DISTRIBUTION OF THE SURFICIAL AND BURIED SAND AQUIFERS

By

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2010

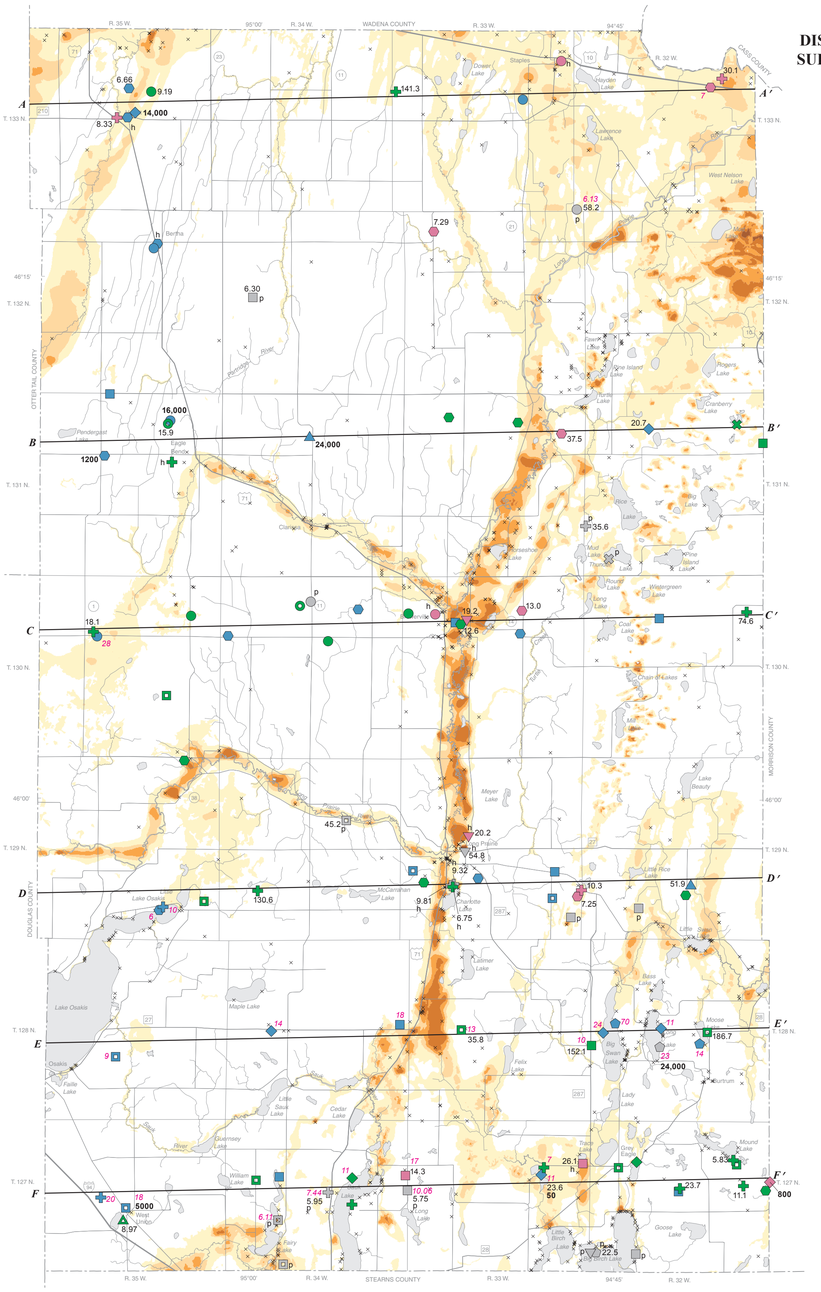
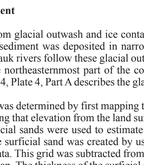


FIGURE 2. ***Surficial sand aquifer thickness and chemistry data from all aquifers.*** *The thickness of the surficial sand deposits, in which the surficial sand aquifer occurs, ranges from a few feet to 100 feet, but 80 percent of these deposits are less than about 30 feet thick. The surficial sand aquifer is the saturated portion of the surficial sand deposits below the water table; in some areas the saturated thickness of the aquifer may be too thin to yield an adequate or reliable supply to a well. The location of all wells that were sampled for general chemistry and isotope analysis for this project are shown for convenience.*



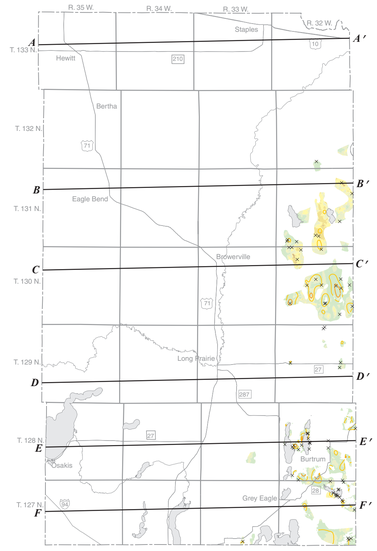


FIGURE 3. *Extent, distribution, depth, and thickness of the C1 buried sand aquifer.*

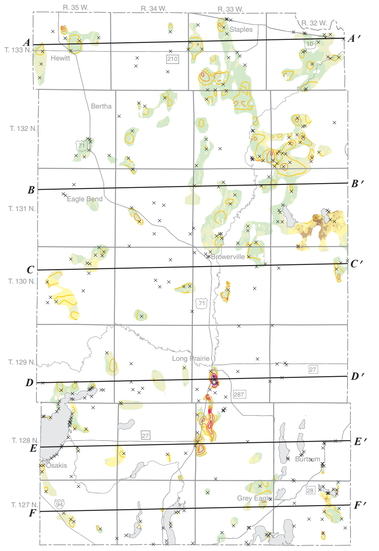


FIGURE 4. *Extent, distribution, depth, and thickness of the H1 buried sand aquifer.*

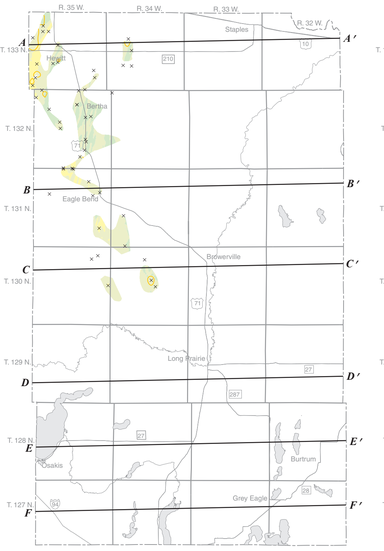


FIGURE 5. *Extent, distribution, depth, and thickness of the B3 buried sand aquifer.*

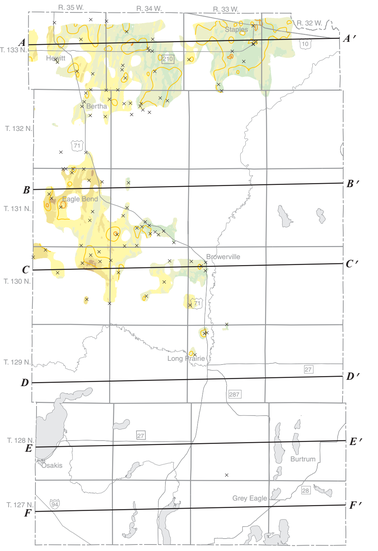


FIGURE 6. *Extent, distribution, depth, and thickness of the B2 buried sand aquifer.*

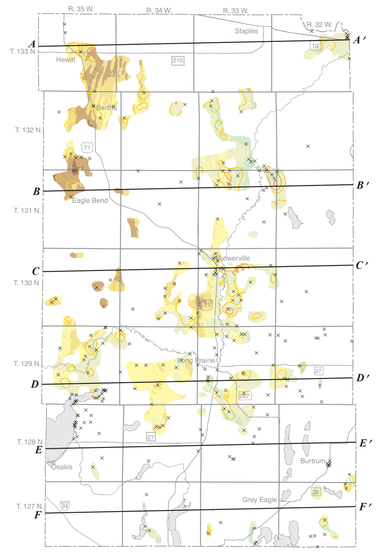


FIGURE 7. *Extent, distribution, depth, and thickness of the B1 buried sand aquifer.*

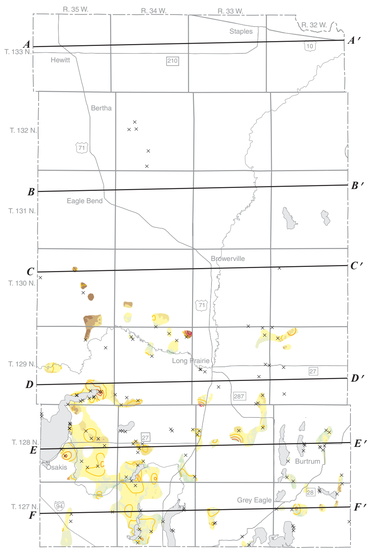


FIGURE 8. *Extent, distribution, depth, and thickness of the X3 buried sand aquifer.*

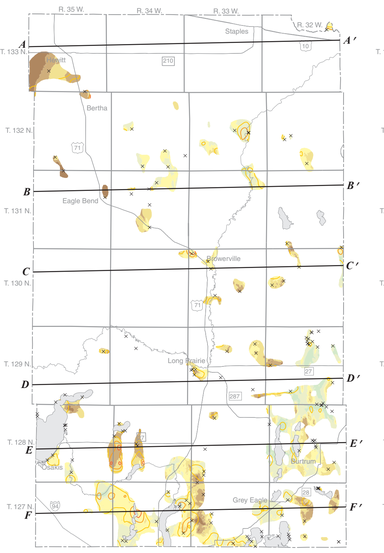


FIGURE 9. *Extent, distribution, depth, and thickness of the X2 buried sand aquifer.*

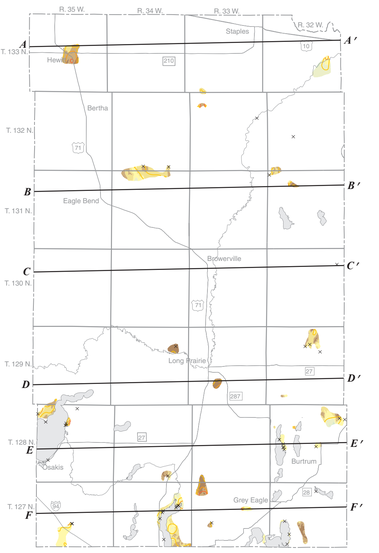


FIGURE 10. *Extent, distribution, depth, and thickness of the X1 buried sand aquifer.*

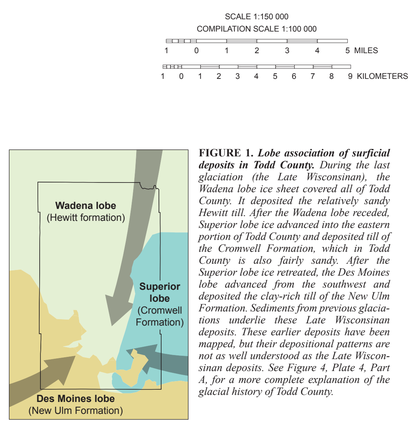


FIGURE 1. ***Lobe association of surficial deposits in Todd County.*** *During the last glaciation (the Late Wisconsinan), the Wadena lobe ice sheet covered all of Todd County. It deposited the relatively sandy Hewitt till. After the Wadena lobe receded, Superior lobe ice advanced into the eastern portion of Todd County and deposited till of the Cromwell Formation, which in Todd County is also fairly sandy. After the Superior lobe ice retreated, the Des Moines lobe advanced from the southwest and deposited the clay-rich till of the New Ulm Formation. Sediments from previous glaciations underlie these Late Wisconsinan deposits. These earlier deposits have been mapped, but their depositional patterns are not as well understood as the Late Wisconsinan deposits. See Figure 4, Plate 4, Part A, for a more complete explanation of the glacial history of Todd County.*

MAP EXPLANATION

SCALE 1:150 000
COMPILATION SCALE 1:100 000
1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 8 9 KILOMETERS

Well and aquifer symbols

- Surficial sand aquifer.
- N1 buried sand aquifer.
- C1 buried sand aquifer.
- H1 buried sand aquifer.
- B3 buried sand aquifer.
- B2 buried sand aquifer.
- B1 buried sand aquifer.
- X3 buried sand aquifer.
- X2 buried sand aquifer.
- X1 buried sand aquifer.
- Older Quaternary aquifers.
- Bedrock aquifers.

Estimated surficial sand aquifer thickness (feet)

- Surficial sand aquifer not present or no data available
- 0–25
- 25–50
- 50–75
- 75–100
- Greater than 100

Tritium age

Color indicates tritium age of water sampled in well.

- Recent—Water entered the ground since about 1953 (10 or more tritium units [TU]).
- Mixed—Water is a mixture of recent and vintage waters (greater than 1 TU to less than 10 TU).
- Vintage—Water entered the ground before 1953 (less than or equal to 1 TU).
- Well not sampled for tritium.

Symbols and labels

- 5.25 If shown, arsenic concentration equals or exceeds 5 parts per billion.
- 14.5 If shown, chloride concentration equals or exceeds 5 parts per million.
- 2000 If shown, groundwater age in years, estimated by carbon-14 (^{14}C) isotope analysis.
- h If shown, well sample chemistry obtained from Minnesota Department of Health database.
- p If shown, well sample chemistry obtained from Minnesota Pollution Control Agency database.
- × Selected well log used to map extent of aquifer.
- F F′ Line of cross section.
- Body of water.

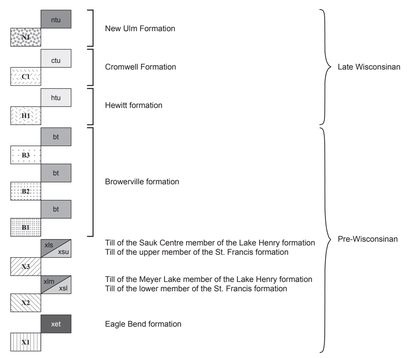


FIGURE 11. ***Correlation of Quaternary buried sand aquifers and till units in Todd County.*** *The till units as mapped in Plate 4, Part A are shown in this figure in shades of gray that indicate relative hydraulic conductivity. The buried sand aquifers, mapped on this plate and corresponding to the geologic units described on Plate 5, Part A, are shown in this figure as patterns and labeled in capital letters. The N1 buried sand aquifer is limited to a small area in southern Todd County and is not shown on this plate. All of the buried sand aquifers are arbitrarily correlated with the overlying till unit as was established on Plate 5, Part A.*

MAP EXPLANATION for Figures 3–10

Depth to aquifer (feet)

- 0–40
- 40–80
- 80–120
- 120–160
- 160–200
- Greater than 200

Aquifer thickness contours (feet)

- 20
- 40
- 60
- 80
- 100
- 120
- 140

SCALE 1:350 000
1 0 1 2 3 4 5 6 7 MILES
1 0 1 2 3 4 5 6 7 KILOMETERS

Symbols and labels

- × Selected well log used to map extent of aquifer.
- F F′ Line of cross section.
- Body of water.

INTRODUCTION

The surficial sand aquifer and several buried sand aquifers are important aquifers that are the major sources of groundwater used in Todd County. The Quaternary sediments in which these aquifers occur were deposited by multiple glaciers that entered and receded from the county. Sediments deposited during the most recent glacial period, the Late Wisconsinan, are better understood than those from previous glaciations because they form the surface materials over most of the county (Figure 1). Three of the mapped aquifers on this plate, the surficial sand aquifer (Figure 2) and two buried sand aquifers, the C1 and H1 buried sand aquifers (Figures 3 and 4, respectively) were deposited during the Late Wisconsinan. The N1 buried sand aquifer was also deposited during the late Wisconsinan and is shown only on cross sections E–E′ and F–F′ on Plate 8. The other six buried sand aquifers shown on this plate (Figures 5–10) were deposited much earlier in the Pleistocene prior to the Wisconsinan. A description of the relative age for these Late Wisconsinan and pre-Wisconsinan ice lobe deposits is shown in Figure 3, Plate 4, Part A.

The stratigraphic correlation of the buried sand aquifers and till units is shown on Figure 11. Till units are shown in shades of gray to show their relative hydraulic conductivity as described on Plate 8.

The surficial sand aquifer exists in outwash deposits from the last three glacial events in Todd County: the Hewitt formation (Wadena lobe), the Cromwell Formation (Superior lobe), and the New Ulm Formation (Des Moines lobe), as well as post-glacial alluvium. Where the surficial sand deposits are thick, the lower portion of the sequence may be composed of pre-Wisconsinan deposits as well. An example of very thick surficial sand deposits in direct contact with buried sand units forming one continuous sand body is shown at the City of Long Prairie on cross section D–D′ on Plate 8. The surface extent of the individual sand units is mapped in Plate 3, Part A, Surficial Geology.

The surficial sand aquifer is that portion of the surficial sand that is both sufficiently thick and saturated so that water can be pumped from wells economically. The outer boundary of the surficial sand aquifer was defined from the outer boundary of the surficial sands mapped in Plate 3, Part A, Surficial Geology. The useable surficial sand aquifer may not fully extend to the boundaries of the surficial sand aquifer shown on Figure 2. Those boundaries likely include some areas of the surficial sand that may not be thick enough to be considered a useable surficial sand aquifer or are unsaturated. The horizontal and vertical extent of the buried sand aquifers is less completely known. These aquifers may extend beyond the boundaries shown on this plate. However, the thickness and horizontal boundaries of these buried sand aquifers are representative of the available well data; the map view of these aquifers shown on this plate is consistent with the cross-section view on Plate 8.

DEPOSITIONAL CHARACTERISTICS OF MAJOR SAND AQUIFERS

Surficial Sand Aquifer Extent

The surficial sand aquifer occurs in the sands and gravels from glacial outwash and ice contact deposits, which are primarily coarse-textured sand and gravel. Much of this sediment was deposited in narrow channels usually one mile or less in width. The modern-day Long Prairie and Sauk rivers follow these glacial outwash channels. The surficial sand aquifer is wider only in the lowlands of the northeasternmost part of the county where outwash from the Wadena and Des Moines lobes intermingled. Figure 4, Plate 4, Part A describes the glacial history and the development of meltwater drainage in the county.

The thickness of the surficial sand aquifer shown in Figure 2 was determined by first mapping the approximate bottom elevation of the surficial sand deposits and then subtracting that elevation from the land surface elevation. Most wells that were constructed in or drilled through the surficial sands were used to estimate the bottom elevation of the sand. A grid representing the bottom elevation of the surficial sand was created by using a minimum curvature spline algorithm to interpolate between known well data. This grid was subtracted from the surface digital elevation model (DEM) to create the surficial sand thickness map. The thickness of the surficial sand ranges from a few feet to about 100 feet with a mean thickness of approximately 20 feet. Notably, 80 percent of the surficial sand is less than 30 feet thick. Some areas may be too thin to be utilized as an aquifer except for limited intermittent use.

Buried Sand Aquifer Distribution

Buried sand aquifers are present throughout most of the county. The aquifers were mapped where sufficient stratigraphic information from well records was available (Figures 3–10). Data were sufficient to map buried sand aquifers primarily in the upper 100 feet, and as deep as 200 feet in some locations. The mapped aquifers are described separately below by their associated stratigraphic assemblages. Deeper sand units are also present and form usable aquifers, but the available well data were insufficient to determine their stratigraphic relationship or map their extent. A few locally identified deeper sand aquifers are shown on cross sections A–A′, B–B′, and D–D′ on Plate 8.

Late Wisconsinan

N1 buried sand aquifer. The N1 buried sand aquifer underlies the New Ulm Formation till. It is restricted to the southernmost portion of Todd County. The extent of this aquifer is limited and not well known; it is shown only on Plate 8, cross sections E–E′ and F–F′. The southwesternmost well sampled for chemistry (green triangle) on Figure 2 was completed in the N1 buried sand aquifer.

C1 buried sand aquifer (Fig. 3). The C1 buried sand aquifer lies beneath the Cromwell Formation till. The C1 aquifer is thin, generally less than 40 feet thick, and is restricted to the eastern region of the county where Superior lobe ice deposited the Cromwell Formation.

H1 buried sand aquifer (Fig. 4). The H1 buried sand aquifer is immediately beneath the Hewitt formation till and found scattered throughout the county. This aquifer is typically less than 60 feet thick; however, it becomes very thick just south of Long Prairie, where it is up to 140 feet thick. That area just south of Long Prairie was a major drainage way for outwash from several glaciers (see Figure 4, Plate 4, Part A). The thick sand that is present south of Long Prairie is identified as the H1 aquifer, but the deepest part of the H1 sand aquifer unit might actually be an older sand that was deposited before the overlying sand unit of the H1 aquifer.

Pre-Wisconsinan

B3 buried sand aquifer (Fig. 5). The B3 buried sand aquifer is the uppermost aquifer within several Browerville formation tills. The tills were deposited by repeated advance and retreat of glacial ice. The B3 buried sand aquifer is thin, generally less than 20 feet thick, and is only present in the northwest portion of the county.

B2 buried sand aquifer (Fig. 6). The B2 buried sand aquifer is a midlevel sand aquifer within Browerville formation tills. This buried sand aquifer is fairly extensive, but is mostly restricted to the northern half of the county. Its thickness reaches 40 feet.

B1 buried sand aquifer (Fig. 7). The B1 buried sand aquifer lies immediately below the lowest till unit of the Browerville formation. It is mostly restricted to the northern three-fourths of the county. This aquifer is as much as 60 feet thick in a few places.

X3 buried sand aquifer (Fig. 8). The X3 buried sand aquifer is mapped immediately below the till of the Sauk Centre member of the Lake Henry formation in most areas. In a few locations, where the till of the upper member of the St. Francis formation is present, the X3 buried sand aquifer lies below that Superior-lobe source unit. The X3 buried sand aquifer is mostly found in the southern half of Todd County and is generally less than 60 feet thick. It exceeds that thickness in only a few areas.

X2 buried sand aquifer (Fig. 9). The X2 buried sand aquifer lies immediately below the till of the Meyer Lake member of the Lake Henry formation in most areas. In a few locations, where the till of the lower member of the St. Francis formation is present, the X2 buried sand aquifer sand lies below that Superior-lobe source unit. The X2 buried sand aquifer is found mostly in the southern third of Todd County, but this sand aquifer is widely distributed elsewhere in the county also. It is generally less than 60 feet thick, exceeding that thickness in only a few places.

X1 buried sand aquifer (Fig. 10). The X1 buried sand aquifer occurs immediately below the Eagle Bend formation till, and is the lowest mapped aquifer. The extent of this aquifer is poorly understood and only mapped in widely scattered locations where deeper wells have penetrated to this aquifer.

ACKNOWLEDGEMENTS

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Base modified from Minnesota Geological Survey, Todd County Geologic Atlas, Part A, 2007.
Project data compiled from 2006 to 2009 at a scale of 1:100,000. Universal Transverse Mercator projection, grid zone 15, 1983 North American datum. Vertical datum is mean sea level.
GIS and cartography by Todd Petersen and Greg Massaro. Edited by Neil Cunningham.

GEOLOGIC ATLAS OF TODD COUNTY, MINNESOTA