2021

To accompany atlas Report and Plate 5.







For detailed descriptions of the units, see the report "Geology and physical hydrology" section and Figure 6 "Bedrock stratigraphy, hydrostratigraphy, and distribution of karst features."

## Northern cross sections: A–A' and B–B'

The landscape is deeply dissected by the Whitewater River valley and smaller tributary valleys. The first bedrock units are primarily the Shakopee (Ops) and Oneota (Opo) formations of the Prairie du Chien Group and are prone to karst feature development. The Oneota is not as protective in this area of the county as it is elsewhere, as suggested by Jordan ( $\mathfrak{C}_j$ ) aquifer samples with mixed tritium and elevated chloride and nitrate.

Where deeply buried, the St. Lawrence aquitard (Csl) limits mixing of recent water with older vintage water. Below the St. Lawrence the carbon-14 age of groundwater ranges from 6,000 years on the western side (near the Whitewater River) to 1,000 years in the east (near CSAH 25). Within valleys the St. Lawrence's protective characteristics are diminished and springs show evidence of groundwater mixing. Local groundwater movement is vertically downward and toward streams and tributaries. Regional groundwater movement is east, where groundwater discharges to the Mississippi River.

## Central cross sections: C–C', D–D', and E–E'

The western county landscape is a relatively flat plateau. Deeply dissected valleys progressively increase from the central portions to the east. First bedrock units are primarily the Shakopee and Oneota formations of the Prairie du Chien Group, which are prone to karst feature development. Sinkholes are common in the western and central portions.

In the western and central portions of cross sections C–C' and D–D', the Oneota lacks the characteristics of an aquitard as indicated by mixed tritium and elevated chloride and nitrate in the Jordan aquifer.

In the western portions of cross sections E–E', the Oneota is more deeply buried and has characteristics of an aquitard, indicated by the carbon-14 age of 2,000 years for a Jordan–St. Lawrence well (near ISTH 90).

Where deeply buried, the St. Lawrence aquitard limits mixing of recent water with older vintage water. Below the St. Lawrence the carbon-14 age of groundwater ranges from 5,500 (E–E', near CSAH 19), to 13,000 (C–C', near Skyline Drive) years. Within valley settings, the St. Lawrence's protective characteristics are diminished and springs show evidence of groundwater mixing. Local groundwater movement is vertically downward and toward streams and tributaries. Regional groundwater movement is east, where groundwater discharge occurs to the Mississippi River.

## Southern cross sections: F–F' and G–G'

The western portions of cross sections F–F' and G–G' are relatively flat plateaus where the Oneota varies in its hydrologic properties. On cross section F–F', a Jordan aquifer sample east of CR-111 shows mixed tritium with elevated chloride and nitrate, suggesting the Oneota lacks protective characteristics in the area. However, on cross section G–G' the unit behaves as an aquitard as indicated by vintage tritium and a carbon-14 age of 2,500 years near Money Creek.

The central and eastern portions of these cross sections are deeply dissected by tributaries to the Root River. First bedrock units are primarily the Shakopee and Oneota formations of the Prairie du Chien Group, which are prone to karst feature development.

Where deeply buried, the St. Lawrence aquitard limits mixing of recent water with older vintage water. However, in the east its protective characteristics are diminished. Samples from the Lone Rock (Ctc) and Wonewoc (Cw) aquifers show mixed tritium and elevated chloride nitrate. Springs also show evidence of groundwater mixing. Local groundwater movement is vertically downward and toward streams and tributaries. Regional groundwater movement is east, where groundwater discharges to the Mississippi River. Groundwater from the Mt. Simon aquifer in extreme southeastern Winona County had a carbon-14 age of 20,000 years (G–G', near USTH 61).



#### **Cross Section Explanation**

#### Bedrock aquifers and aquitards

Interpreted tritium age is indicated by pattern color. See Figure 6 in the report for geologic unit correlation.

- Unconsolidated
- Cummingsville
- Od Decorah Shale\*
- Opg Platteville and Glenwood formations\*
- Os St. Peter
- Ops Shakopee
- Оро Oneota Dolomite\*
- 🕄 Jordan
- €sl St. Lawrence Formation\*
- Ctc Upper Lone Rock
- Etc lower Lower Lone Rock Formation\*
- Cw Wonewoc
- €e Eau Claire Formation\*
- Cm Mt. Simon
- \*aquitard

- Tritium age
  - Darker color in small vertical rectangle (well screen symbol) indicates tritium age of water sampled in well. Lighter color indicates interpreted age of water in aquifer.
  - Recent: water entered the ground since about 1953 ĺ ĺ (8 to 15 tritium units [TU]).
  - Mixed: water is a mixture of recent and vintage waters (greater than 1 TU to less than 8 TU).
  - Vintage: water entered the ground before 1953 (less than or equal to 1 TU).
  - Well not sampled for tritium.

### Symbols and labels

- Spring (symbol color indicates tritium age of water sample)
- 26.9 Chloride: if shown, concentration is  $\geq$ 5 ppm. (\* naturally elevated)
- **1.62** Arsenic: if shown, concentration is  $\geq 1$  ppb.
- **3.53** Nitrate: if shown, concentration is  $\geq 1$  ppm.
- 6000 Carbon-14 (<sup>14</sup>C): if shown, estimated groundwater residence time in years.
- General groundwater flow direction



This map was compiled and generated in a geographic information system. Digital data products are available on the DNR Groundwater Atlas Program page (mndnr.gov/groundwatermapping).

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Base modified from Minnesota Geological Survey, Geologic Atlas of Winona County, 2014.

Universal Transverse Mercator projection, zone 15N, North American Datum of 1983. North American Vertical Datum of 1988.

# DEPARTMENT OF NATURAL RESOURCES

500 Lafayette Road St. Paul, MN 55155-4025 888-646-6367 or 651-296-6157 mndnr.gov

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