

2019

To accompany atlas Report and Plate 7 and Plate 8.

Southern cross sections
I-I', J-J', K-K', L-L', and M-M'

Explanation of H-H' is on Plate 8.
See Report Figure 4 for associated geologic units.

This group of cross sections is characterized by a thin layer of surficial sand and sandy till (approximately 50 to 100 feet thick), shallow bedrock aquifers with likely karst-type porosity and permeability, a deep buried bedrock valley (200 to 250 feet), and faulted bedrock in the east. All of these factors contribute to deep penetration of recent and mixed tritium-age water that can range as deep as 600 feet with the combined effects of deep fractured bedrock from the buried bedrock valleys and lateral groundwater flow.

The location of the main buried bedrock valley relative to the groundwater divide is a major control of the direction of mixed tritium-age groundwater flow in the Jordan (Cj) and Upper Tunnel City (Ctc) aquifers. On cross section I-I', the buried valley lines up approximately with the groundwater divide in the Jordan aquifer. Mixed tritium-age water was found on both sides of the buried valley. A similar tritium distribution is shown on J-J'. Two carbon-14 age dates in the Jordan aquifer are shown on the western and eastern portions with values of 2,500 and 1,800 years respectively, values typical of the Jordan aquifer in the southern part of the county.

The eastern portion of I-I' contains an unusual layering of residence time. Vintage tritium-age water is found above mixed tritium-age water in the Jordan aquifer. Pumping from the Upper Tunnel City and a naturally downward gradient may be drawing mixed tritium-age water deeper than would be expected. Another notable feature is the evaporative signature from a shallow well downgradient from Lake Elmo, signifying lake discharge to groundwater.

On the eastern side of cross sections K-K' and L-L', all the bedrock aquifers were displaced upward by a horst structure, as much as 200 to 300 feet compared to areas west of the horst.

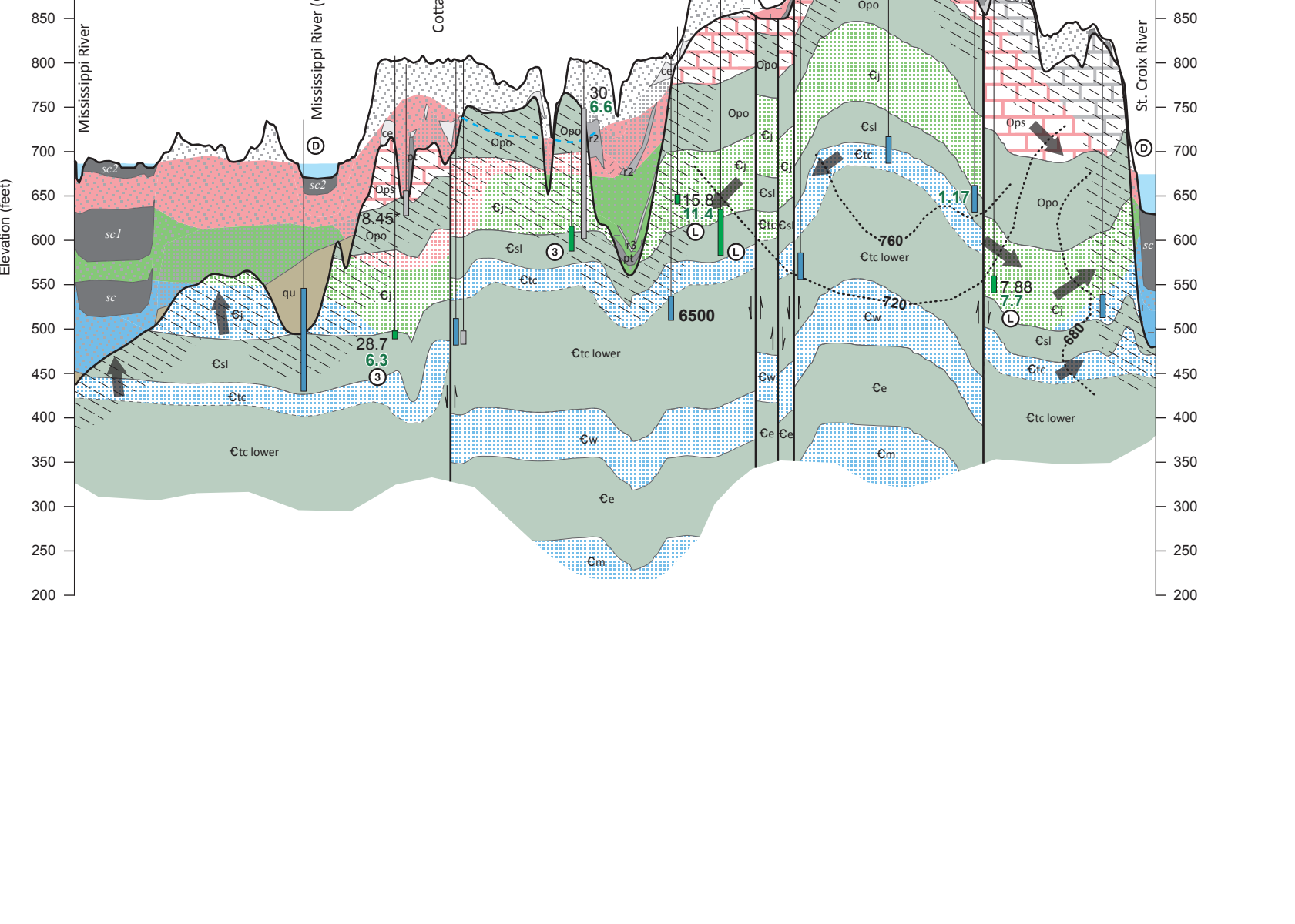
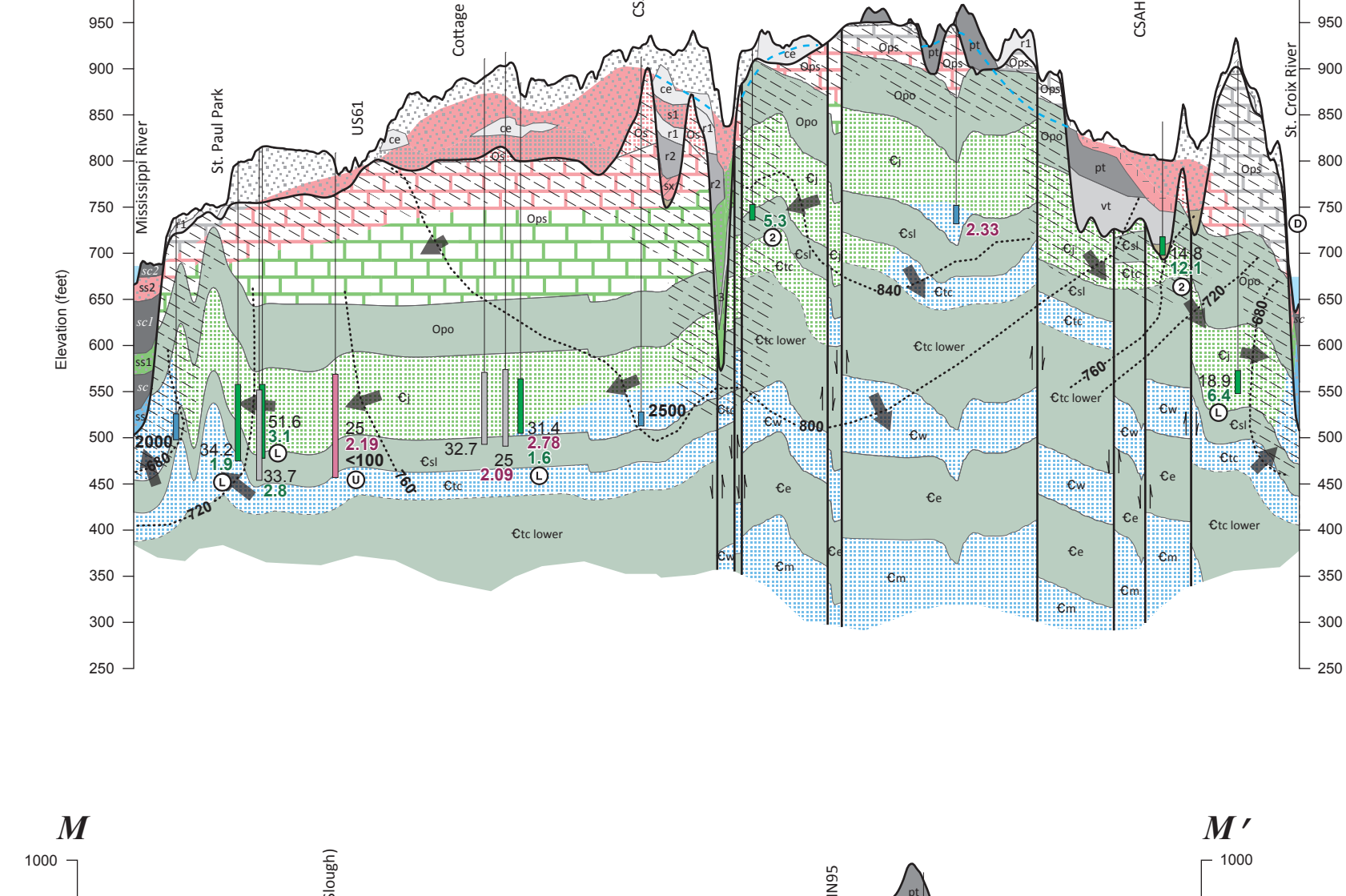
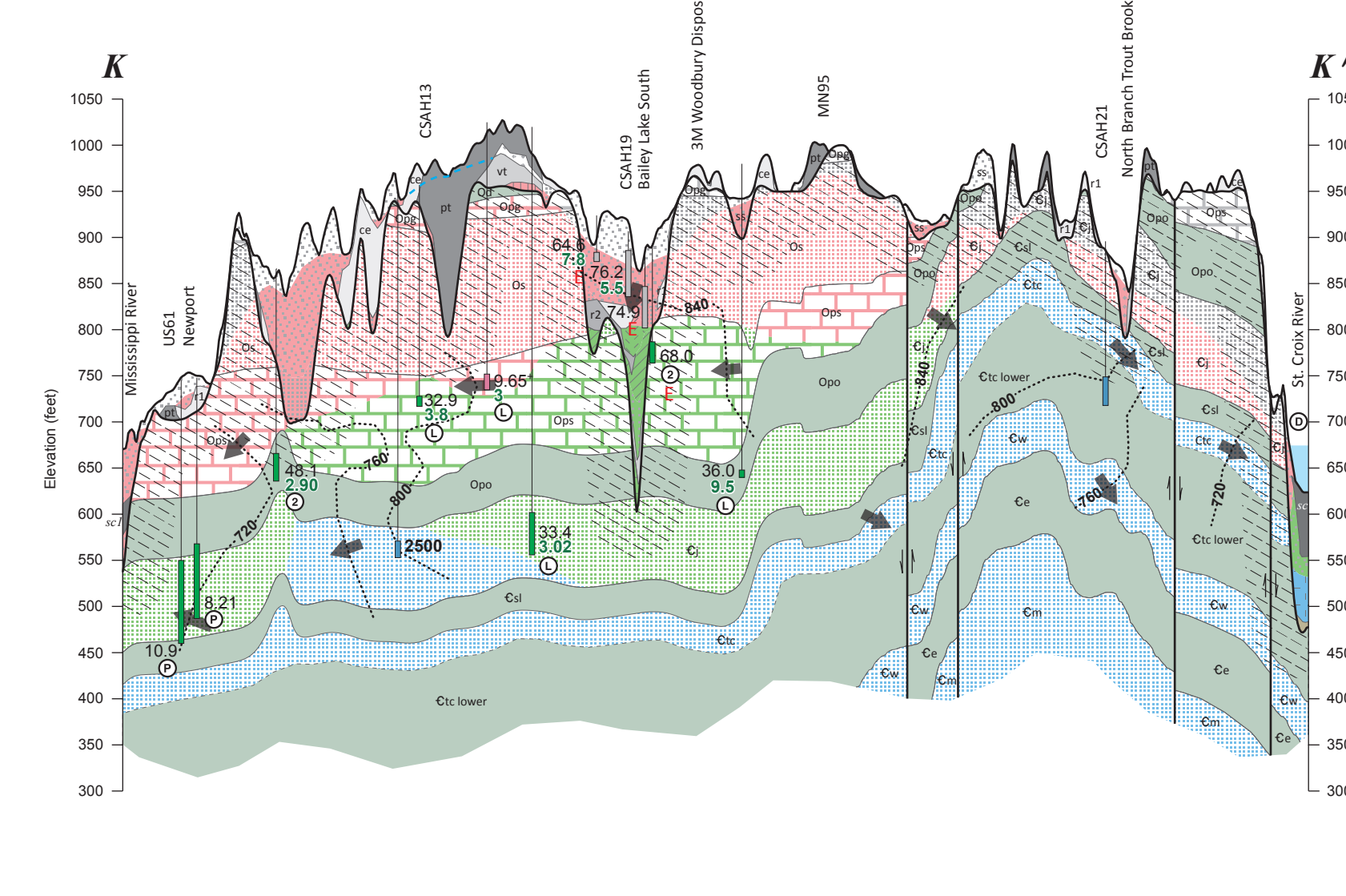
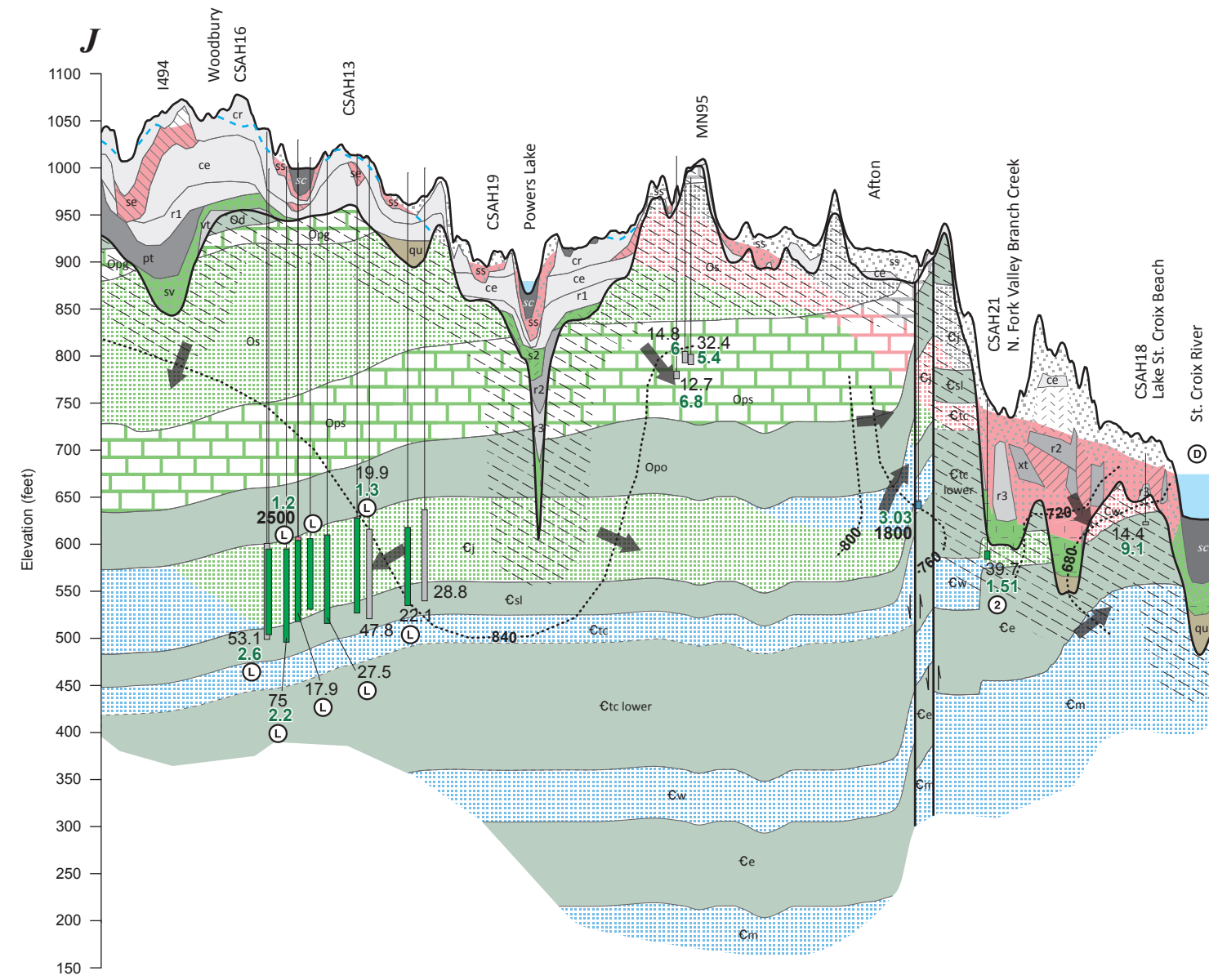
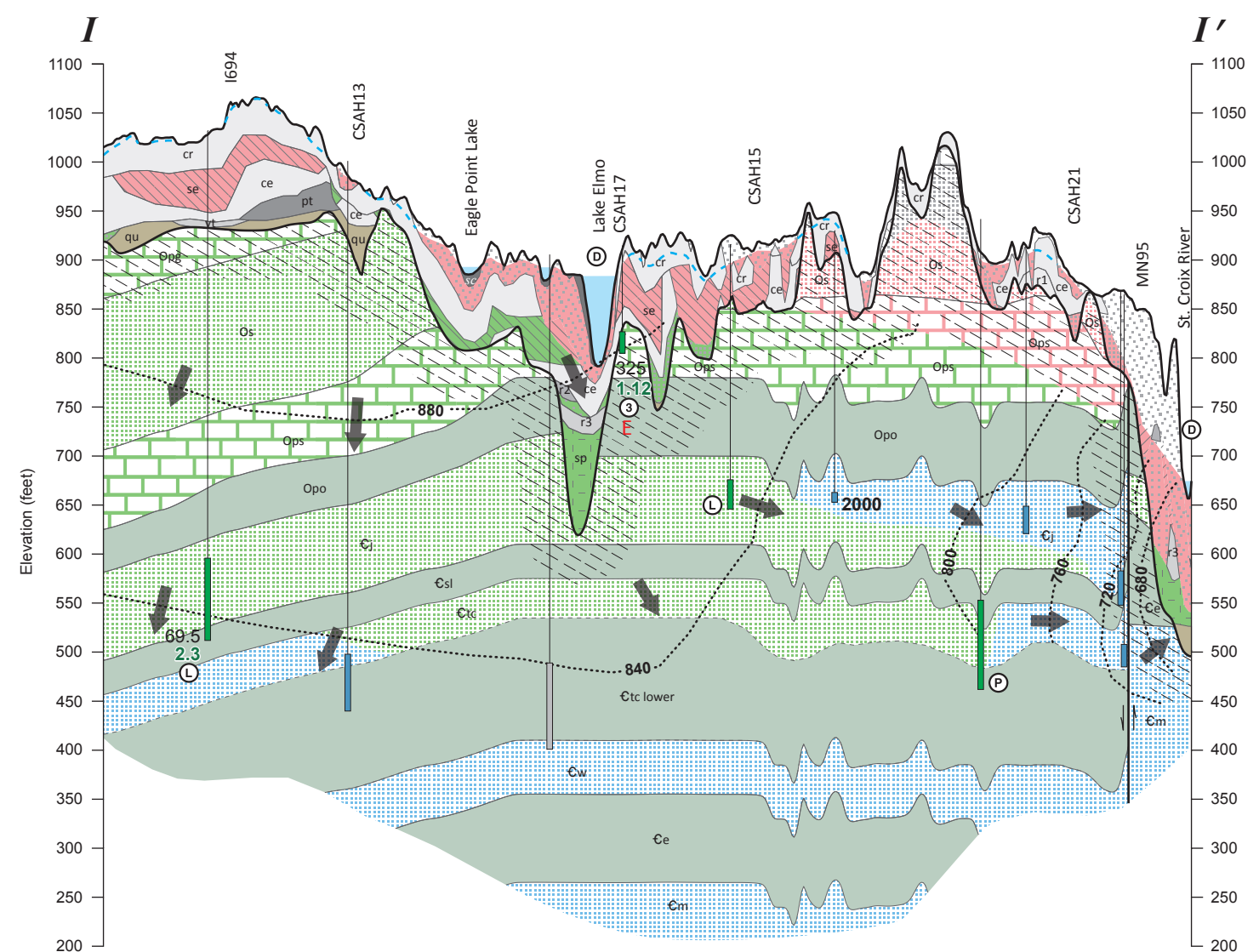
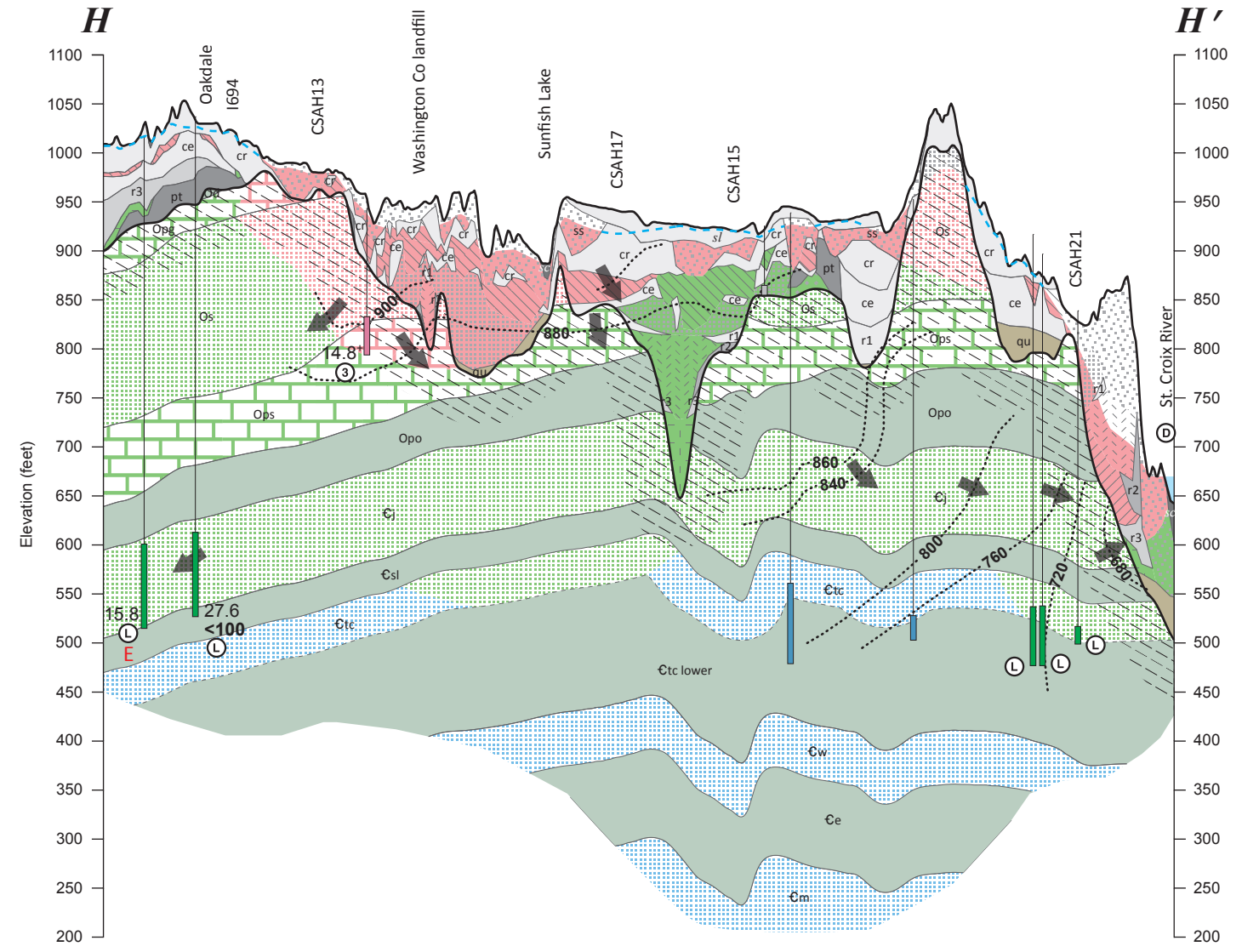
On K-K', recent and mixed tritium-age water was interpreted in the shallow Platteville (Opg), St. Peter (Os), and Prairie du Chien aquifers (Ops and Opo). Evaporative signature water was found south of Bailey Lake in the Prairie du Chien aquifer (Opo) and overlying surficial aquifers. Just west of CSAH 13 for approximately 1.5 miles the Jordan aquifer apparently has some protection from the deep (unfractured) condition of the Oneota (Opo) as indicated by the vintage tritium-age water. Otherwise, the Jordan aquifer appears to get recharge water of mixed tritium age from the buried bedrock valley at CSAH 19 and a shallower bedrock valley farther to the west (east of Newport).

Farther west on K-K' two Jordan aquifer groundwater samples contain mixed tritium-age water where it might be expected to contain vintage tritium-age water from upwelling of older water to the Mississippi River. These locations could be evidence of pumping effects drawing mixed tritium-age water deeper than would otherwise be expected.

On the western portion of L-L' similar residence time conditions appear to exist within the St. Peter and Prairie du Chien aquifers (Ops), which are completely filled with recent and mixed tritium-age water. Portions of the Jordan aquifer containing mixed tritium-age water were sourced from the buried valley east of CSAH 19. A sample collected west of US 61 had recent tritium age and a carbon-14 residence time of less than 100 years. These values seem anomalous in an otherwise mixed tritium setting and may be influenced by high-capacity pumping or a leaky well casing.

Further west on L-L' (between St. Paul Park and the Mississippi River) a Jordan well contained vintage tritium-age water possibly from upwelling of older water to the Mississippi River. The carbon-14 values of 2,000 and 2,500 years were typical of the Jordan aquifer in the southern part of the county.

On cross section M-M' almost the entire Jordan aquifer is within 200 feet of the surface and probably contains recent and mixed tritium-age water. The exceptions are the far western and eastern portions that contain vintage tritium-age water due to the upwelling of older water discharging to the Mississippi and St. Croix rivers. At four locations, vintage tritium-age samples from the Upper Tunnel City aquifer (Ctc) appear protected by the St. Lawrence aquitard (Csl). These locations include a site in Cottage Grove and three sites east of MN 95. West of US 61 an Upper Tunnel City groundwater sample had an estimated carbon-14 age of 6,500 years. Two sites in the Jordan with mixed tritium-age water are near and downgradient of faults that may have enhanced downward flow in these areas. These locations include a site just east of US 61 and a site west of CSAH 21.



Cross Section Explanation

Aquifers and aquitards
Interpreted tritium age is indicated by background color.

Quaternary unconsolidated
See Figure 4 in the report for geologic unit correlation.

Bedrock
Decorah Shale*
Platteville and Glenwood formations
St. Peter
Shakopee
Oneota Dolomite*
Jordan
St. Lawrence Formation*
Upper Tunnel City
Lower Tunnel City*
Wonewoc
Eau Claire Formation*
Mt. Simon
*aquitard

Quaternary aquitards
Grouped by texture ranging from highest to lowest sand content indicating relative hydraulic conductivity.

Geologic unit code

Geologic unit code	Percent sand
ce, cr, r1, sl	>60%
r3, vt	>50% and ≤60%
r2, xt	>40% and ≤50%
pt	>30% and ≤40%

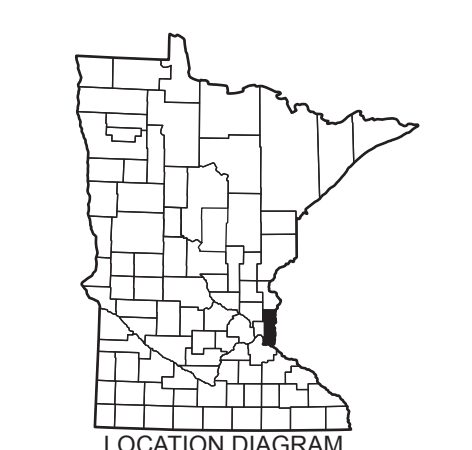
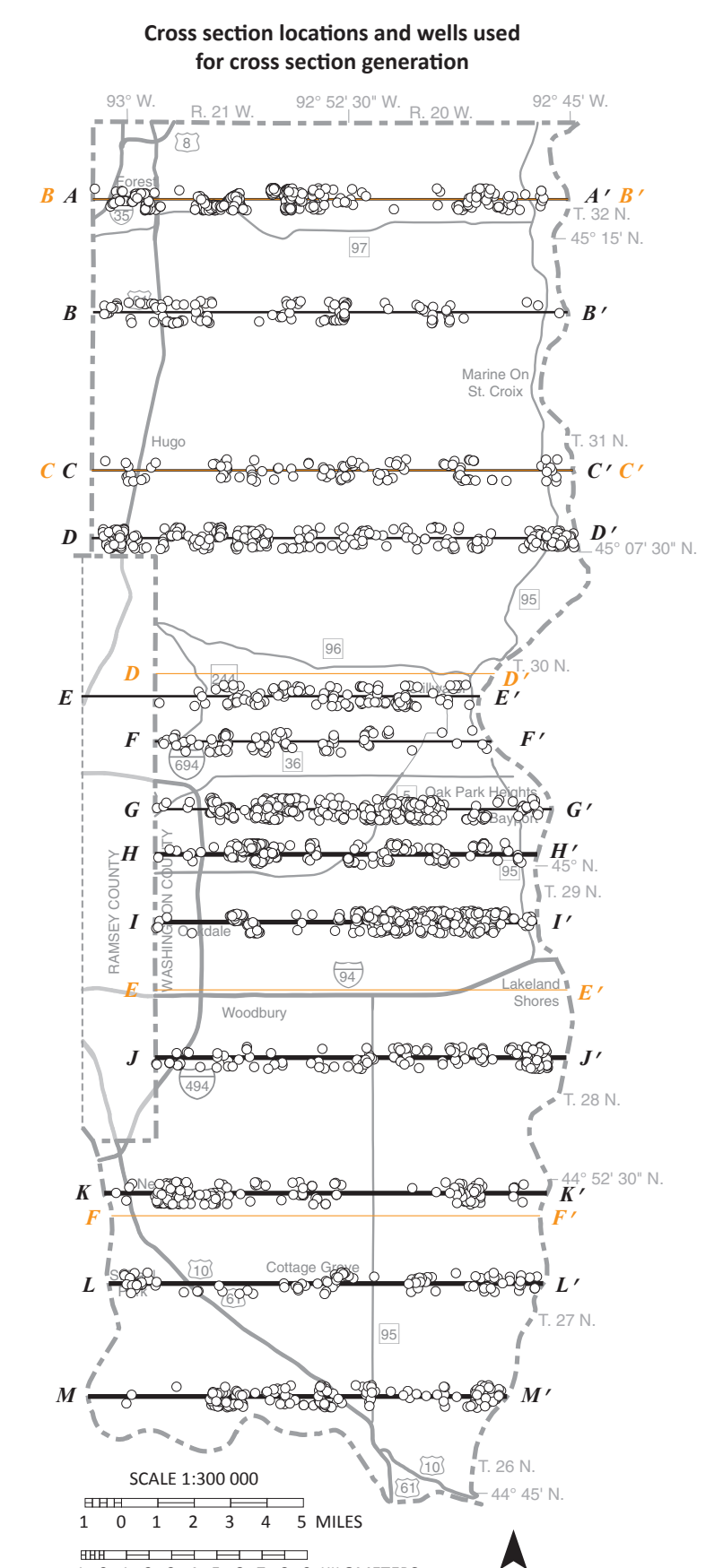
Tritium age
Darker color in small vertical rectangle (well screen symbol) indicates tritium age of water sampled in well. Lighter color indicates interpreted age of water in aquifer.

Symbols and labels

- 32.4 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, * source unknown)
- 2.19 Arsenic: if shown, concentration is ≥2 ppb.
- 6.8 Nitrate: if shown, concentration is ≥1 ppm.
- 2500 Carbon-14 (¹⁴C): estimated groundwater residence time in years.
- E Groundwater sample with evaporative signature
- General groundwater flow direction
- Approximate equipotential contour; contour intervals 20 and 40 feet
- Geologic contact
- Approximate geologic contact
- Land or bedrock surface
- Water table
- Direction of fault movement, arrows indicate relative movement
- Enhanced-permeability zone (see Report page 9)

Groundwater conditions

- Groundwater moves from an overlying surficial aquifer to a buried aquifer.
- Groundwater moves from an overlying buried aquifer to an underlying buried aquifer.
- Groundwater flows laterally.
- Tritium concentrations may be artificially elevated by high capacity pumping.
- Groundwater discharges to a surface-water body.



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

This map was prepared from publicly available information. Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based. However, the DNR does not warrant the accuracy, completeness, or any implied uses of these data. Users may wish to verify critical information; sources include both the references in the report and information on file in the offices of the Minnesota Geological Survey and the DNR. Every effort has been made to ensure the interpretation shown conforms to sound geologic and cartographic principles. This map should not be used to establish legal title, boundaries, or locations of improvements.

Base modified from Minnesota Geological Survey, Washington County Geologic Atlas, Part A, 2016.

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

mn DEPARTMENT OF NATURAL RESOURCES

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

The Minnesota DNR prohibits discrimination in its programs and services based on race, color, creed, religion, national origin, sex, marital or familial status, disability, public assistance status, age, sexual orientation, and local human rights commission activity. Individuals with a disability who need a reasonable accommodation to access or participate in DNR programs and services please contact the DNR ADA Title II Coordinator at info.dnr@state.mn.us, 651-296-6157 (voice) or call using your preferred Telecommunications Relay Provider. Discrimination inquiries should be sent to Minnesota DNR, 500 Lafayette Road, St. Paul, MN 55155-4049.

This information is available in alternative format on request.
© 2019, State of Minnesota, Department of Natural Resources and the Regents of the University of Minnesota

Carbon-14 (¹⁴C): estimated groundwater residence time in years

Sampled well and aquifer symbols

- Prairie du Chien
- Jordan, Jordan-St. Lawrence
- Tunnel City
- Wonewoc-Eau Claire
- Eau Claire
- Wonewoc-Mt. Simon, Mt. Simon, Mt. Simon-Hinckley

Symbols and labels

- 6500 Carbon-14 (¹⁴C): estimated groundwater residence time in years.
- B-B' Line of cross section (Part B)