Generalized Water-Table Elevation Map of Price County, Wisconsin

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Miscellaneous Map 49

Explanation

- average elevation of water table in feet, solid where considered accurate within ±0.5 mile on the land surface; 20-ft contour interval. Datum is mean sea level.
- surface-water divide
- groundwater divide, approximately located
- general direction of shallow groundwater flow

Geologic materials contributing water to well (All geologic information is taken from Wisconsin Department of Natural Resources well constructor's reports on file at the Wisconsin Geological and Natural History Survey. Materials contributing water to the well are those units that are saturated and penetrated by the open, or screened, part of the well.)

- sand and/or gravel
- shallow bedrock and/or sand and gravel
- deep bedrock

Data have not been field checked. Water-level elevation data were generalized from information collected over a period of approximately 50 years.

Introduction

This map is part of the Price County Groundwater Resource Investigation, a joint project of the Wisconsin Geological and Natural History Survey and the Price County Board of Supervisors. The purpose of this project was to compile and interpret hydrogeologic data for Price County. These data were used to construct a water-table elevation map that depicts, in a general way, the direction of shallow groundwater flow, which is primarily perpendicular to lines of equal water-table elevation. Also shown on this map are geologic materials contributing water to wells. The information on this map can be used by those interested in soil-and-water-resource and land-use planning.

The water cycle

Solar energy and gravity play active roles in a continuous water recycling process called the *water cycle* (fig. 1).

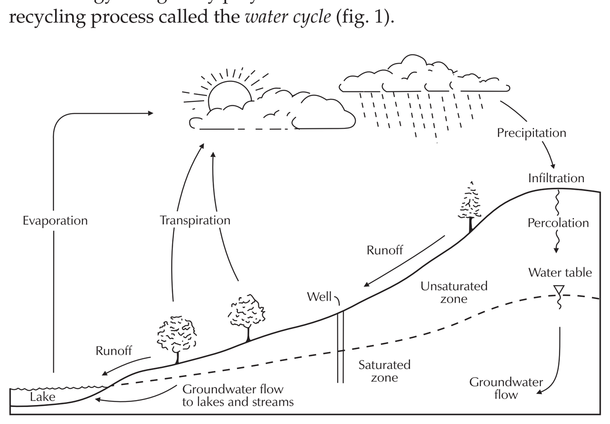

Figure 1. *The water cycle (modified from Dunne and Leopold, 1978).*

Water falling on the land surface can flow downhill as overland runoff, evaporate, transpire through plants, or infiltrate into the ground. As the infiltrating water seeps downward through rock or soil, it travels through pore spaces and open cracks or fractures in the subsurface material. When these pores and cracks are completely filled with water, the material is said to be *saturated*.

The *water table* marks the top of this saturated zone, where hydraulic pressure in the pores is equal to atmospheric pressure. Above the water table, pores and cracks are partly or completely filled with air and partly filled with water, and the material is said to be *unsaturated*. *Groundwater* is the water contained in the saturated zone below the water table. The amount of infiltrating precipitation is one of the factors that determines the position, or elevation, of the water table, which fluctuates seasonally and from one year to another.

Groundwater, under the influence of gravity, moves slowly through pore spaces, eventually discharging to the land surface or to a surface-water body. Solar energy causes some water to evaporate, thus returning it to the atmosphere and continuing the water cycle.

In Price County, the water cycle operates with approximately 33 to 34 inches of precipitation during an average year (Young and Hindall, 1972). About 65 percent (21 to 22 inches) of this total is taken up directly by plants or evaporates from surface-water bodies. These processes are collectively referred to as *evapotranspiration.* The remaining 35 percent either flows over the land surface and collects in surface-water bodies or infiltrates into the ground as *recharge* to the groundwater system. The ratio of overland runoff to groundwater recharge varies considerably around the state, depending upon factors such as topography, the permeability of the unsaturated materials, vegetative cover, rainfall intensity, and individual farming and general land-use practices.

Movement of groundwater and surface water

A saturated subsurface material that yields sufficient water to a well is called an *aquifer*. *Permeability* is a measure of the relative ease with which water can flow through an aquifer; it is dependent on the nature of the material through which the water is flowing. Large pores or fractures can hold more water than small ones, but for water to flow effectively, these pores or fractures must be connected.

Groundwater can move as rapidly as several feet per day in porous sand and sandstone, or as slowly as inches per year in clay or in unfractured granite. Sandy soil and sandstone may have relatively large pore spaces that are well connected with each other, allowing water to move more easily than it can in clayey soil that has small, poorly connected pores. Rocks such as granite have low permeability except where they are fractured. If the fractures are well connected, these rocks can transmit water easily; however, if there are just a few poorly connected fractures, these rocks transmit little water.

No matter how rapidly or slowly the groundwater flows, its natural direction of movement is in response to gravity, from upland recharge areas, where water infiltrates into the subsurface, to lowland discharge areas (lakes, rivers, springs, and seeps), where groundwater emerges again. Many surface-water bodies are groundwater-discharge areas, so groundwater quality has a significant impact on the water quality of lakes, streams, and wetlands. Wells are manmade groundwater-discharge points.

A *surface-water divide* is a line of separation, commonly a ridge or narrow tract of high ground that separates the surface water that flows naturally into one basin from surface water that flows naturally into a different basin. Eastern Price County has one major surface-water divide. Most of the streams and rivers in Price County flow into the Flambeau or Jump Rivers. These rivers empty into the Chippewa River, which empties into the Upper Mississippi River; watersheds along the eastern edge of the county drain southeastward into the upper Wisconsin River system.

A *groundwater divide* is similar to a surface-water divide, in that it is a ridge defined by contours of the water table. Shallow groundwater moves away from the divide toward groundwater-discharge areas. A groundwater divide does not necessarily coincide with a surface-water divide. However, the major groundwater divide in Price County does coincide with the major surface-water divide, as shown on the map.

This map depicts, in a general way, the direction of shallow groundwater flow, which is primarily away from groundwater divides and perpendicular to lines of equal water-table elevation.

Geology of Price County

Price County is characterized by numerous lakes, bogs, and marshes, and is mostly forested. In Price County Precambrian crystalline rock is overlain by till and outwash deposited during the most recent glaciation of the area, between about 25,000 and 12,000 years ago. Most of the upland areas are underlain by reddish-brown sandy till deposited by the southwestern-flowing ice of the Chippewa Lobe. The northeast to southwest orientation of the drainage system in the area is controlled by the elongate uplands that formed beneath the Chippewa Lobe. Many of the lakes, bogs, and wetlands occupy closed depressions formed where buried blocks of glacial ice melted from beneath sandy outwash that was deposited by meltwater streams flowing from the Chippewa Lobe.

Contamination of groundwater

Because groundwater originates from precipitation that percolates down from the land surface, any water-soluble material or liquid that is put on or in the ground has the potential to be transported to the saturated zone. The unsaturated zone can serve as a natural filter and may remove many harmful materials from the recharging water by a variety of physical, chemical, and biological processes referred to as *attenuation.* In general, thick sequences of fine-grained materials are better able to attenuate contaminants; as a result, areas that have thin or sandy soils over bedrock or thin or sandy soils with a shallow depth to groundwater are especially susceptible to groundwater contamination. Once a contaminant reaches the saturated zone, it has the potential to move with the groundwater and discharge to wells or surface-water bodies. Concentrations of contaminants in the saturated zone can be reduced by the processes of dilution, adsorption onto fine-grained particles, and chemical or biological breakdown.

Contamination that occurs today may not become evident for several or even hundreds of years because groundwater can move as slowly as a few inches per year. Once contaminated, groundwater is difficult to clean and may take many years, decades, or centuries to be cleaned.

Data compilation and interpretation

Data were compiled by Peter Roffers and K.J. Cates at a scale of 1:24,000, using U.S. Geological Survey quadrangles (7.5-minute series, topographic) as base maps. Locations of all available Wisconsin Geological and Natural History Survey geologic logs were plotted onto these maps. In addition, Wisconsin Department of Natural Resources well constructor's reports were examined and information from reports that contained the most reliable, representative and useful data available for each section was also plotted. A total of 830 well data points was used in constructing the water-table map.

Domestic wells, as represented by information on well constructor's reports, are not ideal measuring points for determining water-table elevation because they provide measurements taken at different times of the year and in different years. Because of the seasonal variations in water levels as well as changes in water levels with depth, a water level determined from a well constructor's report was not used as an exact data point. Instead, the water level was considered to be part of a range of values.

Because Price County is characterized by numerous rivers, streams, lakes, bogs, and marshes, the elevations of these surface-water discharge points were also used as data points. A total of 3,721 surface-water points was used in constructing the water-table map. Data density across Price County averages 3.5 data points (well-data points and surface-water points) per square mile. At the scale of this water-table map (1:100,000), the shallow groundwater system appears to be a single unconfined aquifer. In this county the water table closely mimics topography.

Most wells in Price County are completed in the sand and/or gravel aquifer (91%). The remaining wells (9%) are completed in the bedrock aquifer—most of these wells are drilled deep (50 to 100 feet) into the aquifer (7%); the remaining wells are drilled less than 10 feet into the bedrock (2%). In these shallow wells, the sand and gravel aquifer directly overlying the bedrock probably supplies most of the water; the bedrock borehole provides an open interval without need of a well screen.

Limitations of the map

It was beyond the resources of this study to field-check the locations and water levels given on the Wisconsin Department of Natural Resources well constructor's reports that were used to construct this map. This map is a summary of available water-level data for Price County. The accuracy of the interpretation varies throughout the county, increasing with greater data density. The water-table elevation lines represent a degree of confidence within ±0.5 mile on the map. It is intended for use at the published scale of 1:100,000 and should *not* be considered definitive for site-specific applications.

References

Dunne, T., and Leopold, L.B., 1978, *Water in Environmental Planning:* W.H. Freeman and Company, San Francisco, 818 p.

Young, H.L., and Hindall, S.M., 1972, Water Resources of Wisconsin: Chippewa River Basin: United States Geological Survey, Hydrologic Investigations, Atlas HA-386 (4 plates).

Sources of data

U.S. Geological Survey quadrangles (7.5-minute series, topographic; 1972–74) were used to determine surface- and well-water elevations.

Wisconsin Department of Natural Resources well constructor's reports (1936–87).

Wisconsin Geological and Natural History Survey published and unpublished geologic logs (1896–1988).

This map is an interpretation of the data available at the time of preparation. Every reasonable effort has been made to ensure that this interpretation conforms to sound scientific and cartographic principles; however, the map should not be used to guide site-specific decisions without verification. Proper use of the map is the sole responsibility of the user.

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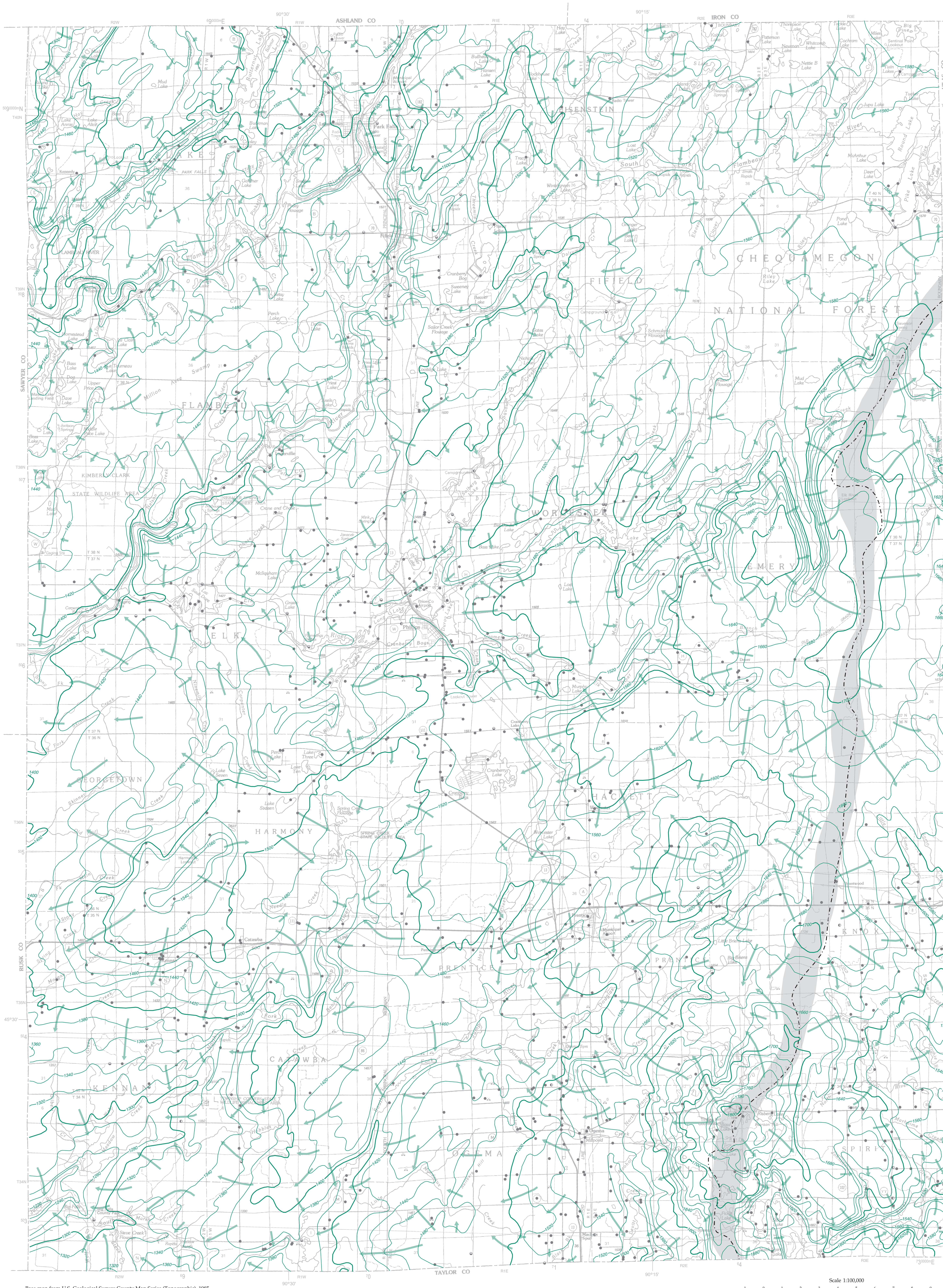

Base map from U.S. Geological Survey County Map Series (Topographic), 1985.

Scale 1:100,000

1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

1 0 1 2 3 4 5 MILES