year. Six to ten inches of that precipitation seep into the ground to become groundwater recharge. The amount of recharge varies depending upon the topography, soil, vegetation and land use.

Groundwater moves through openings between soil or rock particles or along fractures. A layer of rock or soil that is capable of storing, transmitting and yielding water to wells is called an aquifer.

The water surface below which water fills all the openings in soil and rock is called the water table. Above the water table is the unsaturated zone and below it is the saturated zone.

Groundwater normally migrates from upland areas to lowland areas, eventually discharging in low places where the water table intersects the land surface in lakes, streams and wetlands. Most precipitation that recharges groundwater moves only a few miles from the point of recharge to the point of discharge. Wisconsin's groundwater doesn't come from Canada or Lake Superior, or flow in some mysterious underground stream.

Figure 1. Groundwater in the water cycle



Because groundwater naturally moves to and discharges in lowland areas, it is a significant factor in maintaining flow in our lakes, streams and wetlands. This is especially true in seasons with low precipitation. Streams, and most lakes and wetlands, are fed during the winter and dry periods by groundwater from the uplands surrounding that stream, wetland or lake. This groundwater contribution is called baseflow and is particularly critical for aquatic systems during low flow or drought conditions.

For more information on groundwater and the water cycle, check out the following resources:

- Wisconsin Department of Natural Resources (WDNR), 1999, Groundwater: Protecting Wisconsin's Buried Treasure, WDNR publication PUBL-DG-055-99, 32 p. Available for viewing at: http://www.wnrmag.com/supps/1999/aug99/intro.htm
- WDNR Environmental Education for Kids website: http://dnr.wi.gov/org/caer/ce/eek/earth/groundwater/index.htm
- Portage County groundwater website: http://www.uwsp.edu/water/portage/main/index.htm
- University of Wisconsin – Stevens Point, 1998, What is this groundwater? 12 minute video produced by the College of Natural Resources and available from the Groundwater Model Project, 715-346-4613 or http://www.uwsp.edu/stuorg/awra/h2omodel.html.

Groundwater and Land Use

So what's the connection between groundwater and land use? Why do I need to be concerned about groundwater in planning for my community?

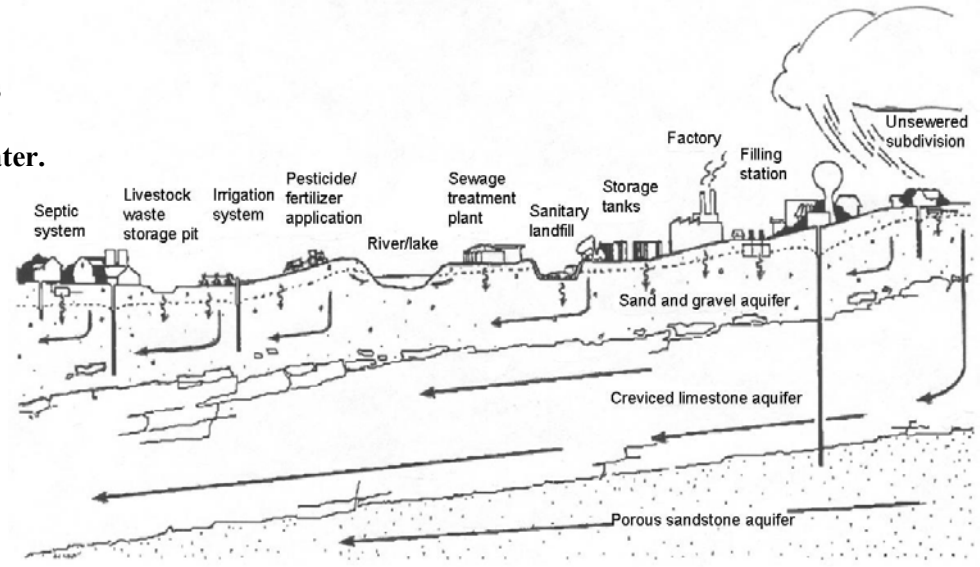
Since groundwater gets into the ground at the land surface, it makes sense that what happens on the land surface can have impact on groundwater (figure 2). In fact, it can affect both groundwater quality and quantity.

A great many land use activities have the potential to impact the natural *quality* of water, as shown in Table 1. A landfill may leach contaminants into the ground that end up contaminating groundwater. Gasoline may leak from an underground storage tank into groundwater. Fertilizers and pesticides can seep into the ground from application on farm fields, golf courses or lawns. Intentional dumping or accidental spills of paint, used motor oil, or other chemicals on the ground can result in contaminated groundwater. The list could go on and on. A fairly comprehensive list of activities that could contaminate groundwater under the right circumstances is on a WDNR contaminant source inventory form (form # 3300-215) available at http://dnr.wi.gov/org/water/dwg/gw/forms/cui.pdf or from the WDNR. For information on potential threats from agricultural activity, visit the Department of Agriculture, Trade and Consumer Protection water quality website at http://datcp.state.wi.us/arm/agriculture/land-water/water-quality/index.html.

Groundwater *quantity* can also be impacted by a number of land uses, particularly as communities grow. As the population grows, there is an increased demand for water to supply new homes, businesses and industries. When wells are installed to withdraw groundwater, the natural groundwater flow is disrupted. A portion of the water that normally would have discharged to a surface water body is pumped out of the ground to be used in a home, factory, or irrigation system. If groundwater is withdrawn from an aquifer by wells faster than it is recharged, then the amount of water in the aquifer is reduced.

There is increasing concern in the Lower Fox River Valley, southeast Wisconsin and Dane County, among other areas, where the water tables in the aquifers are dropping rapidly because of heavy groundwater use resulting from community growth.

Figure 2. Land uses can affect groundwater.



As communities grow, land is paved over for roads, houses, shopping centers and parking lots. These land uses do not allow precipitation to recharge into the subsurface. Instead, the water runs off into lakes, streams and wetlands, picking up contaminants as it goes. The result is three-fold.

- First, there is less recharge to groundwater, thereby reducing the amount of groundwater that can be withdrawn from the aquifer at the same time that demand for water is increasing.
- Second, more runoff during precipitation events means more flooding than was the case before development. That water has to go somewhere. Those living near surface waters may find flooding of their properties that didn't happen before.
- Third, as precipitation runs off the land, it may pick up fertilizers or pesticides from lawns, golf courses or farm fields. It may pick up oil and other waste products from streets. This nonpoint source pollution can seriously degrade the quality of the runoff as it moves toward a stream.

The reductions in baseflow, increased flood flows and nonpoint source pollution may have significant impacts on the flora and fauna that inhabit a stream, lake or wetland. An outstanding trout stream may be adversely affected by a change in streamflow quantity or quality.

For more information on groundwater quality and quantity, check out the following resources:

- WDNR, 1997, Status of Groundwater Quantity in Wisconsin, WDNR publication PUBL-DG-043-97, 53 p.
- WDNR, 1999, Groundwater: Protecting Wisconsin's Buried Treasure, WDNR publication PUBL-DG-055-99, 32 p.
- Wisconsin Groundwater Coordinating Council (GCC), 2004, Wisconsin Groundwater Coordinating Council Report to the Legislature, 148 p.
- Wisconsin GCC, 2002, Residential Development and Groundwater Resources, Comprehensive Planning and Groundwater GCC Fact Sheet 3.

Groundwater and Comprehensive Planning

So how can I minimize the impact of my community on groundwater?

Hopefully, it is apparent that land use decisions can have significant and unanticipated impacts on groundwater and surface water resources. It is appropriate that, in developing a long-term comprehensive plan, you address the groundwater resources of your community and consider the implications of the plan on those resources. Your community will likely deal with groundwater mainly in the agricultural, cultural and natural resources element of your comprehensive plan. However, table 2 illustrates that groundwater fits into each of the nine elements. If your community relies on groundwater, it is important that your community's water supply be protected for the future. By identifying your groundwater resources, you can help your community make wise development decisions that maintain and protect the integrity of your water supply for future generations.

Table 1. Activities that may contaminate groundwater.

<table>
<tr><th>Place of Origin</th><th colspan="4">Potential Pollution Sources</th></tr>
<tr><td></td><td>Municipal</td><td>Industrial</td><td>Agricultural</td><td>Other</td></tr>
<tr><td></td><td colspan="4">Waste-related</td></tr>
<tr><td rowspan="2">At or near the land surface</td><td colspan="2">Sludge and wastewater disposal</td><td>Feedlots

Manure storage and spreading

Whey spreading</td><td>Septage disposal

Junkyards</td></tr>
<tr><td></td><td>Wastewater irrigation & landspreading</td></tr>
<tr><td rowspan="2">Below the land surface</td><td colspan="2">Landfills

Wastewater impoundments</td><td rowspan="2">Manure pits</td><td rowspan="2">Septic systems

Holding tanks</td></tr>
<tr><td>Seepage cells

Sanitary sewers</td><td></td></tr>
<tr><td></td><td colspan="4">Non-waste</td></tr>
<tr><td rowspan="2">At or near the land surface</td><td rowspan="3">Salt piles

Snow piles

Contaminated stormwater infiltration</td><td colspan="2">Above and on the ground storage of chemicals</td><td>Highway deicing salt

Lawn fertilizers

Pesticides</td></tr>
<tr><td>Stockpiles

Spills

Tailing piles</td><td>Irrigation

Fertilizers

Pesticides

Silage</td></tr>
<tr><td>Below the land surface</td><td>Underground tanks

Pipelines</td><td></td><td>Improperly constructed and abandoned wells

Over-pumping (induced pollution)</td></tr>
</table>

For more information on groundwater and comprehensive planning, check out these resources:

- WDNR and University of Wisconsin Extension, 2002, Planning for Natural Resources – A Guide to Including Natural Resources in Local Comprehensive Planning, 83 pages. Available from County Extension offices, the Department of Administration's Office of Land Information Services (608-267-2707) and at the WDNR Land Use website.
- WDNR Land Use website: http://dnr.wi.gov/org/es/science/landuse/ index.htm
- Wisconsin GCC, 2002, Resources to Help You Protect Your Drinking Water Supply, Comprehensive Planning and Groundwater GCC Fact Sheet 2.
- Wisconsin GCC, 2002, Residential Development and Groundwater Resources, Comprehensive Planning and Groundwater GCC Fact Sheet 3.

Table 2. The relationship of groundwater to other elements of comprehensive planning.

Comprehensive planning element	Relationship to groundwater
Issues and Opportunities	Important issues may include • the amount of water needed for future homes, farms and businesses • whether the needed water is available, how it will be provided and at what cost • how growth will affect the future quality and quantity of available groundwater • the need for community wellhead protection planning
Housing	• Additional houses increase the demand for clean water and other services. • Paved areas may reduce the amount of groundwater recharge. • More homes may mean more fertilizer and pesticide use. • The potential for household chemicals or used oil to be dumped on the ground or into septic systems increases. • Decisions must be made on whether new houses will have public sewers or private on-site wastewater disposal systems. (See Fact Sheet 3).
Transportation	New roads needed to serve growing areas may mean: • more runoff of water off impervious surfaces that might have recharged groundwater. • more salt to keep the new streets safe in winter, which may seep into groundwater. • more chemicals leaking from automobiles and entering storm sewers or seeping into the ground.
Utilities and community facilities	• Communities must assess future water needs and the ability of existing systems to meet future needs, including the infrastructure and any environmental limitations to the siting of new wells or reservoirs. See also Economic development below.
Agricultural, natural and cultural resources	• Groundwater provides the majority of the water in many Wisconsin lakes, streams and wetlands. • Pumping municipal, industrial, agricultural or other high-capacity wells may reduce flow to surface water bodies. • Agricultural land use may increase potential for groundwater contamination from fertilizers and pesticides. • Groundwater information is important in assessing the ability of the resource to sustain growth over the long term.
Economic development	• Water demand may increase from new residences and businesses. • Water costs may increase due to pumping from deeper aquifers or adding new wells to the system to meet demand. • New high capacity wells could affect groundwater quantity and sensitive surface water resources. • New businesses may have facilities, operations or land use practices that could cause accidental spills or other groundwater contamination.
Intergovernmental cooperation	• Because groundwater impacts go beyond political boundaries, a coordinated effort is important to avoid potential problems down the road. Working together can maximize the use and protection of the available water resources.
Land use	• Many land uses (agricultural, urban, residential, commercial, industrial) have the potential to impact groundwater quality. • Impermeable areas such as buildings, roads, houses and parking lots prevent precipitation from infiltrating into the subsurface, increasing runoff and potential flooding. • Water and sewer service plans, subdivision plans, and wellhead or source water protection plans are all forms of land use planning that can mitigate groundwater impacts.
Implementation	•As communities develop a schedule to implement the comprehensive plan, communities need to make sure that protection of the groundwater resource is considered. Developing a wellhead protection plan is one way to accomplish this important step. It is important to have information on groundwater resources to make sound planning decisions.

This is one of a series of groundwater fact sheets designed to provide information to assist communities with comprehensive planning. Other fact sheets and more detailed information to assist planners can be found at the Groundwater Coordinating Council (GCC) website, http://dnr.wi.gov/org/water/dwg/gcc/, the WDNR groundwater website, http://dnr.wi.gov/org/water/dwg/gw/, or the WDNR Land Use Team website at http://dnr.wi.gov/org/es/science/landuse/index.htm. To order publications listed in this fact sheet, call 608-266-9265.

Acknowledgements: Illustration, page 1 from Extension publication G3652 Do Deeper Wells Mean Better Water?; page 2,Wisconsin Geological and Natural History Survey (WGNHS) Special Report 11 Groundwater Protection through Local Land-Use Controls; table, page 3, adapted from WGNHS Special Report 9 A Guide to Groundwater Quality Planning and Management for Local Governments

Comprehensive Planning and Groundwater Fact Sheets were produced by GCC subcommittee members Dave Lindorff, WI Department of Natural Resources; Christine Mechenich, Central WI Groundwater Center, and Chuck Warzecha, WI Department of Health and Family Services, July 2002.