Kane County Water Resources Investigations: Interim Report on Three-dimensional Geologic Modeling

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EXECUTIVE SUMMARY

This report summarizes the results to date of a continuing multiphase investigation on the water resources of Kane County. The objective of this report is to describe the development of a three-dimensional model of the geology of Kane County. This model will be used to further analyze the hydrogeology of Kane County and provide input to a shallow groundwater flow model of Kane County as part of an assessment of its water resources (Meyer et al. 2002). The emphasis of this geologic modeling effort is on the Quaternary glacial deposits and underlying shallow bedrock geology.

This report builds on the work reported in *Kane County Water Resources Investigations: Interim Report on Geological Investigations* (Dey et al. 2004a). The conceptual model, project database, and geologic mapping described in that report provided the framework for the ongoing geologic modeling described in this report. During this present phase of the work, additional data from water-well records have been added to the project database. The lithostratigraphic assignments made from well records have been refined and augmented. Some previous lithostratigraphic assignments have been changed due to an increased understanding of the geology and hydrogeology of the area through geologic mapping associated with this report.

Based on the work to date, this report is accompanied by the following products: the *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005a) and *Interim Map of Bedrock Geology, Kane County, Illinois* (Dey et al. 2005b). Both maps were produced at a scale of 1:100,000. Final versions of these maps are scheduled for publication in April 2007. This report describes the methods used to produce a three-dimensional geologic model. The three-dimensional model described in this report was delivered to the Illinois State Water Survey in a format that can be used for groundwater flow modeling. Also, the work conducted to produce the model and report provides a foundation for additional geologic mapping and input for mapping of potentiometric surfaces.

INTRODUCTION

Kane County is undergoing tremendous population growth. The population in Kane County was 404,119 in 2000 and is projected to grow to 710,000 by 2030 (Kane County 2004). In anticipation of the need for reliable information on available water resources, the County has contracted with the Illinois State Water Survey (ISWS) and Illinois State Geological Survey (ISGS) to assess its water resources (Meyer et al. 2002). The overall goal of this assessment is to provide Kane County with the scientific basis for developing policies and management strategies for its water resources.

This *Interim Report on Three-dimensional Geological Modeling* presents the results of work continuing beyond that documented in *Interim Report on Geologic Investigations* (Dey et al. 2004a). A preliminary three-dimensional model was developed as part of that report (Abert et al. 2004). This present report summarizes the methods and results of the ongoing work by the ISGS to produce a more detailed three-dimensional geologic model of Kane County and vicinity. The new model depicts the Quaternary deposits and shallow bedrock geology. The main purpose of the model is to provide the reliable geologic input data that are fundamental for generating accurate predictions from a groundwater flow model (Alley et al. 2002). The more accurately the geologic model depicts the actual field conditions, the more accurate the groundwater flow model will be (Anderson and Woessner 1992).

The three-dimensional geologic model also has important applications as a county-scale planning tool. The model can be used to generate derivative maps, such as maps of aquifers and of aquifer sensitivity to contamination.

The results of this geologic modeling effort are being incorporated into groundwater flow models at the ISWS that will be reported in *Computer Flow Models of Aquifer Systems Used in Kane County and Sup-*

porting Hydrologic Database (in progress). Results of the geological modeling will also provide input to the *Final Report on Geological Investigations* (in progress) and the *Final Report on Groundwater Investigations* (in progress). These reports and accompanying maps and models are due for delivery to Kane County in April 2007.

The focus of work covered by this report was to develop an accurate model of Kane County's geology, with particular emphasis on groundwater resources in the unlithified deposits that overlie the bedrock. To aid in the accurate interpretation of the geology, the study area was defined to extend one township (approximately 6 miles) beyond all the edges of Kane County (fig. 1) in order to prevent distortion of interpretations near the county line and to aid in the assessment of hydrogeologic influences coming from outside the county. Although the conceptual model and geologic interpretations extended into the adjacent counties, the main effort was concentrated inside Kane County, and only map products of the county have been produced.

Three terms should be clarified as to their usage in this report: lithology, stratigraphy, and lithostratigraphy. *Lithology* is the term used to refer to the descriptions of basic properties of earth materials such as texture, porosity, and color. *Stratigraphy* is the term used in reference to descriptions of the age and origin of earth materials. *Lithostratigraphy* is used in reference to a combination of the two previous terms, describing geologic units that share common origins, age, and certain physical properties. Because this report is focused on describing the geology of the shallow groundwater resources of Kane County, the lithologic properties of main concern are those that define a recognizable geologic unit as being composed of aquifer or non-aquifer materials.

METHODS

A detailed description of the methods used in geologic mapping and in developing the three-dimensional geologic model are described in *Kane County Water Resource Investigations: Interim Report on Geologic Investigations* (Dey et al. 2004a). A brief summary of those general methods follow, and methods specific to the three-dimensional modeling effort are described in greater detail.

Conceptual Model

A conceptual model of the geology of Kane County and adjacent areas was developed. The conceptual model is a compilation of the current understanding of the county's geology and the processes by which it formed. This model reflects current interpretations of information from previously published materials, knowledge gained by ISGS staff and colleagues from other studies in Kane County and northeastern Illinois, and the efforts for this mapping project. The basic components of the conceptual model are the lithostratigraphic units, which are the layers of sediment that occur in a particular position in the succession of materials. Lithostratigraphic units have characteristic physical properties (such as particle-size distribution, color, and moisture content) that are readily observed in the field; the units are extensive enough to justify showing them on maps and cross sections. The conceptual model reflects our current understanding of how the properties and geometries of the lithostratigraphic units influence the hydrogeology of the area. Dey et al. (2004a) described the glacial history, vertical and lateral distribution, and some material properties of the Quaternary lithostratigraphic units in Kane County. The lithostratigrahic units are shown in figure 2. Figure 3 is a geologic map of Kane County showing the areal distribution of the lithostratigraphic units that are present at the ground surface.

Data Acquisition and Management

Records of water wells and other borings on file at the ISGS were the main source of data for the three-dimensional geologic modeling. A project database was constructed to facilitate the use of these records (Dey et al. 2004a). For simplicity, the term *wells* is used to describe data from water wells or other types of borings. Currently, the project database contains 27,794 well records and 9,313 other forms of point data, such as seismic data, outcrop descriptions, and other observations made at the land surface.

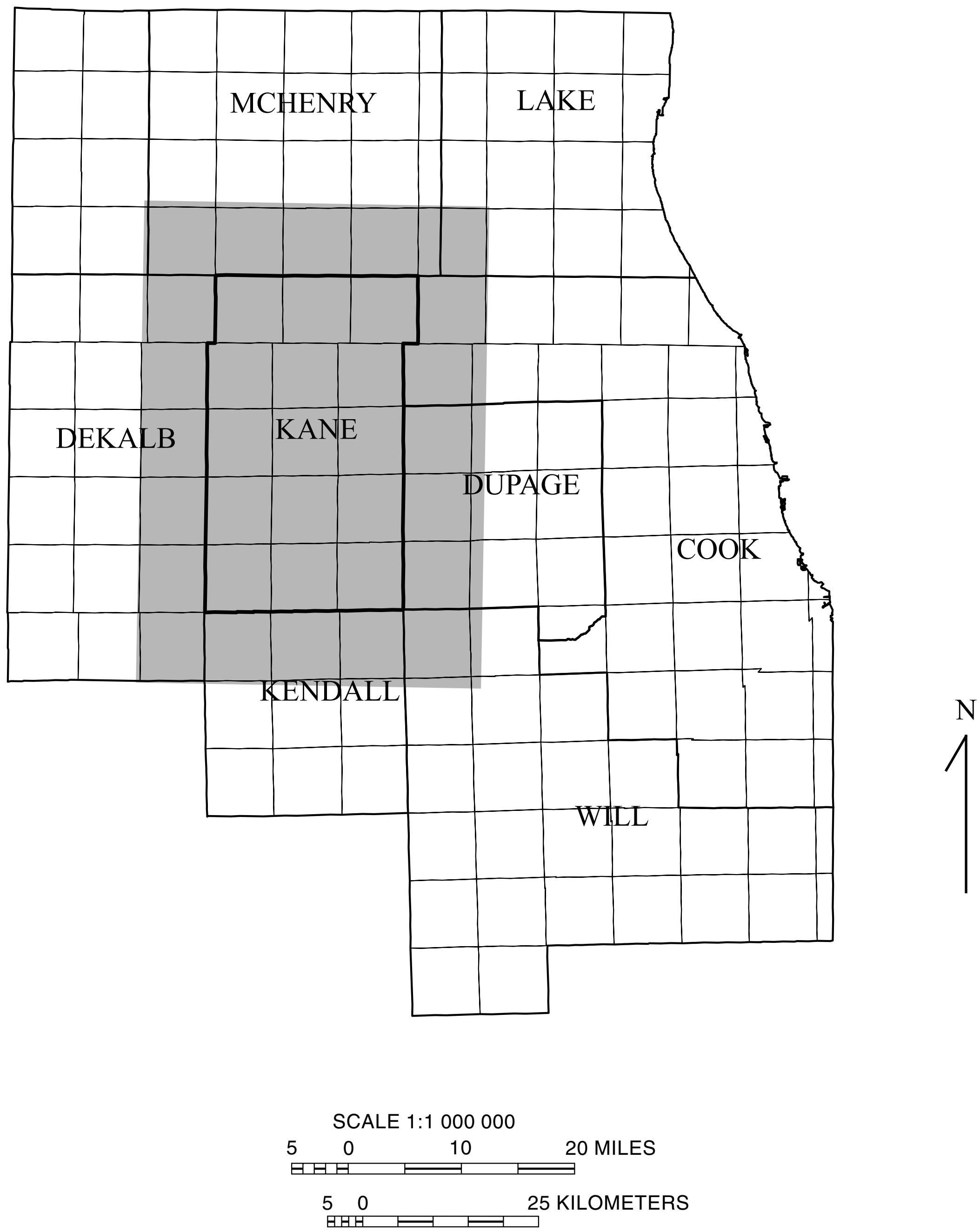

Figure 1 *Location of the study area (in gray).*

Material Description	Unit	Interpretation
	HUDSON EPISODE (~ 12,500 years B.P. to present)	
Peat and muck (black and brown); interbedded sand, silty clay (gray), and marl (white to light gray)	Grayslake Peat gr	Decomposed wetland vegetation and sediment in depressions and on toe slopes
Sand and gravel; well-sorted sand and lenses of peat, grading laterally to silt and clay	Cahokia Formation c	Floodplain alluvium along rivers and streams
	HUDSON AND WISCONSIN EPISODES (~ 55,000 years B.P. to present)	
Silt, clay, and fine sand; layered to massive; gray to brown	Equality Formation e	Lake deposits in kettles and some valleys tributary to the Fox River
	WISCONSIN EPISODE (~12,500 - 75,000 years B.P.)	
Silt and clay at ground surface; upper foot or so organic-rich in most places; contains abundant soil structures, burrows, roots, etc.	Peoria Silt p	Windblown fines (loess) modified by modern soil processes
Sand and gravel, or sand; contains lenses of silt and clay, or diamicton	Henry Formation h	Channelized proglacial outwash, proglacial outwash deposited in deltas and alluvial fans as outwash plains downslope of glacial margins, or kames
Diamicton; sandy loam to loam; dolomite-rich; yellowish brown; includes lenses and layers of sand and gravel	Haeger Member, Lemont Formation lh	Till and debris flow deposits associated with the Woodstock Moraine
Diamicton; silty clay, silty clay loam, and clay; gray, oxidizing to yellowish brown; includes layers of sand and gravel, silt, and silty clay	Yorkville Member, Lemont Formation ly	Till and debris flow deposits associated with the St. Charles and Minooka moraines
Diamicton; sandy loam, loam, and silt loam; gray to grayish brown, oxidizing to yellowish brown to brown; includes common layers of sand and gravel or silt and sorted sediment	Batestown Member, Lemont Formation lb	Till and debris flow deposits associated with the Elburn Complex, Farm Ridge, and Arlington moraines
Diamicton; clay loam to loam with lenses of sand and gravel, or sand; reddish brown, oxidizing to brown	Tiskilwa Formation t	Till and debris flow deposits forming the Marengo Moraine and Bloomington Morainic System
	ALTON SUBEPISODE, WISCONSIN EPISODE (~ 55,000 to 24,500 years B.P.)	
Silt and clay; organic-rich, black to brown; leached of carbonate minerals; contains wood fragments	Robein Member, Roxana Silt rr	Deposits accreted in low-lying areas; patchy distribution
	ILLINOIS EPISODE (~ 200,000 to 130,000 years B.P.)	
Diamicton; sandy loam to loam, reddish brown, pinkish brown, and brown; bouldery in places, with abundant lenses and layers of sand and gravel	Glasford Formation g	Till, debris flow deposits, outwash, lake sediment
	PALEOZOIC ERA (~570 to 225 million years ago)	
Dolomite; microcrystalline; cherty in places (Kankakee and Joliet Fms.), shaly, fossiliferous dolomite, shale, and thin beds of vuggy dolomite (Maquoketa Group)	Kankakee and Joliet Formations; Maquoketa Group Pz	Bedrock

Figure 2 *Stratigraphic framework of the glacial drift and shallow bedrock in Kane County.*

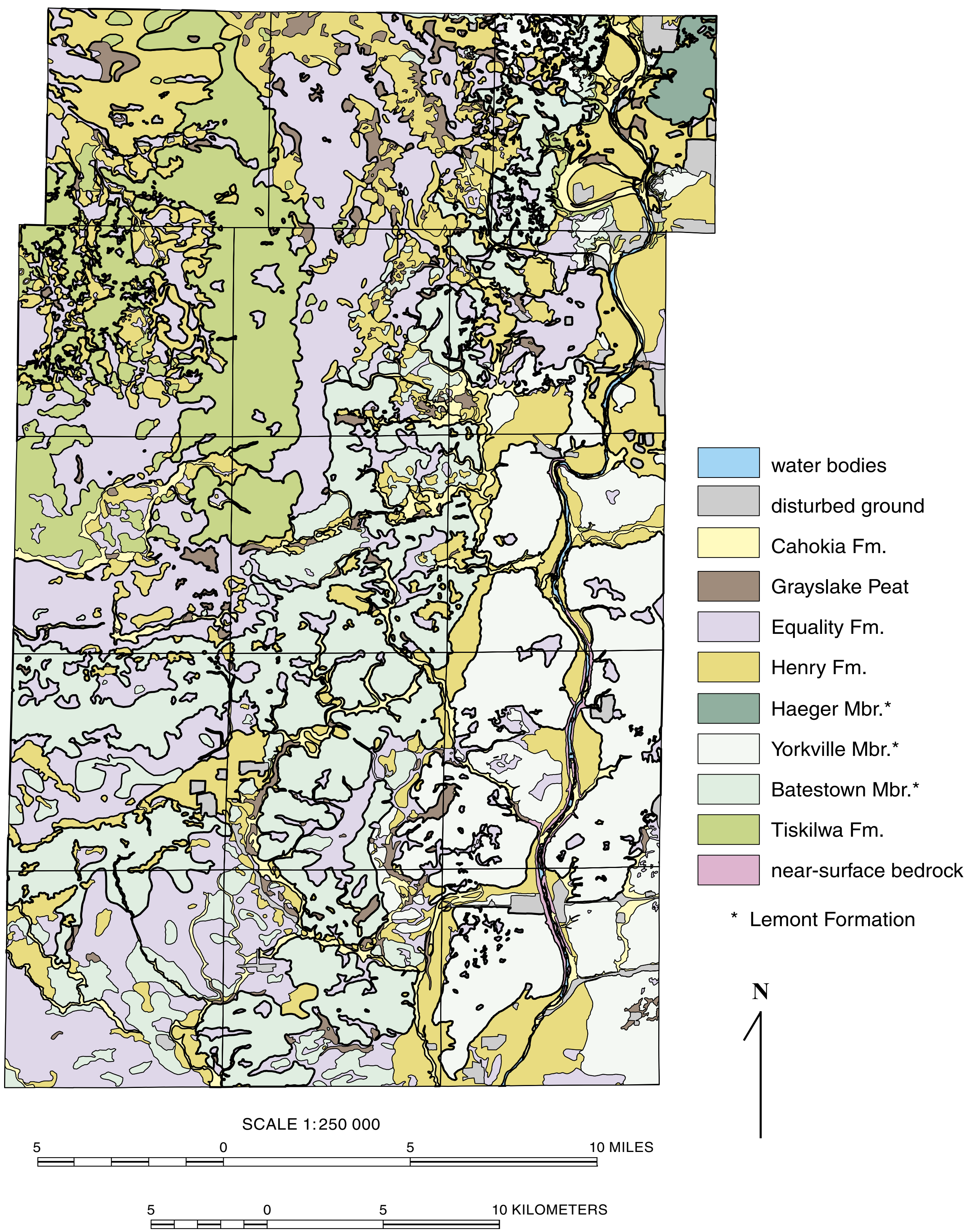

Figure 3 *Surficial geology of Kane County.*

A primary data set was created as a subset of all well records and point data in the project database. Wells were selected for the primary data set based on the quality of both the data and the location information. Wells included in the primary data set are referred to in this report as primary wells. A goal was to have a somewhat evenly distributed set of primary wells across the study area, with one well per each quarter section. This goal was not achieved in some areas and was exceeded in others. Wells have continually been added to the primary data as they have been identified. For example, most of the wells from the ISWS piezometric monitoring network (Locke and Meyer 2005) were correlated to wells in the project database and were added to the primary data set. A total of 4,830 wells have been designated as primary wells. Figure 4 shows the distribution of primary wells throughout the study area.

Verification of Well Locations

Efforts were made to establish the physical location of all wells in the primary data set, both by physical inspection in the field and reference to records in the office. Verification of a well location in some instances resulted in new location information being added to the project database. All wells have been ranked for the quality or accuracy of the information describing their location. With the location of each well accurately defined, a digital elevation model (DEM) was used to define the elevation of the top of each well in the project database (Dey et al. 2004a).

Lithostratigraphic Assignments

Lithostratigraphic assignments to recognized Quaternary or bedrock stratigraphic units were made based on the geologic information in the descriptive logs of the primary wells and by using the conceptual model, published stratigraphic interpretations, and the professional judgment of geologists working on the project. Table 1 lists the lithostratigraphic units that were used in making assignments and their positions in the vertical sequence. Imposition of this mandatory vertical succession kept the three-dimensional model from becoming overly complex.

The vertical sequence of lithostratigraphic units resulted in some simplification of the interpretations of the geology observed in a few well records. For example, where a lacustrine unit identified in the subsurface was overlain by the Henry Formation or a member of the Lemont Formation, stratigraphically it could be assigned to the Equality Formation, but to conform to the mandatory vertical sequence, this lacustrine material had to be assigned to the next lower (i.e., older) fine-grained lithostratigraphic unit. Also, in a few places where the Peddicord Tongue of the Equality Formation was identified above the Ashmore Tongue of the Henry Formation, the lithostratigraphic unit was assigned to the Tiskilwa Formation rather than the Peddicord Tongue. In the few cases where either of these substitutions was made, notes were appended to the record in the project database for future reference. Additionally, lithostratigraphic assignments used for the Glasford Formation were limited to three fine-textured and three coarse-textured facies within the Glasford. Very rarely were more than six distinct lithologic units observed in the Glasford Formation. Table 2 summarizes the number of assignments made to major lithostratigraphic units using data from primary wells in Kane County and in the study area. Divisions within the Glasford Formation are not noted in the table.

As described by Dey et al. (2004a), a digital map was compiled to depict the areal distribution of the uppermost lithostratigraphic units for the Kane County study area. The main input was an unpublished preliminary surficial geology map of Kane County at 1:100,000 scale compiled by Curry and Grimley (fig. 2). This map has been updated over the last year. A grid of nodes with a spacing of 1/8 mile was superimposed on the surficial geology map of the study area. The uppermost lithologic unit was identified at each node, and these lithostratigraphic assignments were added to the project database.

Synthetic data points were generated to define the presence or absence of units in areas of sparse data or where the existing data did not allow for adequate depiction of the geometry of the lithostratigraphic units. These synthetic data points were used mainly to delineate surficial or near-surface units. Synthetic data points are created or defined at a location chosen by the mapper. Geological inferences made at synthetic data points are based on the conceptual model and the judgment of the mapper. Lithostratigraphic assign-

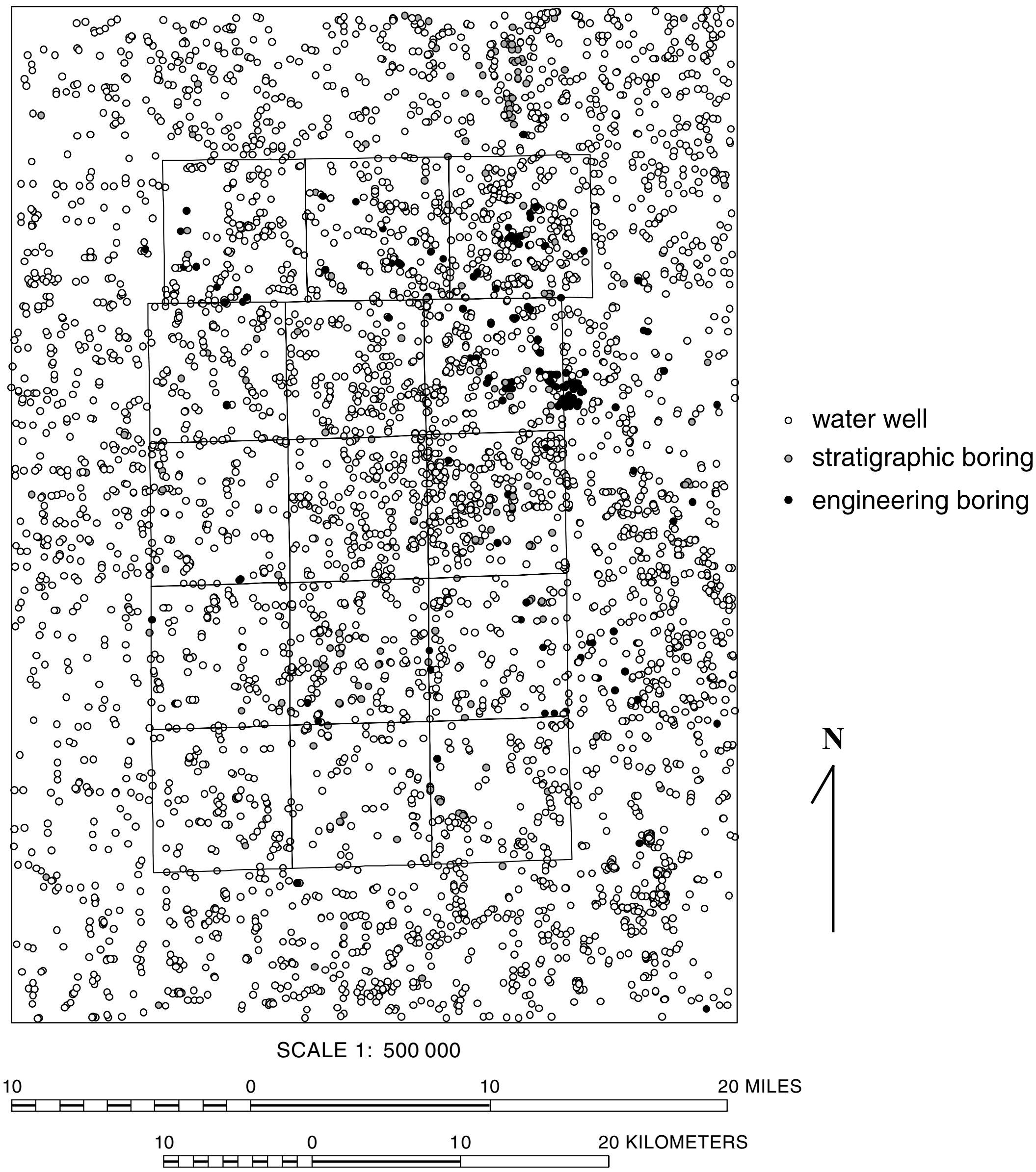

Figure 4 *Distribution of primary wells used to generate lithostratigraphic surfaces.*

ments made to synthetic data points were based on conditions observed or reported at the land surface and/or by extrapolating between lithostratigraphic assignments made at primary wells. These synthetic data points were added to the project database. Table 3 summarizes the number of assignments made to each lithostratigraphic unit for synthetic data points in Kane County and in the study area.

Three simplifications were made to the assigned lithostratigraphic units before any lithostratigraphic surfaces were created. First, assigned occurrences of the Robein Member of the Roxanna Silt and the Peddicord Tongue of the Equality Formation were used only to define the upper surface of the Glasford Formation and were not modeled as independent units. Although the Robein has stratigraphic significance as a marker bed, its relative thinness and discontinuous occurrence made representing it in the three-dimensional model impractical. The documented occurrences of the Peddicord were too few to justify modeling it as a separate unit, so the Peddicord, a fine-textured unit, was combined with underlying fine-textured units of the Glasford Formation. The second simplification made in constructing the current model was to model the fine-textured facies of the Cahokia Formation, the Grayslake Peat, and surficial and near-surface deposits of the Equality Formation as a single near-surface unit, hereafter referred to as the “surficial mélange.” All three units tend to occupy low-lying spots on the landscape and occur often in association throughout the study area. Coarser-textured facies of the Cahokia Formation were assigned to the Henry Formation for this modeling effort. Third, initially only an upper surface of the Glasford was created; its lower surface was defined by the bedrock surface. How sands within the Glasford Formation were uniquely modeled is described in the next section of this report. Table 4 lists the succesion of lithostratigraphic units modeled as independent layers.

Lithostratigraphic Surfaces and Isopach Maps

A three-dimensional geologic model of the major lithostratigraphic units was constructed using a grid with a 1/8-mile node spacing. The modeling process defines the elevation of the top and bottom of each lithostratigraphic unit at each of these grid nodes. Where a unit is absent, the upper surface and lower surface have the same elevation value.

Table 1 Lithostratigraphic units and their mandatory vertical sequence.

Lithostratigraphic unit
1. Disturbed land
2. Peoria Silt
3. Cahokia Formation
4. Grayslake Peat
5. Equality Formation
6. Henry Formation, surficial
7. Wadsworth Formation (d)*
8. Unnamed tongue, Henry Formation associated with Wadsworth Formation
10. Haeger Member, Lemont Formation (d)*
11. Beverly Tongue, Henry Formation.
12. Yorkville Member, Lemont Formation (d)*
14. Unnamed tongue, Henry Formation associated with Yorkville Member.
15. Batestown Member, Lemont Formation (d)*
16. Unnamed tongue, Henry Formation associated with Batestown Member
17. Tiskilwa Formation (d)*
18. Ashmore Tongue, Henry Formation
19. Peddicord Tongue, Equality Fprmation
20. Robein Member, Roxanna Silt
21. Glasford Formation, uppermost fine-textured unit
22. Glasford Formation, uppermost coarse-textured unit
23. Glasford Formation, middle fine-textured unit
24. Glasford Formation, middle coarse-textured unit
25. Glasford Formation, lower fine-textured unit
26. Glasford Formation, lower coarse-textured unit
27. Bedrock, undifferentiated
28. Silurian, undifferentiated
29. Maquoketa Group
30. Galena-Platteville Groups
31. Ancell Group
32. Undifferentiated Cambrian formations

*d, diamicton lithology of the stratigraphic unit listed.

Table 2 Number of primary wells and lithostratigraphic assignments representing the surfaces of mapped units.

Lithostratigraphic unit	Kane County	Study area
Top of Equality Formation	388	634
Bottom of Equality Formation	387	629
Top of Henry Formation, surficial	601	1,100
Bottom of Henry Formation, surficial	600	1,094
Top of Haeger Member (d)*	9	465
Bottom of Haeger Member (d)	8	543
Top of Beverly Tongue, Henry Formation	11	519
Bottom of Beverly Tongue, Henry Formation	10	412
Top of Yorkville Member (d)*	496	1,355
Bottom of Yorkville Member (d)*	447	1,231
Top of Batestown Member (d)*	1,186	1,773
Bottom of Batestown Member (d)*	1,111	1,678
Top of Tiskilwa Formation (d)*	1,511	2,453
Bottom of Tiskilwa Formation (d)*	1,319	2,132
Top of Ashmore Tongue, Henry Formation	597	1,050
Bottom of Ashmore Tongue, Henry Formation	579	1,025
Top of Glasford Formation	729	1,515
Top of Silurian, undifferentiated	305	564
Top of Maquoketa Group	501	899
Top of Galena-Platteville Groups	191	420
Top of Ancell Group	95	159
Top of Cambrian formations, undifferentiated	1	5

*d, diamicton lithology of the stratigraphic unit listed.

Table 3 Number of synthetic data points with lithostratigraphic assignments representing surfaces of select units.

Lithostratigraphic unit	Kane County	Study area
Top of Equality Formation	1,290	1,831
Bottom of Equality Formation	1,290	1,831
Top of Henry Formation, surficial	1,227	1,711
Bottom of Henry Formation, surficial	1,227	1,711
Top of Haeger Member (d)*	3	45
Bottom of Haeger Member (d)*	3	18
Top of Beverly Tongue, Henry Formation	4	41
Bottom of Beverly Tongue, Henry Formation	3	18
Top of Yorkville Member (d)*	162	275
Bottom of Yorkville Member (d)*	20	21
Top of Batestown Member (d)*	968	1,276
Bottom of Batestown Member (d)*	59	70
Top of Tiskilwa Formation (d)*	1,025	1,366
Bottom of Tiskilwa Formation (d)*	5	11
Top of Ashmore Tongue, Henry Formation	0	0
Bottom of Ashmore Tongue, Henry Formation	0	0
Top of Glasford Formation	12	79

*d, diamicton lithology of the stratigraphic unit listed.

Table 4 Lithostratigraphic units represented in the three-dimensional geologic model and their vertical sequence.

Lithostratigraphic unit
1. Surficial mélange (Cahokia Formation, Grayslake Peat, and Equality Formation)
2. Henry Formation, surficial
3. Wadsworth Formation
4. Unnamed tongue, Henry Formation associated with Wadsworth Formation
5. Haeger Member, Lemont Formation
6. Beverly Tongue, Henry Formation
7. Yorkville Member, Lemont Formation
8. Unnamed tongue, Henry Formation associated with Yorkville Member
9. Batestown Member, Lemont Formation
10. Unnamed tongue, Henry Formation associated with Batestown Member
11. Tiskilwa Formation
12. Ashmore Tongue, Henry Formation
13. Glasford Formation, uppermost fine-textured unit
14. Glasford Formation, coarse-textured unit
15. Glasford Formation, lower fine-textured unit
16. Top of Silurian, undifferentiated
17. Top of Maquoketa Group
18. Top of Galena-Platteville Groups
19. Top of Ancell Group

The data used to create the digital three-dimensional geologic model came from the lithostratigraphic assignments made to the primary wells throughout the study area, synthetic data points, and the digital map of the surficial geology. The lithostratigraphic assignments define a series of points where each unit is in contact with its underlying and overlying units or the land surface.

A general method was used to model the surfaces for each lithostratigraphic unit. The bedrock surface was modeled first using a slightly different method, and this surface was used in modifying the other lithostratigraphic surfaces. The general method is described first, then the variation used to produce the bedrock surface, followed by descriptions of how the general method was used in conjunction with the bedrock surface to create the final surfaces of the major lithostratigraphic units. Variations of the general method used for specific units are described last.

A data set was compiled for each major lithostratigraphic unit by first searching the project database for all occurrences of the unit in primary wells at surficial grid nodes or at synthetic data points where either the unit's upper or lower surface was defined. Then the project database was searched to find all instances where the unit was absent, which was indicated by an older unit being defined at the land surface or by the presence of a defined direct contact between units younger and older than the unit under consideration. Elevation values assigned to define the upper and lower surface of the unit at each location of implied absence were the same as the elevation of the defined contact of the overlying and underlying units.

Each data set contained location coordinates (x and y) and elevation value (z) for all the points representing a surface of a lithostratigraphic unit from the project database. The final data set for each unit was simply a list of locations of all data points and the elevations representing the upper and lower bounding surfaces for the unit at each point.

Each surface was created using Surfer® (Golden Software Inc. 2002) and an interpolation algorithm, in our case kriging, which takes as an input a set of coordinates (x, y) and an elevation at those points (z) defined in the data set. The interpolation uses spatial trends in the data to establish values between data points. The resulting output is an evenly spaced grid of values representing the elevation of the surface.

A node spacing of 1/8 mile was used on the output grids. Node location is not precisely where the primary wells were located; hence, the elevation of the modeled surface may not be exactly the same as what is indicated in the primary well record.

The bedrock surface is different from the other surfaces of the model in that its features, in our conceptual model, were shaped primarily by erosion by flowing water instead of deposition by ice or water. Using a special algorithm for the interpolation of elevations that favors creation of water drainage features (topogrid http://support.esri.com/), we created a topographic surface for the top of the bedrock with continuous valleys and other features that are more geologically plausible than a surface defined by a simple kriging-based interpolation of the elevation data would have been. The shape of this surface was created independent of the bedrock lithology.

The basic method explained here was used to create grids that defined the upper and lower surfaces of the diamictons of the Wadsworth Formation; the Haeger, Yorkville, and Batestown Members of the Lemont Formation; and the Tiskilwa Formation. The method was also used to model the upper surface of the Glasford Formation, but the bottom surface of the Glasford was defined by the top of the bedrock surface. In addition, upper surfaces were created for each of the major bedrock units. The lower surface of each major bedrock unit was defined by the upper surface of the underlying unit.

In addition to these unit's surfaces, thickness grids of each of the major sand units and the surficial mélange were created using the kriging algorithm. A data set containing information on each unit's presence and thickness or absence was used instead of elevation to generate a grid of thickness for each major unit of the Henry Formation, the surficial mélange, and a composite of Glasford Formation sand and gravels. The latter is of somewhat limited use as these sands do not always form continuous layers and may represent distinct aquifers separated by thick layers of fine-textured material that is much less porous and permeable than the aquifer. An additional method was used to model the sands in the Glasford Formation. That method is described later in this section.

Having completed the initial modeling of the surfaces, constraints were established to reshape the surfaces to follow certain logical and geological rules. For example, the top of any glacial deposit cannot be above the ground surface, nor can the base be below the bedrock surface. In addition, a given unit must be above all older units and below any younger units.

Working from the bottom upwards, the bedrock topographic surface was constructed first. The bedrock surface was then truncated using a DEM of the land surface. The bedrock surface defined the bottom surface of the Glasford Formation. Next, the upper surface of the Glasford Formation was constructed and was truncated using the bedrock surface (i.e., where the bedrock surface elevation is higher than the upper Glasford surface elevation, the Glasford is absent). The upper Glasford surface was then truncated using the DEM of the land surface. The lower surface of the Tiskilwa Formation was constructed next, following the succession of steps used to define the upper surface of the Glasford Formation, being first truncated using the bedrock surface, and then truncated using the DEM. Next, the lower surface of the Tiskilwa was compared to the upper surface of the Glasford. The comparison showed where there was void space or overlap between the surfaces. At locations where surfaces overlapped, new stratigraphic assignments were made to correct the discrepancies. The void space between the surfaces was compared to a thickness grid of the Ashmore Tongue of the Henry Formation, which underlies the Tiskilwa. In general, the comparison was very good; where significant discrepancies occurred, a geologist's judgment was used to adjust previous stratigraphic assignments or to make new assignments to correct each case. Following each round of new stratigraphic assignments, new surfaces were generated for each unit. The comparison and correction process was repeated until the two surfaces conformed and the intervening void space compared reasonably to the modeled thickness of the Ashmore Tongue of the Henry Formation. Then an upper surface of the Tiskilwa was created and compared to the lower surface of the Tiskilwa. The comparison and correction process was performed until the modeled thickness of the Tiskilwa was reasonable. In this same way, working up from the bedrock surface, each surface was modified to conform to those above and below it.

A different method was used to model the upper and lower surfaces of the surficial Henry Formation and the surficial mélange because their occurrence is less uniform across the landscape than the other major lithostratigraphic units. The isopachs or thickness grids for the surficial Henry Formation and the surficial mélange were projected downward from the DEM of the land surface. The land surface defined the upper surface of these units where they are present. Their lower surface was defined by subtracting their thickness at each grid node from the land surface elevation at that node. Thus, they are defined as having zero thickness where other major lithostratigraphic units are present at the land surface. Where the surficial mélange overlies the surficial Henry Formation, the combined thickness of the two units was subtracted from the land surface elevation to define the bottom of the Henry Formation. The presence of these two units superceded or truncated underlying units, except for bedrock.

As mentioned previously, a net sand thickness map was created to show the composite thickness of sand and gravel in the Glasford Formation. This type of isopach provides some insight into the probable occurrence of aquifers within the Glasford, but has limitations. The isopach does not define where the sand and gravel layers occur vertically in the Glasford, it does not effectively describe whether there is any connection between discrete sand and gravel layers within the Glasford, and it cannot be used to describe potential continuity between the Glasford sands and the bedrock below or any overlying, younger sands and gravels. To address these limitations, a lithologic model was created to incorporate interpretations of continuity between observed coarse-textured and fine-textured facies within the Glasford Formation.

A three-layer lithologic model of the Glasford Formation was created. This model included an upper fine-textured unit, a middle coarse-textured unit, and a lower fine-textured unit. Basic input to the model was the lithostratigraphic assignments made to the six lithologic units that were used to describe the Glasford Formation (table 1). Coarse-textured units were assigned a numerical code of 1, and fine-textured units were assigned a numerical code of 0. This numeric code is referred to as the property value. A file was created for every well that had lithologic assignments within the Glasford Formation. Each file contained the x and y location coordinates and the elevation of the top, the thickness, and a property value for each lithologic unit. Additionally, units that were greater than 5 feet thick were divided into 5-foot intervals until the bottom of the unit was reached. Elevations and property values were defined for each interval. A single data set was then compiled containing the data for all the wells describing the Glasford Formation. The resulting data set contained the location coordinates (x and y) and the top and bottom elevations (z) for a set of units defined by a property value of 1 or 0. These data were contoured using the EarthVision® 3-D minimum tension algorithm (Dynamic Graphics Inc. 1997). This algorithm builds three-dimensional contour shells around similarly coded units. The "Vertical Influence" option was set during the contouring process so that the contour shells were shaped more laterally (like a hamburger) than uniformly (like a meatball). This process resulted in a three-dimensional grid with a value ranging between 1 and 0 at each grid node. For this model, the horizontal node spacing was 1/8 mile, and the vertical node spacing was 5 feet. The 0.5 value contour was chosen to define the boundary between fine-grained and coarse-grained units.

To extract the upper and lower boundaries of the coarse-grained layer within the Glasford Formation, the range of values (from 0 to 1) was simplified. All values less than 0.5 were converted to 0, and all values equal to or greater than 0.5 were converted to 1. A utility within EarthVision® was used to extract two-dimensional grids from the three-dimensional grid at each x and y grid node. One two-dimensional grid represented the greatest elevation of the 1 property value, and a second two-dimensional grid represented the lowest elevation of the 1 property value. Essentially, the top and bottom of the coarse-textured unit were extracted from the three-dimensional grid. These two-dimensional surfaces were generalized with a grid smoothing algorithm within EarthVision® that somewhat flattened any isolated peaks in the surfaces.

The upper fine-grained layer was defined as having the previously created upper surface of the Glasford Formation as its top and the upper surface of the coarse-textured unit as its bottom. The lower fine-textured unit was defined with the lower surface of the coarse-textured unit as its top and the bedrock surface as its bottom.

The resulting lithologic model of the Glasford Formation was visually inspected by creating vertical cross sections through the model at approximately one-mile intervals, working north to south through the study area. Fairly reasonable geometries of the three lithologic layers were observed throughout the study area, particularly within the boundaries of Kane County.

Although the surfaces or grids themselves are two-dimensional data sets, they represent three-dimensional surfaces that can be used to create three-dimensional models and derivative maps based on the gridded properties, such as the map of major Quaternary aquifers (described in the following section). Isopach maps, for example, are simply contour maps of unit thicknesses, which can be easily obtained by subtracting the elevation grid for the bottom of a unit from the elevation grid for the top of the unit.

The lithostratigraphic surfaces and isopach maps are the basic geologic maps of the Kane County study area. The lithostratigraphic surfaces were compiled into a three-dimensional geologic model of the study area. In addition, the lithostratigraphic surfaces and isopach maps were used to generate two derivative maps, which can be used directly as planning tools, the *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005a) and the *Interim Map of Bedrock Geology, Kane County, Illinois* (Dey et al. 2005b). Although the basic geologic maps encompassed the entire study area, the derivative maps cover only Kane County.

Details of how the individual surfaces and isopach maps were used to construct the three-dimensional geologic model and each derivative map are included in the following section.

GEOLOGIC MODEL AND MAPS

Three-dimensional Geologic Model

The methods just described were used to produce the surfaces of the lithostratigraphic units from the conceptual model, where the units have lateral and vertical mapped dimensions. For example, Figures 5 and 6 depict the upper and lower surfaces of the Batestown Member of the Lemont Formation. Figure 7 is the isopach of the same unit. Isopach maps of the major lithostratigraphic units modeled are presented in Appendix A to communicate the distribution, thickness, and interrelationships of these units.

The lithostratigraphic surfaces were imported into three-dimensional modeling software (Earth Vision®, Dynamic Graphics Inc.). The surfaces were combined to produce a three-dimensional model similar to those produced for other ISGS publications (Abert 2000, 2001). The software allowed the mappers to see the relationships between geologic units and make adjustments where the geologic units are out of accordance with the conceptual model. The output from this process has some similarity to results depicted in *Preliminary Three-dimensional Model, Kane County, Illinois* (Abert et al. 2004) but is a product of the additional data and enhanced methods described in this report. The lithostratigraphic surfaces are defined by more real data points than those depicted in the preliminary model. The current model also includes the lithologic three-dimensional model used for delineation of sands in the Glasford Formation, simplified into a single layer.

Figures 8, 9, and 10 are isopach maps of the three layers of the Glasford Formation lithologic model; the upper fine-textured layer, the coarse-textured layer, and the lower fine-textured layer. The isopach of coarse-textured layer (fig. 9) and the isopach map of net sand thickness of the Glasford Formation (fig. 11) shows the same general areal distributions of the thickest sand bodies. Although the lithologic model depicts sand and gravel present in fewer places, these sand and gravel layers, where present, have a large potential for lateral and vertical continuity. Because the lithologic model defines upper and lower elevations of the surfaces of the three layers, it can be used as input for a three-dimensional groundwater flow model, where the net sand thickness map could not be efficiently used as input because its top and bottom surfaces are not defined within the Glasford Formation.

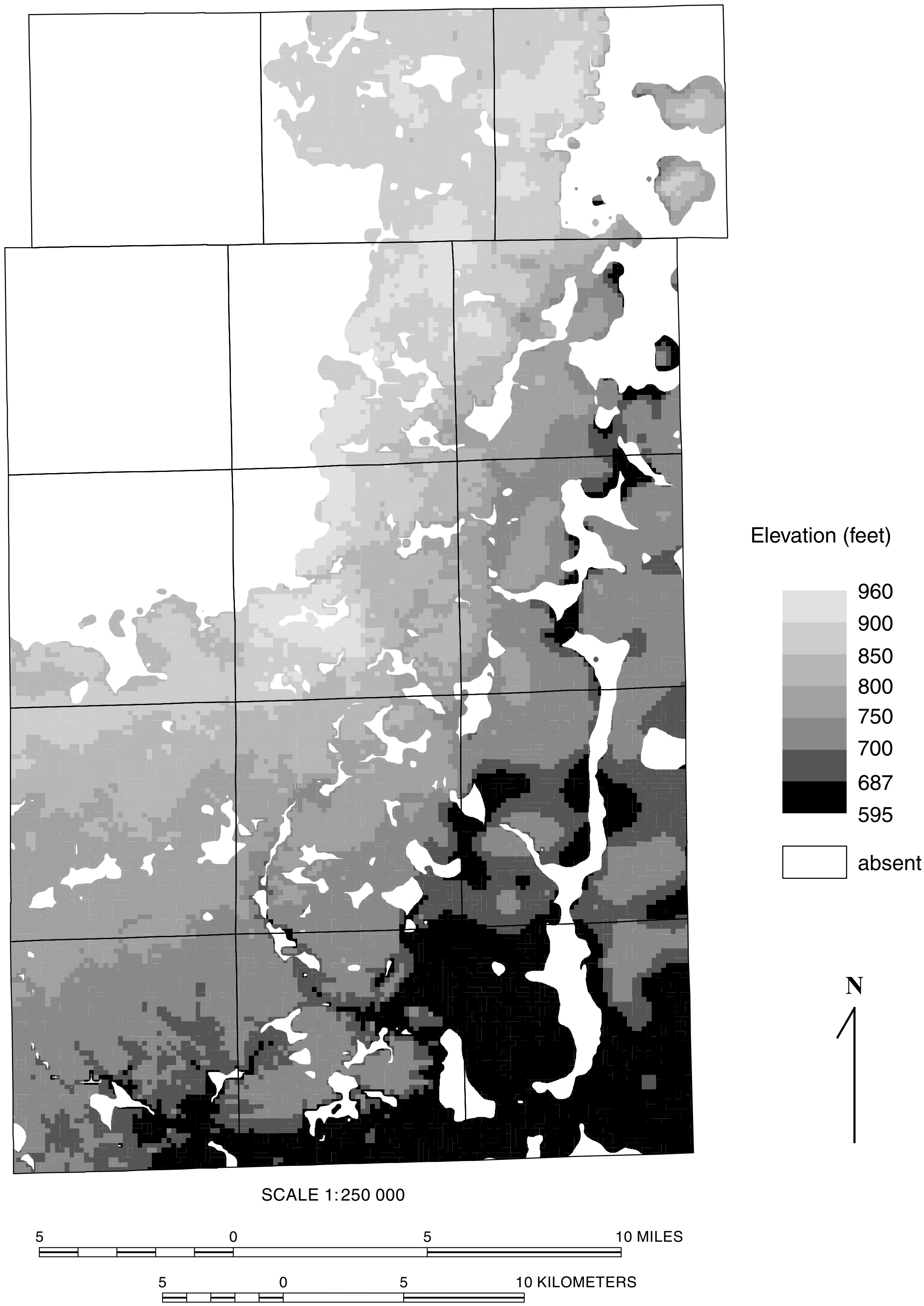

Figure 5 *Elevation grid of the upper surface of the Batestown Member, Lemont Formation, in Kane County.*

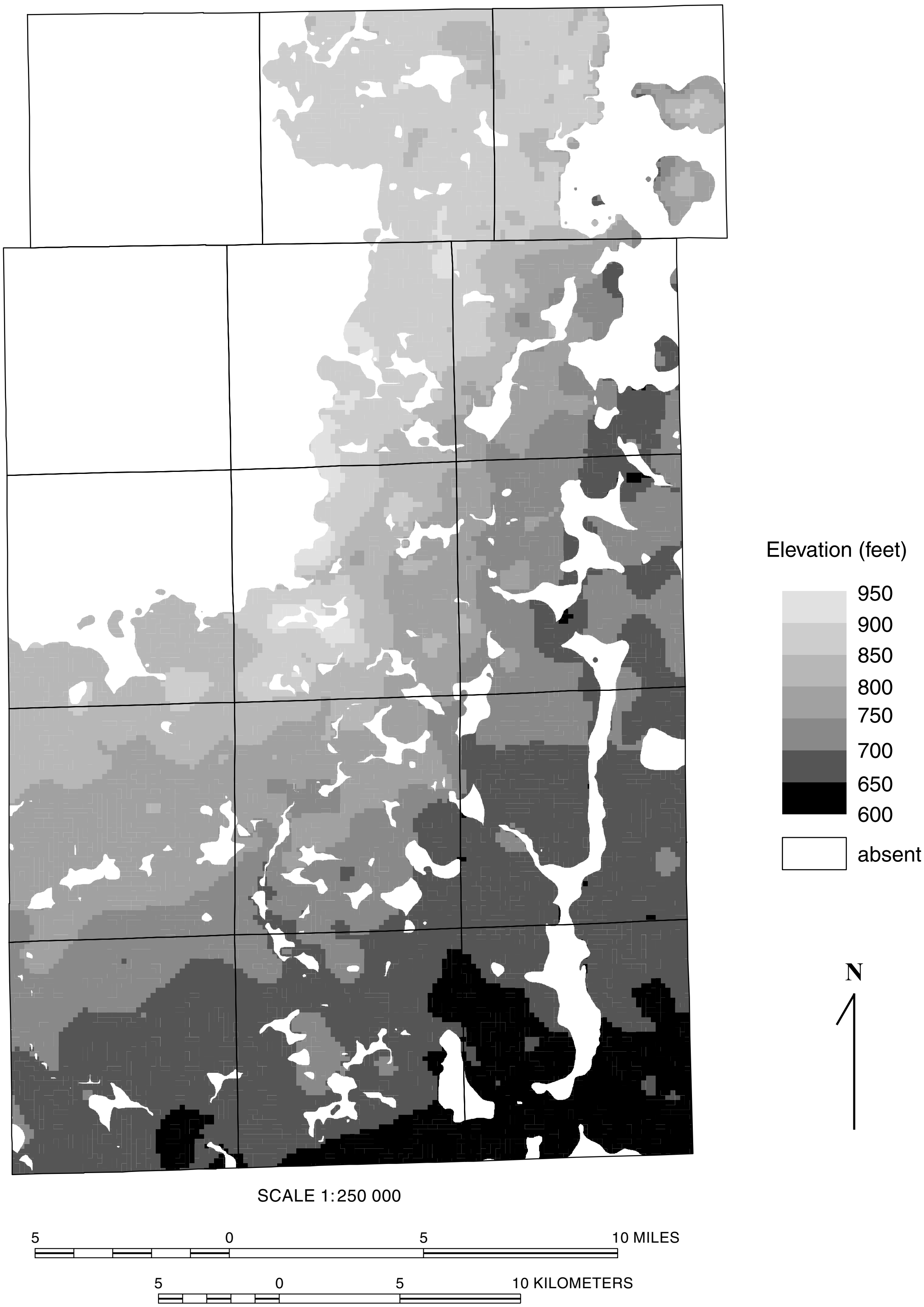

Figure 6 *Elevation grid of the lower surface of the Batestown Member, Lemont Formation, in Kane County.*

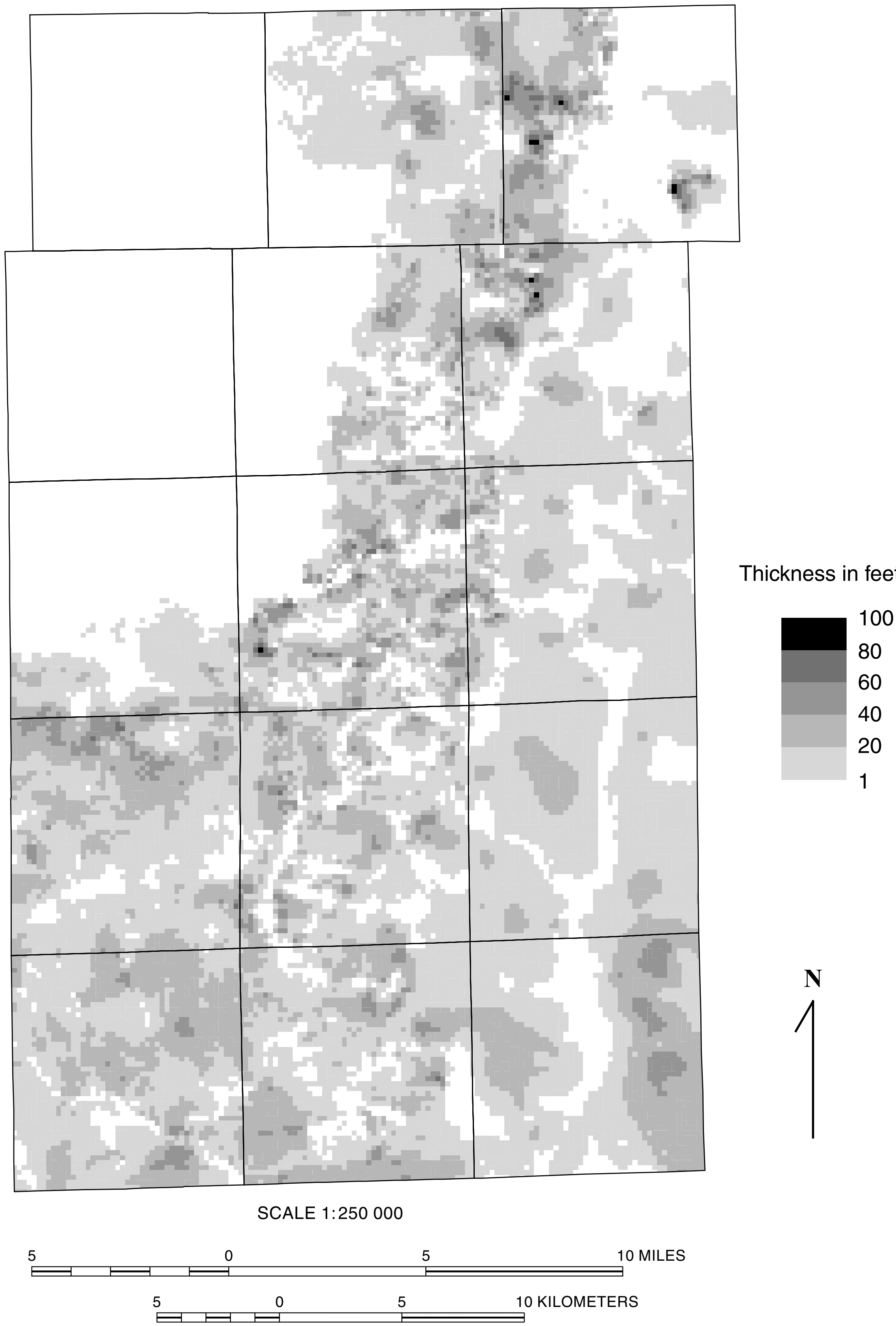

Figure 7 *Isopach map of diamicton of the Batestown Member, Lemont Formation, in Kane County.*

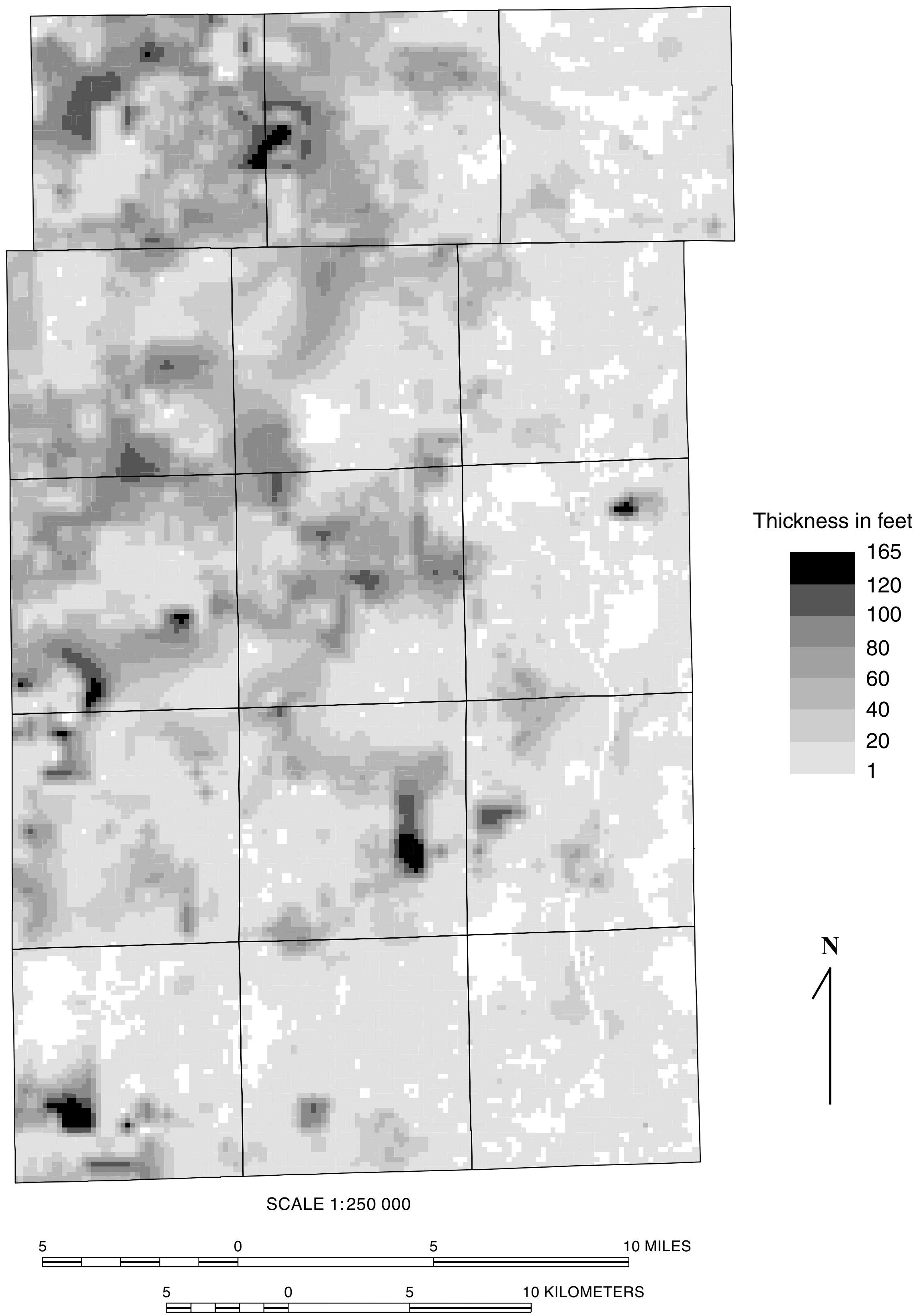

Figure 8 *Isopach map of upper fine-textured unit from the lithologic model of the Glasford Formation in Kane County.*

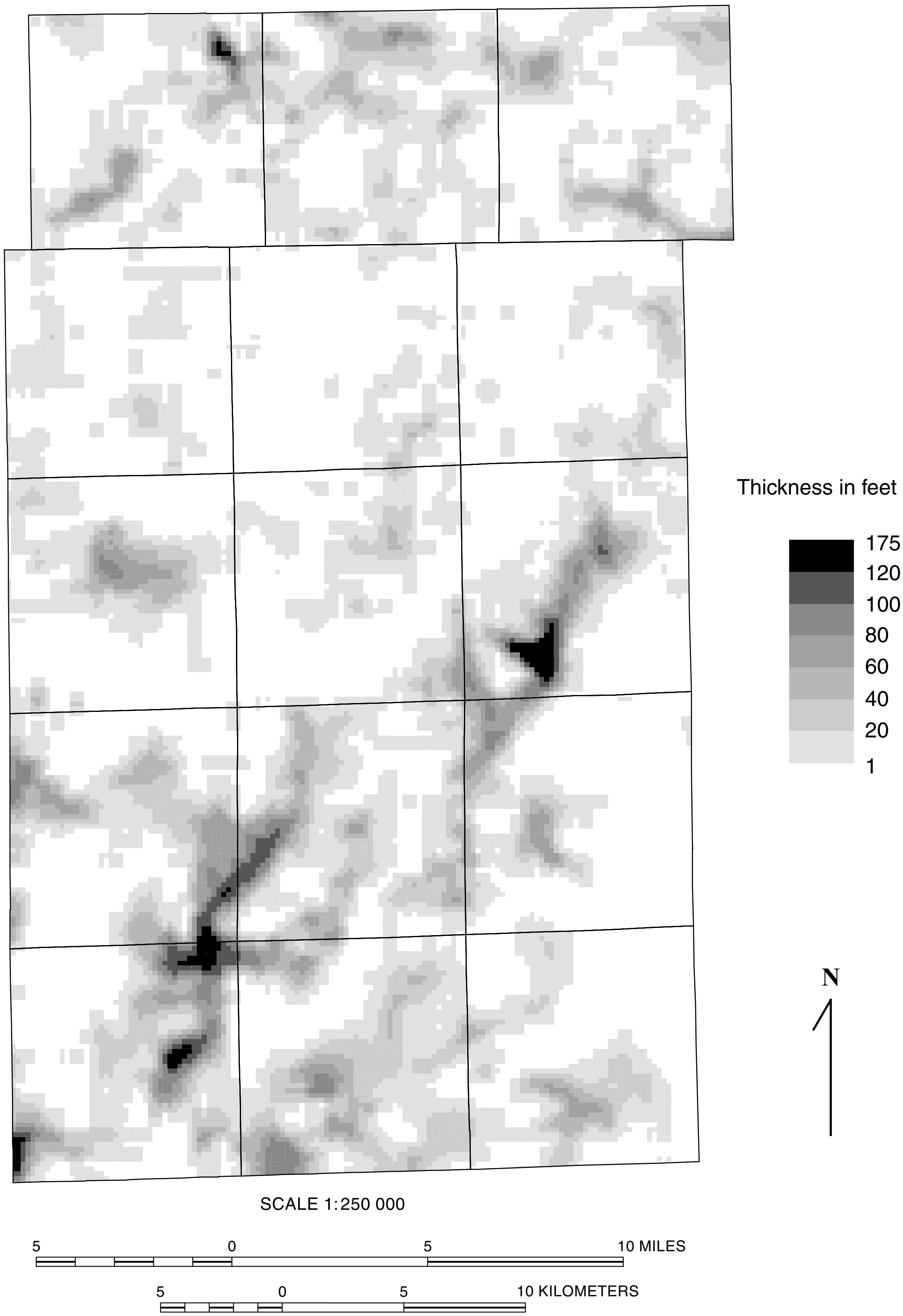

Figure 9 *Isopach map of coarse-textured unit from the lithologic model of the Glasford Formation in Kane County.*

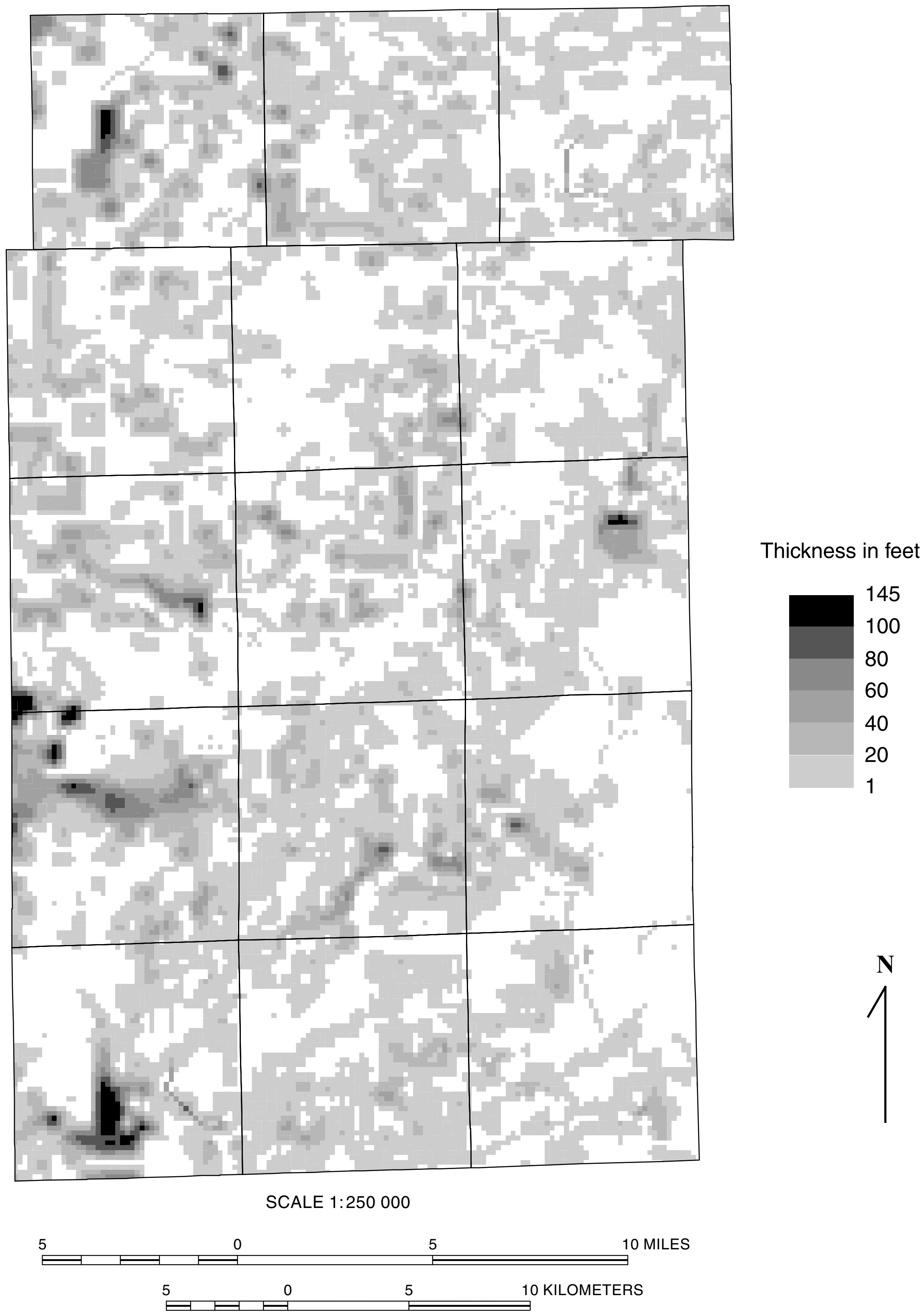

Figure 10 *Isopach map of lower fine-textured unit from lithologic model of the Glasford Formation in Kane County.*

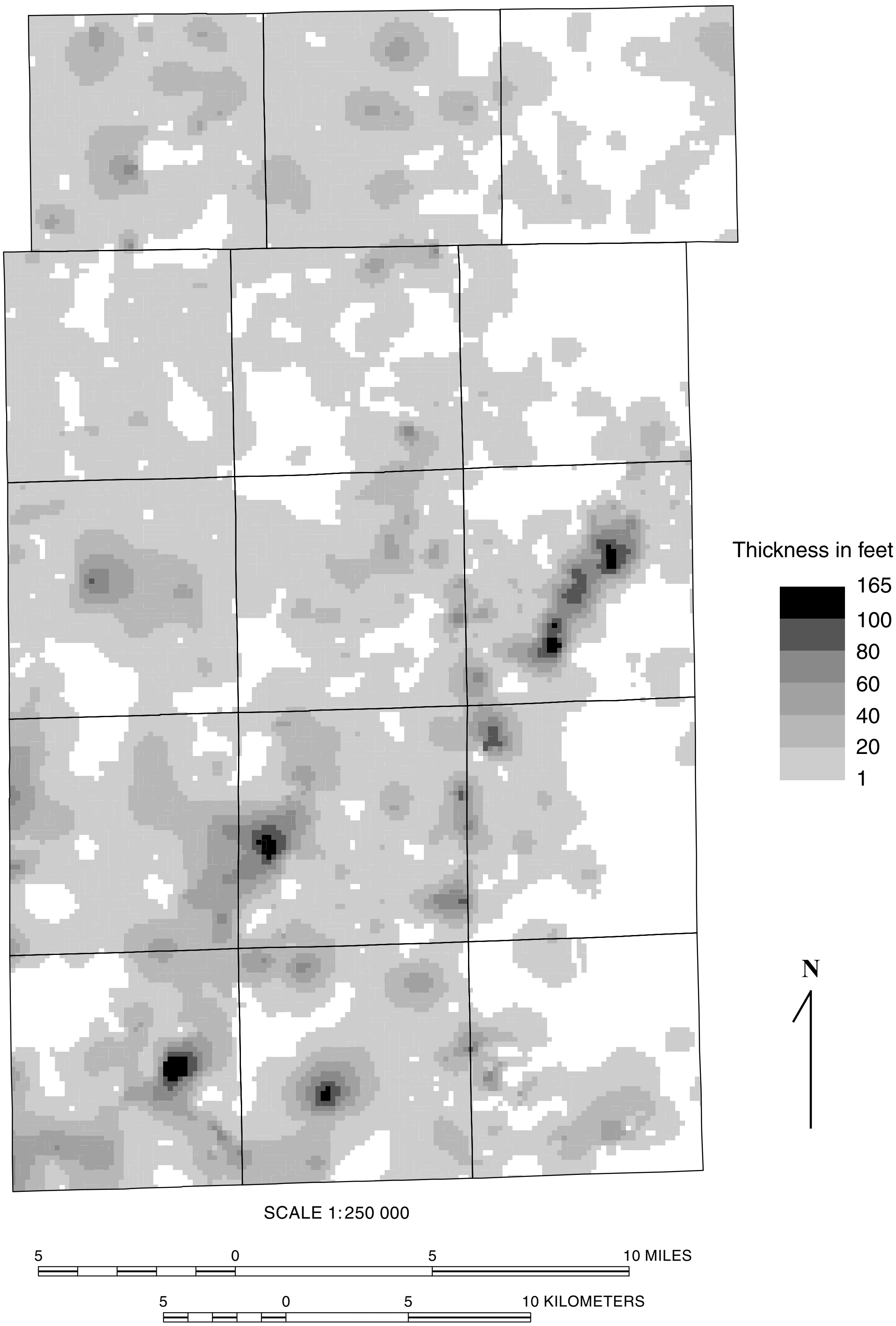

Figure 11 *Isopach map of net sand and gravel thickness of the Glasford Formation in Kane County.*

Depicting the undifferentiated Glasford Formation with three lithologic layers has improved the utility of the three-dimensional geologic model, but the resulting output shows some irregularities that need to be addressed. Lithologic assignments made within the Glasford Formation will be reassessed as input for future models. Particular emphasis will be given to identifying lithologic assignments of coarse-textured units that lack apparent lateral or vertical continuity and may be associated with irregularities in the surfaces of the three-layer model. Other methods of modeling the lithology of the Glasford Formation will be explored.

Application
The primary application of the interim three-dimensional geologic model is for input to a groundwater flow model in use by the ISWS. Initial results from ISWS groundwater flow modeling efforts will be used to identify additional areas where the geologic model may need refinement.

Major Quaternary Aquifers
The elements of the three-dimensional geologic model were used to produce the *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005a), replacing the *Preliminary Map of Major Quaternary Aquifesr, Kane County, Illinois* (Dey et al. 2004b). The preliminary map was based on aquifer definitions by Curry and Seaber (1990). The newer interim map adjusts the definitions of two of the four major aquifers and was built using newly delineated lithostratigraphic units that compose each aquifer.

In Illinois, major aquifers are defined as "geologic units (sand and gravel, or fractured and/or permeable bedrock) capable of yielding at least 300 liters of water per minute [80 gpm] to wells completed in them (a designation consistent with the Water Use Act of 1983)" (Berg and Wehrmann 1989). The Quaternary aquifers in Kane County are composed of thick sand and gravel deposits. At this stage of the project, it is impossible to accurately predict the water yield from any aquifer. Therefore, the *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005a) depicts the location of large contiguous sand and gravel deposits that may reasonably have the potential to meet the water-yield definition of a major aquifer. The mapped aquifers are greater than 50 feet thick at some point and several are square miles in areal extent. Boundaries were set where the mapped thickness of the aquifer became less than 20 feet thick, but the actual hydrostratigraphic units have greater extent.

Curry and Seaber (1990) described four major Quaternary aquifers in Kane County with the potential for development as public water supplies: the St. Charles, the Valparaiso, the Bloomington, and the Kaneville aquifers.

The St. Charles aquifer is located in the St. Charles Bedrock Valley in eastern and southern Kane County. The aquifer was defined as being composed of sand and gravel of the Ashmore Tongue of the Henry Formation and sands and gravels of the Glasford Formation (Curry and Seaber 1990; fig. 12). For this report, this definition is extended to other bedrock valleys as well. Other potential major aquifers with the same lithostratigraphic composition are identified on the interim map.

A portion of the Valparaiso aquifer is located in northeastern Kane County immediately below the ground surface. The aquifer was defined as being composed of surficial deposits of the Henry Formation and sand and gravel of the Beverly Tongue of the Henry Formation and the Haeger Member of the Lemont Formation (Curry and Seaber 1990). For this report, the definition is extended to include the Ashmore Tongue of the Henry Formation and the unnamed tongues of the Henry Formation associated with the Yorkville and Batestown Members of the Lemont Formation (Curry, 2005a, in review; fig. 13) in areas where the Beverly Tongue is present.

The Bloomington aquifer was defined by Curry and Seaber (1990) as consisting of surficial deposits of the Henry Formation and sand and gravel of the Ashmore Tongue of the Henry Formation, located west of the Marengo Moraine in northwestern Kane County. Sand and gravel of the Glasford Formation has been identified in contact with the Ashmore Tongue of the Henry Formation in the Hampshire area (Curry

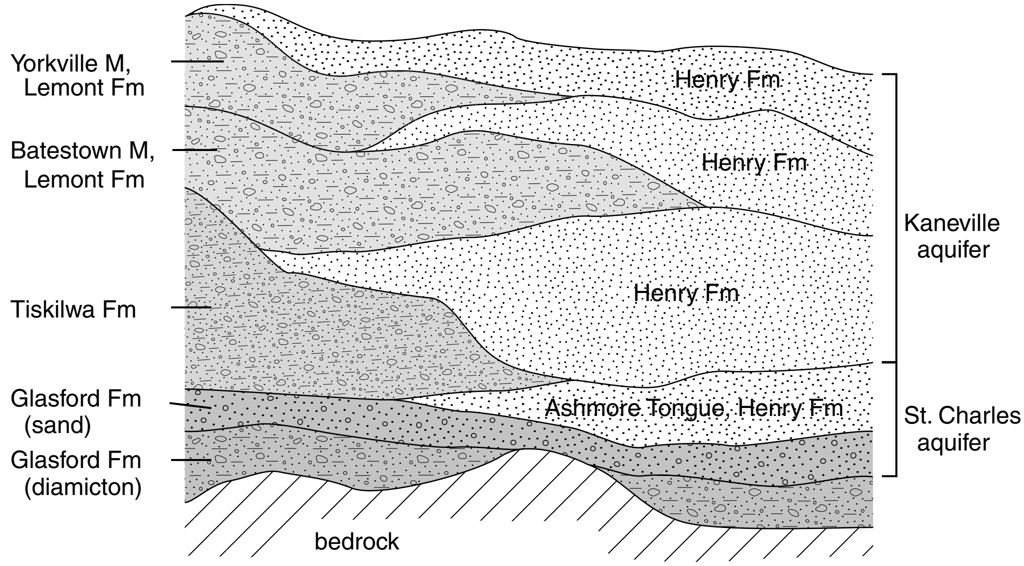

Figure 12 *Schematic diagram showing the relationship of the lithostratigraphic units of the St. Charles and Kaneville aquifers. M, member.*

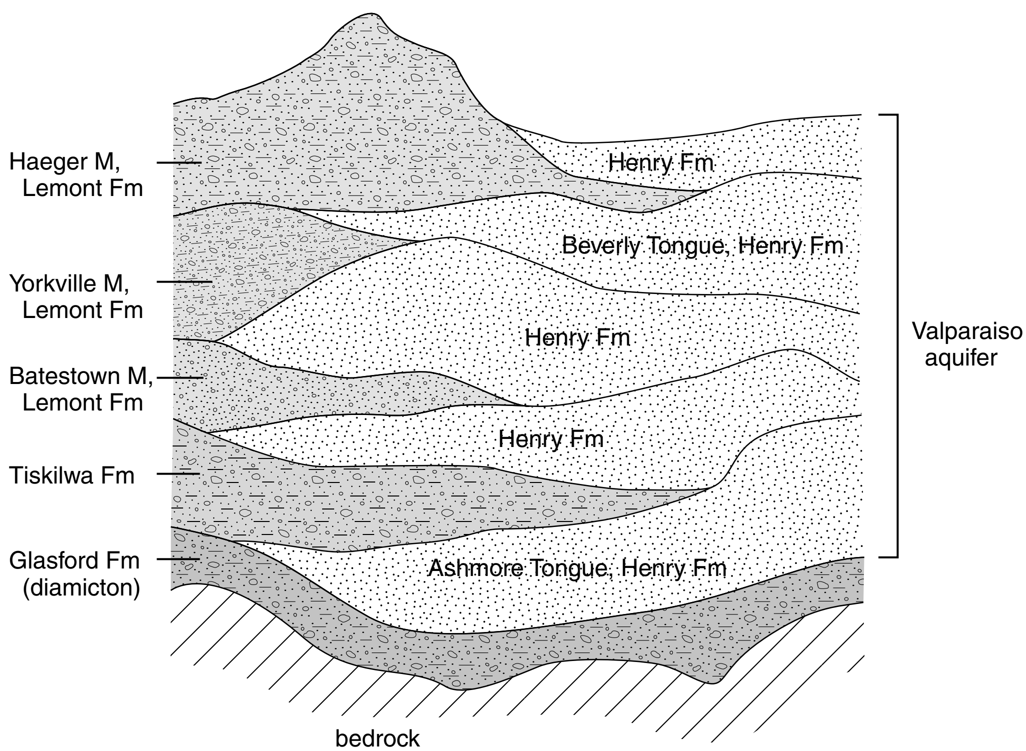

Figure 13 *Schematic diagram showing the relationship of the lithostratigraphic units of the Valparaiso aquifer. M, member.*

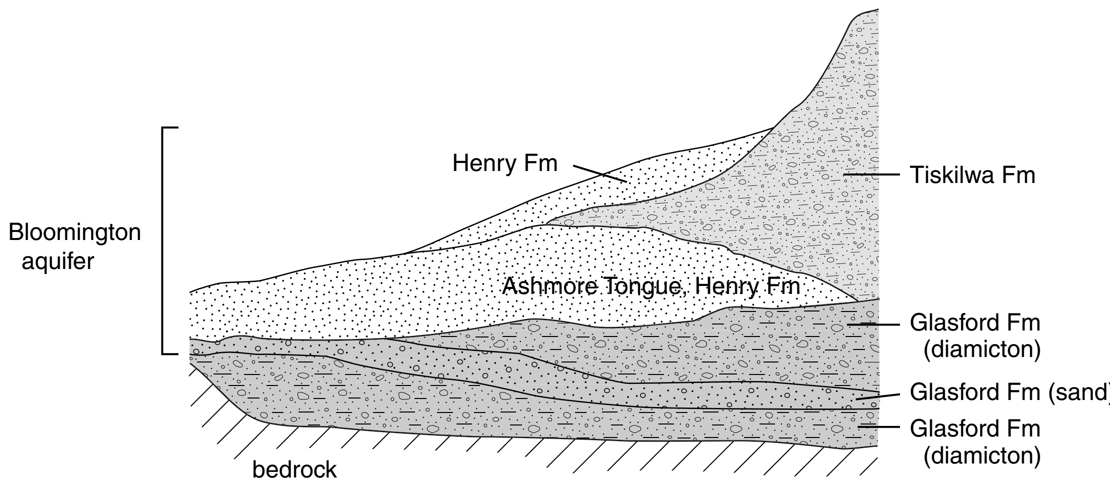

Figure 14 *Schematic diagram showing the relationship of the lithostratigraphic units of the Bloomington aquifer.*

2005b, in review). Therefore, the sands of the Glasford Formation are now included as a component of the Bloomington Aquifer (fig. 14).

The Kaneville aquifer member of the Elburn aquiformation was mapped by Vaiden and Curry (1990) as occurring in isolated patches across Kane County. The Kaneville aquifer was defined as consisting of surficial deposits of the Henry Formation and sand and gravel deposits associated with the Batestown and Yorkville Members of the Lemont Formation (Curry and Seaber 1990). Based on results from this report, the unnamed tongue of the Henry Formation associated with the Batestown Member composes the bulk of this aquifer, although the other two lithostratigraphic units contribute some to its total thickness and extent (fig. 12).

The *Interim Map of Major Quaternary Aquifers* (Dey 2005a) was constructed by compiling appropriate individual isopach maps for each of the major sand and gravel units. Once compiled, any limiting geographic elements of the aquifer definition were imposed on the compiled thickness map to delineate the aquifer (e.g., the Bloomington aquifer only was confined to the area west of the Marengo Moraine). The three-layer lithologic model of the Glasford Formation was not completed in time to be used in generating the interim map. Instead, the net sand and gravel thickness map of the Glasford Formation was used where sand and gravel of the Glasford Formation compose a portion of an aquifer.

The St. Charles aquifer was delineated by combining isopach map of the Ashmore Tongue of the Henry Formation with the net sand and gravel thickness map of the Glasford Formation (fig. 12). The combined thicknesses were superimposed on the bedrock topography map. The St. Charles aquifer was identified as the thick sands in the vicinity of the St. Charles Bedrock Valley. Similar associations were made with the Elburn and Montgomery Bedrock Valleys as well as the unnamed bedrock valley that enters western Kane County near Maple Park. Areas where these units are greater than 20 feet thick are shown in figure 15. Striped areas indicate areas of discontinuous occurrence of the aquifer based on interpolated geometry of the bedrock valleys, but are unsubstantiated by boring records. Additional aquifers with the same lithostratigraphic composition as the St. Charles aquifer were identified, but, because they are not associated with prominent bedrock valleys (fig.16), they are shown on the interim aquifer map (Dey et al. 2005a) as unnamed aquifers. Given their similar lithostratigraphic definitions, the unnamed aquifers were included in either the Bloomington or Valparaiso Aquifers where the geographic elements of their definitions were applicable.

The Valparaiso aquifer was mapped by combining the isopachs of the surficial deposits and the Beverly and Ashmore Tongues of the Henry Formation with the isopachs of the unnamed Tongues of the Henry Formation associated with the Yorkville and Batestown Members of the Lemont Formation (fig. 13).

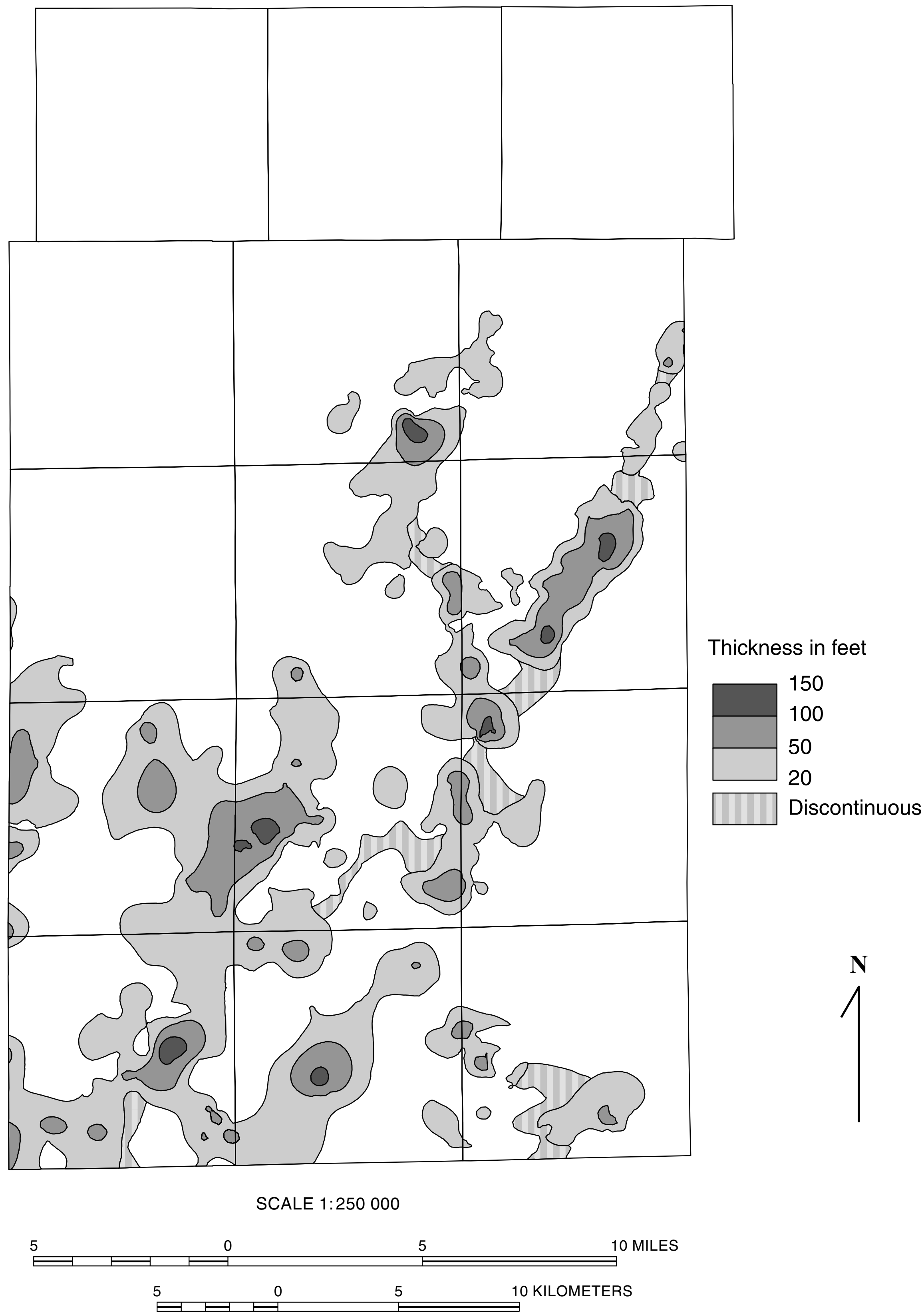

Figure 15 *Distribution and thickness of the St. Charles aquifer in Kane County.*

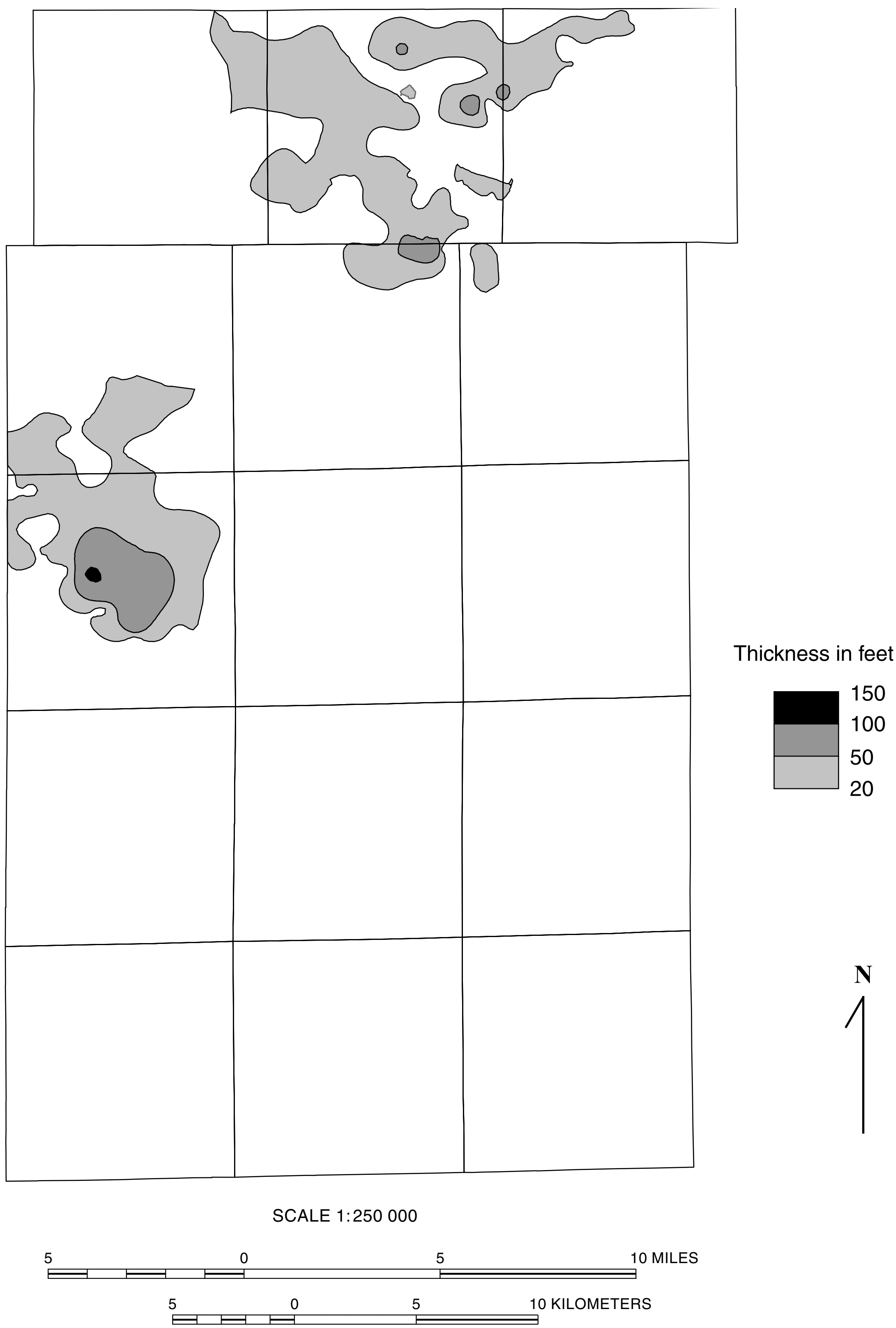

Figure 16 *Distribution and thickness of the unnamed aquifers stratigraphically associated with the St. Charles aquifer in Kane County.*

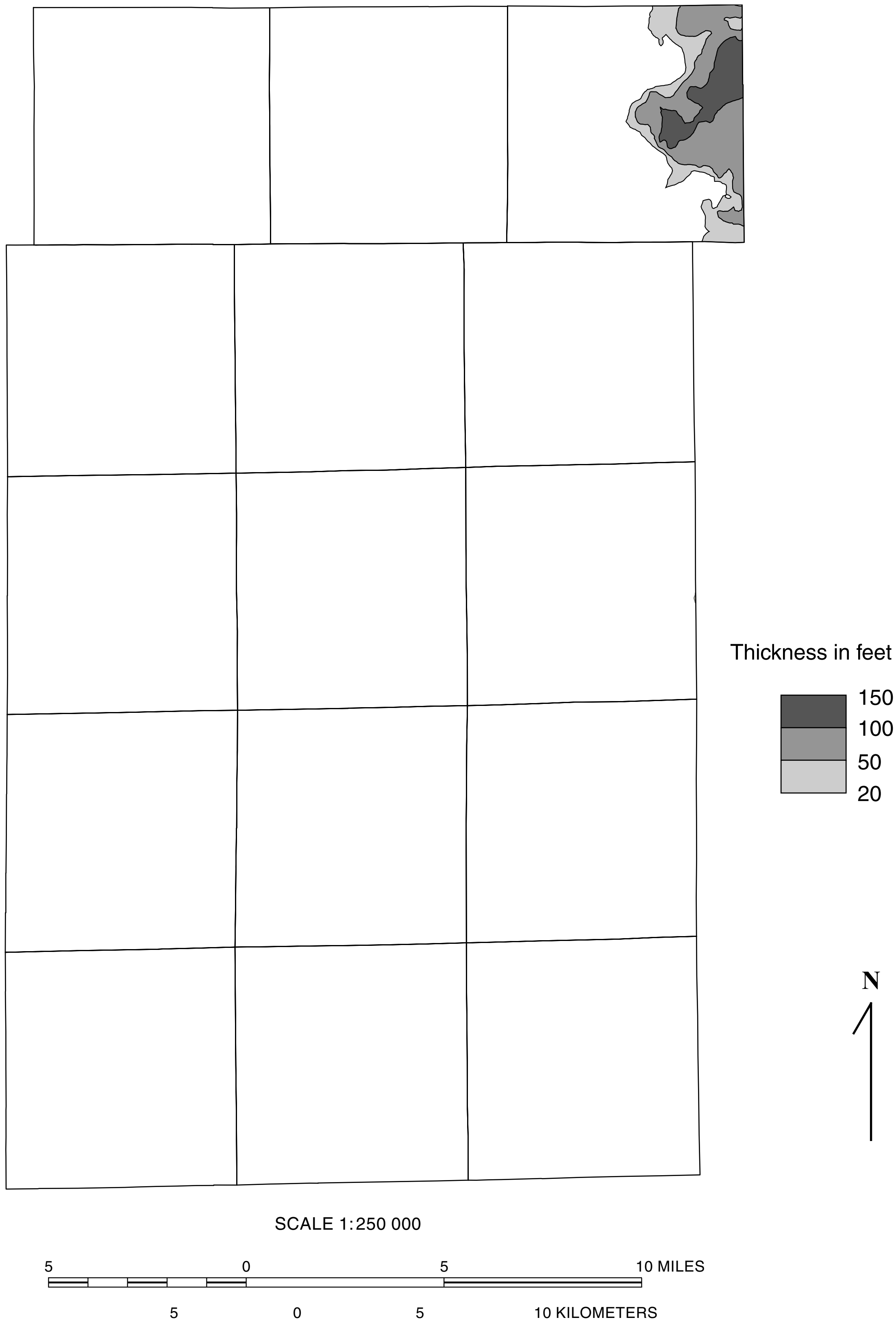

Figure 17 *Distribution and thickness of the Valparaiso aquifer in Kane County.*

The isopach of the Haeger Member of the Lemont Formation was not included because of questions concerning its hydraulic properties in Kane County. The Valparaiso aquifer was limited to areas generally east of the Fox River in Kane County, the only area in the county where the Beverly Tongue is present (fig. 17). Ongoing geologic mapping and groundwater flow modeling should help in delineating the lateral continuity of the Valparaiso aquifer with adjacent aquifers and with underlying sands of the Glasford Formation.

The Bloomington aquifer was delineated by combining isopach maps of the surficial deposits of the Henry Formation and the Ashmore Tongue of the Henry Formation and the composite isopach of sands in the Glasford Formation for areas west of the Marengo Moraine (figs. 14 and 18). The southern limit of the Bloomington aquifer was determined somewhat arbitrarily, as the combined thickness of the Glasford sands and the Ashmore Tongue define the St. Charles aquifer in this area as well. Ongoing geologic mapping and groundwater flow modeling should help to delineate the lateral continuity or boundaries between these aquifers.

The Kaneville aquifer was delineated by combining the isopachs of surficial deposits of the Henry Formation and sand and gravel deposits associated with the Batestown and Yorkville Members of the Lemont Formation (fig. 19). The Kaneville was not mapped in areas mapped as either the Bloomington or Valparaiso aquifers. The three-dimensional model was used to assess where the Kaneville aquifer has significant hydraulic connection with the St. Charles aquifer. These areas were delineated wherever the fine-textured material separating the two aquifers, generally diamictons of the Tiskilwa Formation, was less than three feet thick or absent. Areas of expected interaction between the St. Charles and Kaneville aquifers are indicated on the interim map.

Application
The *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005a) is intended for county-scale planning. Groundwater flow modeling may change the delineations and possibly definitions of the specific aquifers shown on this map. Groundwater flow modeling should provide estimates of the sustainable yields from these aquifers. A page-size depiction of the map is included in Appendix B1. The final version of this map is due in April 2007.

Bedrock Geology
Information on the topography of the bedrock surface and composition of the uppermost bedrock unit were combined to produce the *Interim Map of Bedrock Geology, Kane County, Illinois* (Dey et al. 2005b). The methods used in producing this map were the same as those used for the *Preliminary Bedrock Geology Map, Kane County, Illinois* (Dey et al. 2004c). Additional data were used in mapping the bedrock topography and delineating the surfaces of the bedrock units.

The topographic map of the bedrock surface was compiled using data from field observations and primary wells in the project. The elevation of the bedrock surface and location of the deepest parts of buried bedrock valleys also were estimated using seismic refraction methods (Heigold 1990). Bedrock surface elevation estimates from seismic refraction data are generally within 20 feet of the actual bedrock surface elevation as determined by subsequent test drilling (Gilkeson et al. 1987, Curry and Seaber 1990). Because of this greater uncertainty, seismic refraction data were used to guide mapping only in areas of sparse well data.

To construct the map, 5,722 data points were used (fig. 20). Of these data points, 4,045 were primary wells, and 188 were seismic refraction data from previous publications (Heigold 1990, Larson et al. 1991). Seismic reflection data collected in August 2002 along Merrill, Dugan, and Wheeler Roads near Sugar Grove resulted in 1,485 closely spaced data points used in this map.

As described previously, the bedrock topographic surface was created using an algorithm for the interpolation of elevations that favors creation of water drainage features (topogrid http://support.esri.com/). The

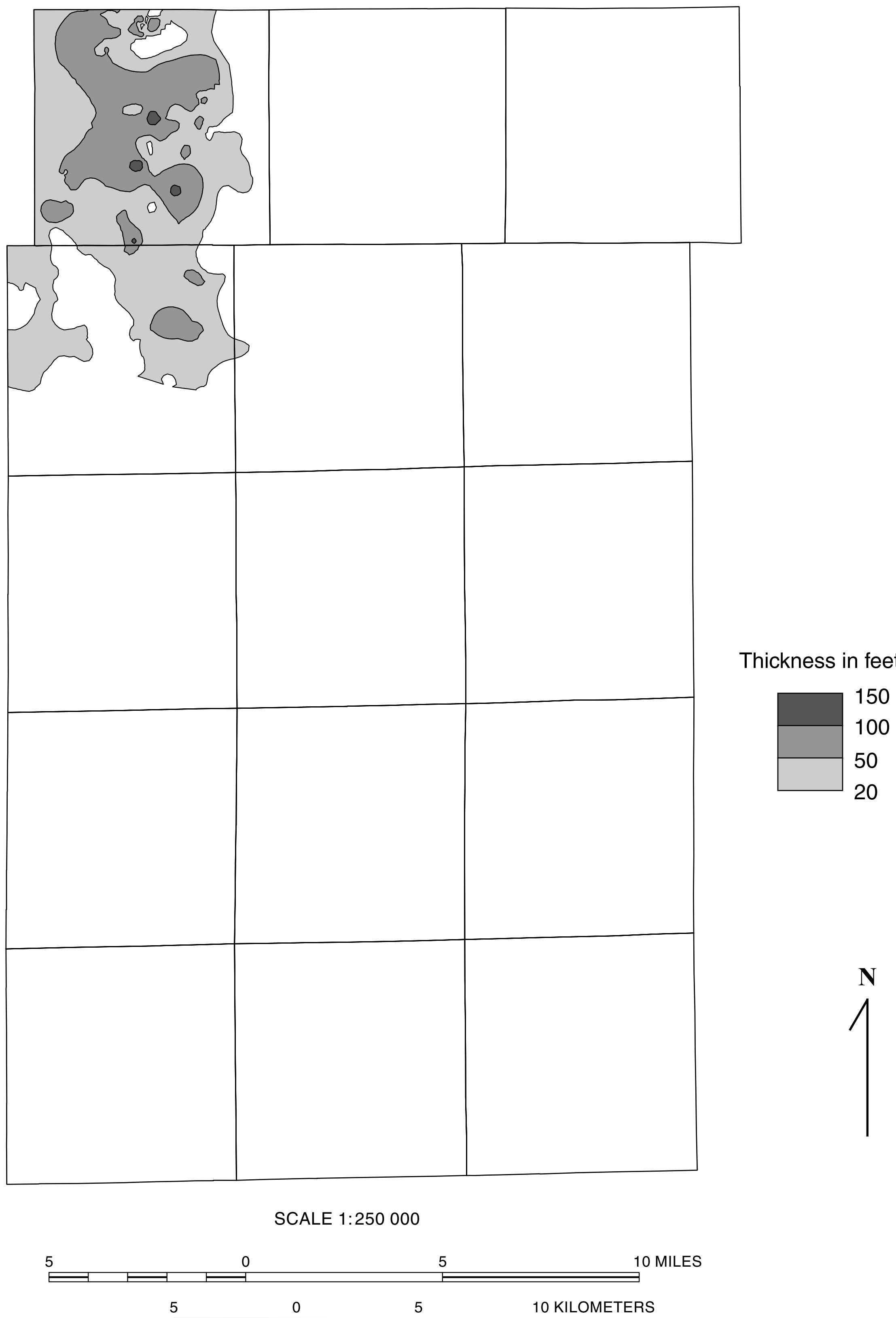

Figure 18 *Distribution and thickness of the Bloomington aquifer in Kane County.*

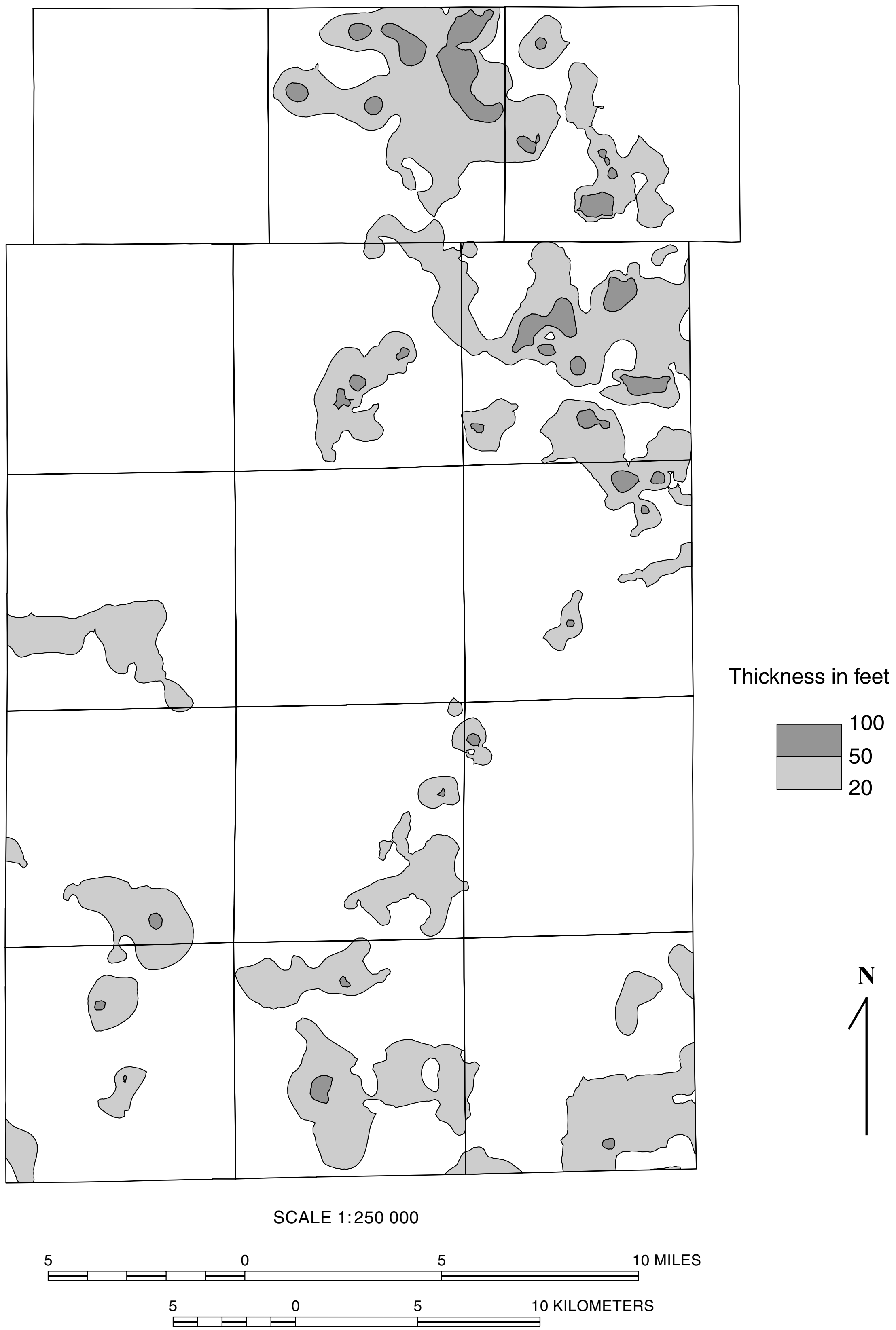

Figure 19 *Distribution and thickness of the Kaneville aquifer in Kane County.*

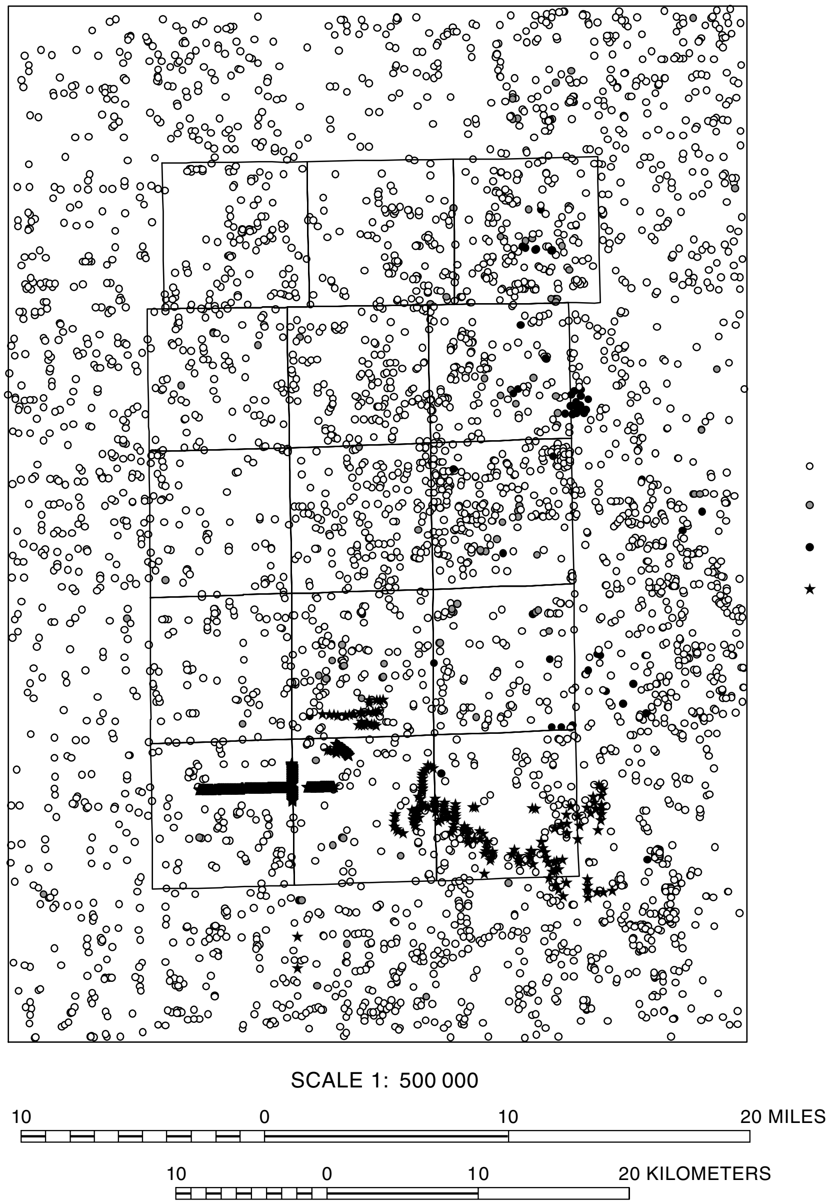

Figure 20 *Distribution and data type used to generate the bedrock topographic surface.*

resulting map has continuous valleys and other features that are more geologically plausible than the map would have been using the simple kriging interpolation used to create the other lithostratigraphic surfaces. The topographic surface was further adjusted using the insights of the authors. The bedrock surface of the whole study area was then cropped to conform to county boundaries.

Minor differences between the new bedrock topography map and the *Preliminary Bedrock Geology Map, Kane County, Illinois* (Dey et al. 2004c) include changes to the course of the St. Charles Bedrock Valley in the vicinity of Sugar Grove in southwestern Kane County and in the vicinity of Elgin in northeastern Kane County. Otherwise, the shapes of the major bedrock valleys were not significantly changed (fig. 21). The bedrock lithostratigraphic map was created largely from previous lithostratigraphic assignments made by ISGS staff members (Graese, unpublished data; Kolata and Graese 1983; Kempton et al. 1987a,b; Curry et al. 1988; Vaiden et al. 1988). Additional lithostratigraphic assignments were made for this report from wells in the project database. Data from 928 wells provided one or more bedrock lithostratigraphic assignments.

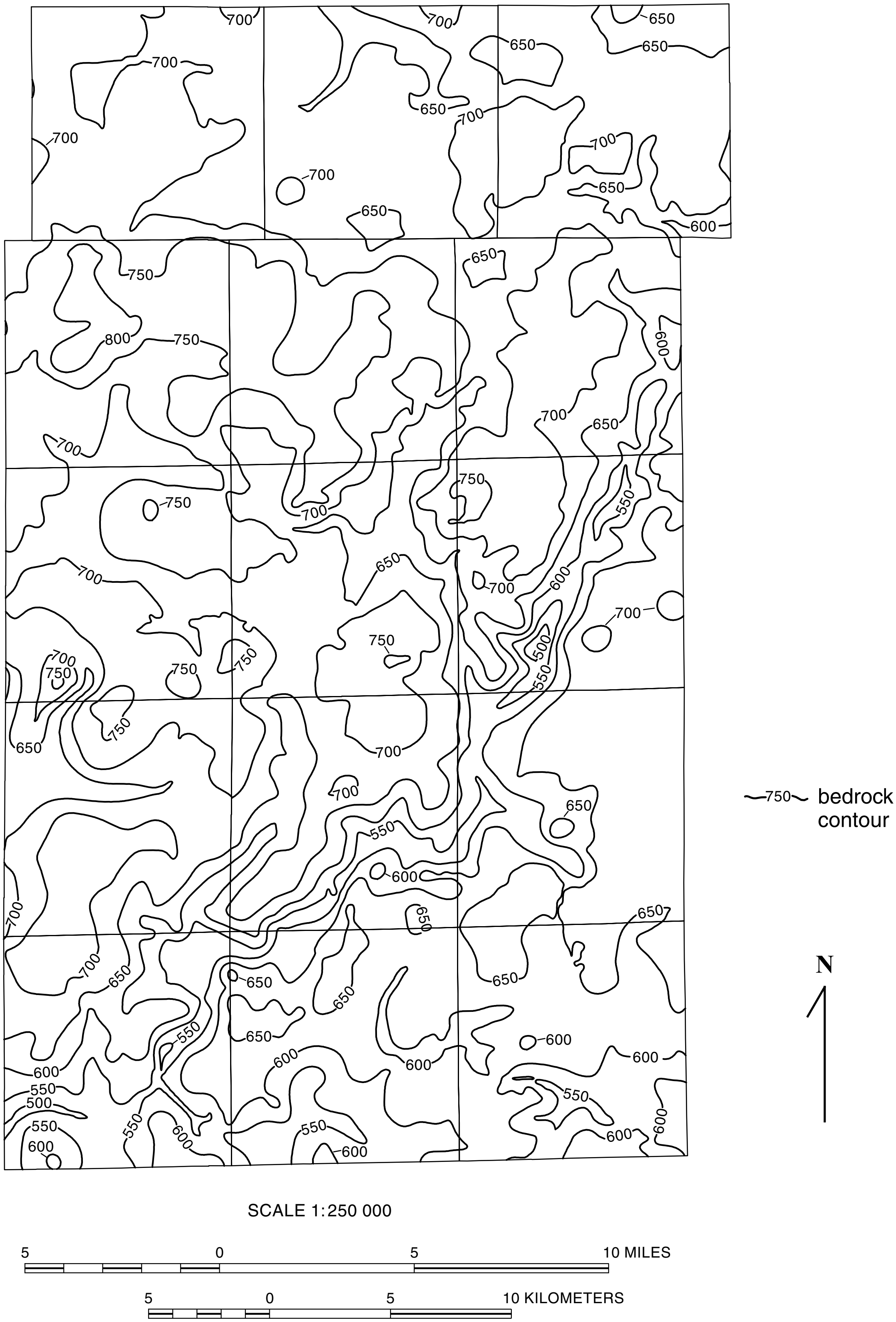

Figure 21 *Bedrock topography of Kane County.*

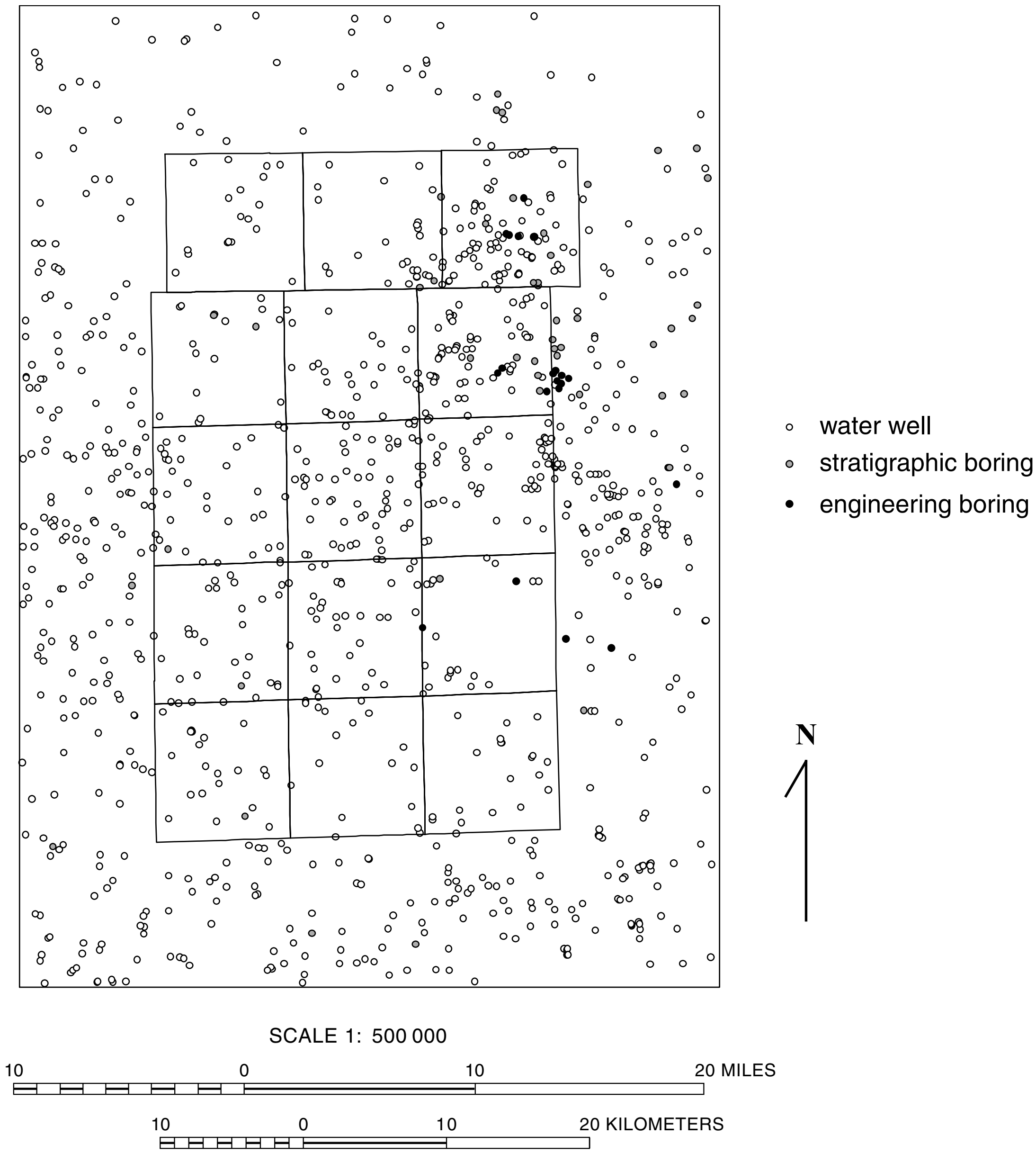

Figure 22 *Distribution of borings used to the generate bedrock lithology map.*

Stratigraphic assignments were simplified into five units: undifferentiated Silurian formations, the Maquoketa Group, the Galena-Platteville Groups, the Ancell Group, and undifferentiated Cambrian formations. The reported uppermost occurrences of each unit were used to produce a surface defining the upper extent of that unit. The surface of each unit was truncated using our bedrock topography map, which either removed the unit or lowered the elevation of its upper surface across the study area. The upper surface of a subsequent lower unit defines the bottom of each unit. Although not depicted on the map, distribution and thickness were produced for each bedrock unit in the study area. A map of the uppermost bedrock unit was created for the entire study area and then was cropped to the county boundaries.

Figure 22 shows the distribution of data points used in creating the bedrock lithology map, and table 2 shows the number of wells with assignments to each major unit. Figure 23 is the resulting map of the uppermost bedrock units for Kane County.

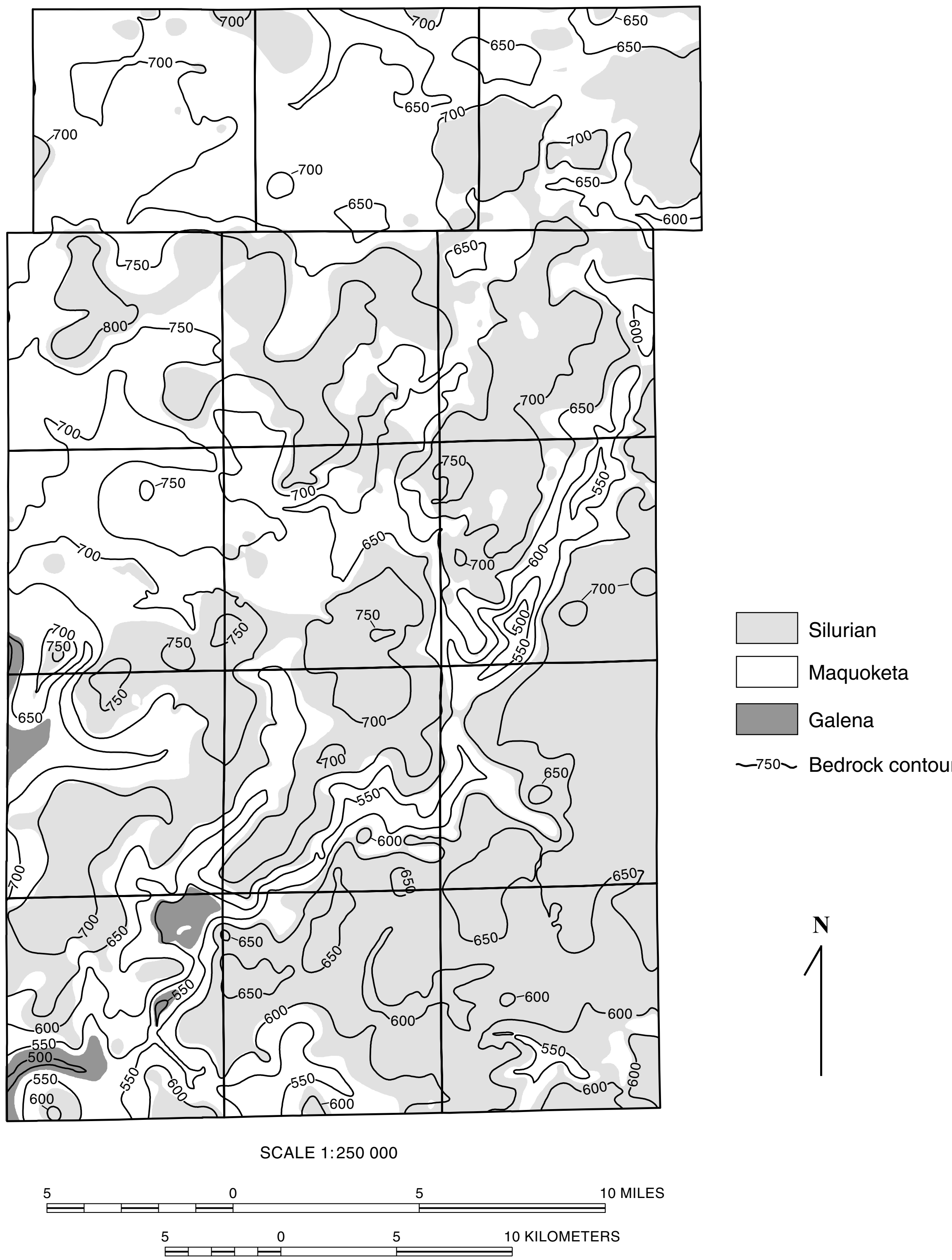

Figure 23 *Bedrock topography and subcrop pattern of the major stratigraphic bedrock units.*

Application

The *Interim Map of Bedrock Geology, Kane County, Illinois* (Dey et al. 2005b) can be used to identify the lithology of the uppermost bedrock units across the county and the location of major bedrock valleys. Both uses are important in delineating potential sources of groundwater. For example, the St. Charles aquifer is defined, in part, by association with bedrock valleys. Also, the map displays where the uppermost bedrock unit is an aquifer, which is the case for the Silurian rocks. The data distribution used to construct the bedrock lithostratigraphy map (fig. 23) is much sparser than that used in making the bedrock topography map (fig. 20) or in mapping the distribution of Quaternary deposits (fig. 14). We did not map facies in the Maquoketa Group identified by Graese (1991). As with all maps at 1:100,000, the map should not be used as a substitute for site-specific work. A page-size depiction of the map is included in Appendix B2.

Continuing work toward producing the final version of this map (due April 2007) will include efforts to better delineate the courses of the St. Charles, Elgin, and Aurora Bedrock Valleys and the intersection of the Elburn and St. Charles Bedrock Valleys (fig. 23). In addition, we will attempt to delineate areas of the dolomitic facies of the Maquoketa Group, which is used locally as a source aquifer for private water supplies.

SUMMARY AND FUTURE PLANS

An improved three-dimensional geologic model was generated for Kane County and vicinity. The project database has been continually updated and now contains 37,107 water-well and boring records and other point data. Primary wells used in the mapping effort have been increased to 4,092.

Over the last year, the number of lithostratigraphic assignments delineating each of the major geologic units has doubled (table 2). These assignments were used to create a new set of surfaces and isopachs of selected lithostratigraphic units. The surfaces were checked and corrected for conformation to the conceptual model and to one another. The surfaces were compiled into a three-dimensional geologic model and were used to generate two interim maps: the *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005a) and *Interim Map of Bedrock Geology, Kane County, Illinois* (Dey et al. 2005b).

The ISGS is conducting a related study to create a statewide database of hydraulic conductivity values from Quaternary units in Illinois. This study is independent of the Kane County investigation, but the data gained can be used to improve the quality of products produced for Kane County. Results from 228 hydraulic conductivity tests at 92 sites in Kane County have been compiled from consultant reports on file with the Illinois Environmental Protection Agency (IEPA). The data include location information, values of hydraulic conductivity, the depth and thickness of the screened interval, the type of test conducted (in situ vs. ex situ), and the method of analysis. Results from individual tests are being evaluated for potential correlation to lithostratigraphic units in the three-dimensional geologic model.

We have planned additional geophysical surveys in southern Kane County to further map the location of the St. Charles and Aurora Bedrock Valleys. We plan to drill additional stratigraphic borings in southern Kane County to correlate with the seismic work. Also, we plan to drill stratigraphic borings and collect downhole gamma ray logs to help delineate the distribution and thickness of the Valparaiso aquifer in northeastern Kane County and adjoining portions of Cook County.

Findings from this report will be shared with ISWS for use in completing the *Computer Flow Models of Aquifer Systems Used in Kane County and Supporting Hydrologic Database*. Results from ISWS flow modeling will be used to refine our geologic model and will contribute to the *Final Report on Geological Investigations*, due in April 2007. The final report will be accompanied by final versions of the preliminary maps presented in *Interim Report on Geological Investigations.*

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APPENDIX A

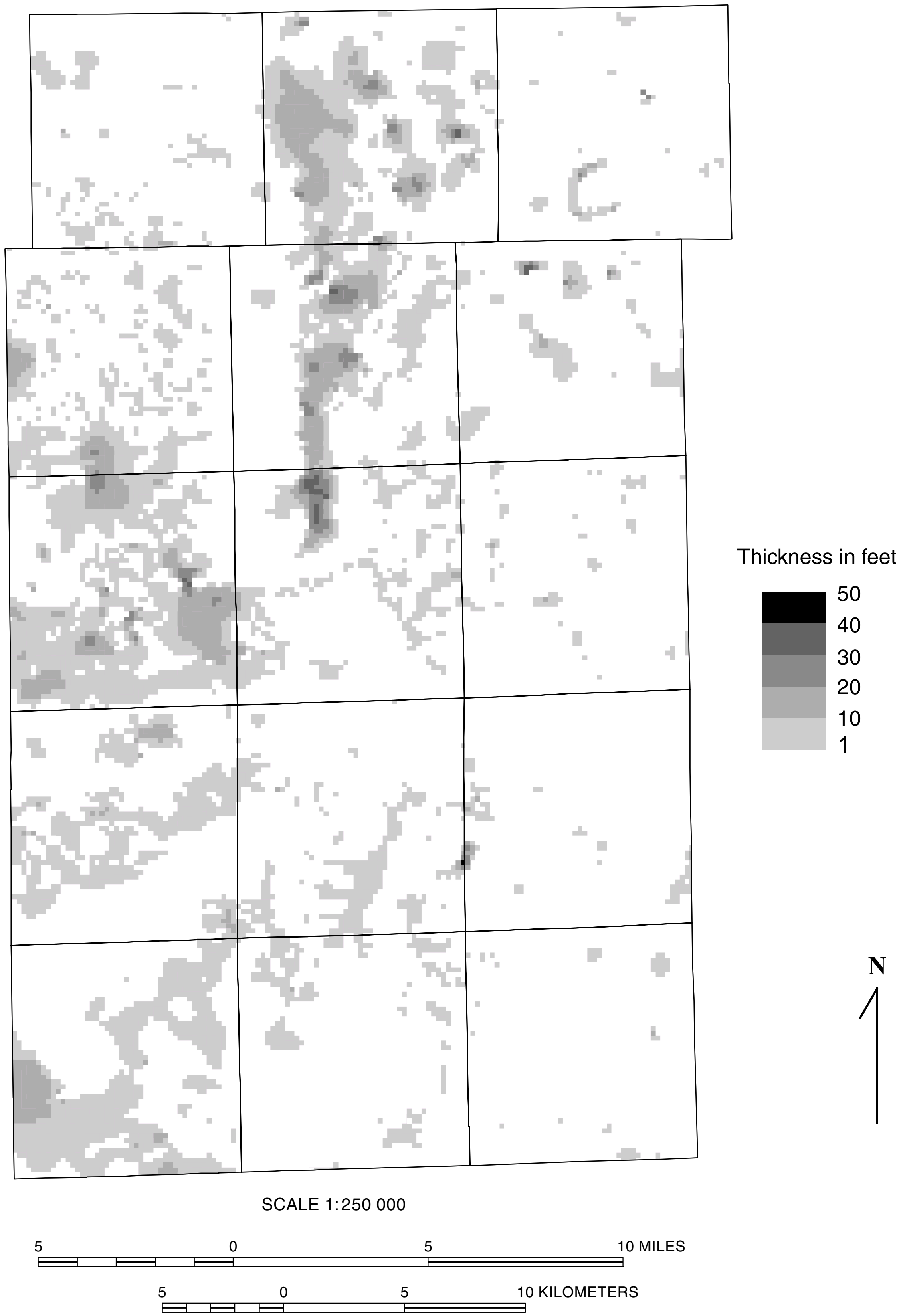

Figure A1 *Isopach map of combined Grayslake Peat, Cahokia Formation, and Equality Formation in Kane County.*

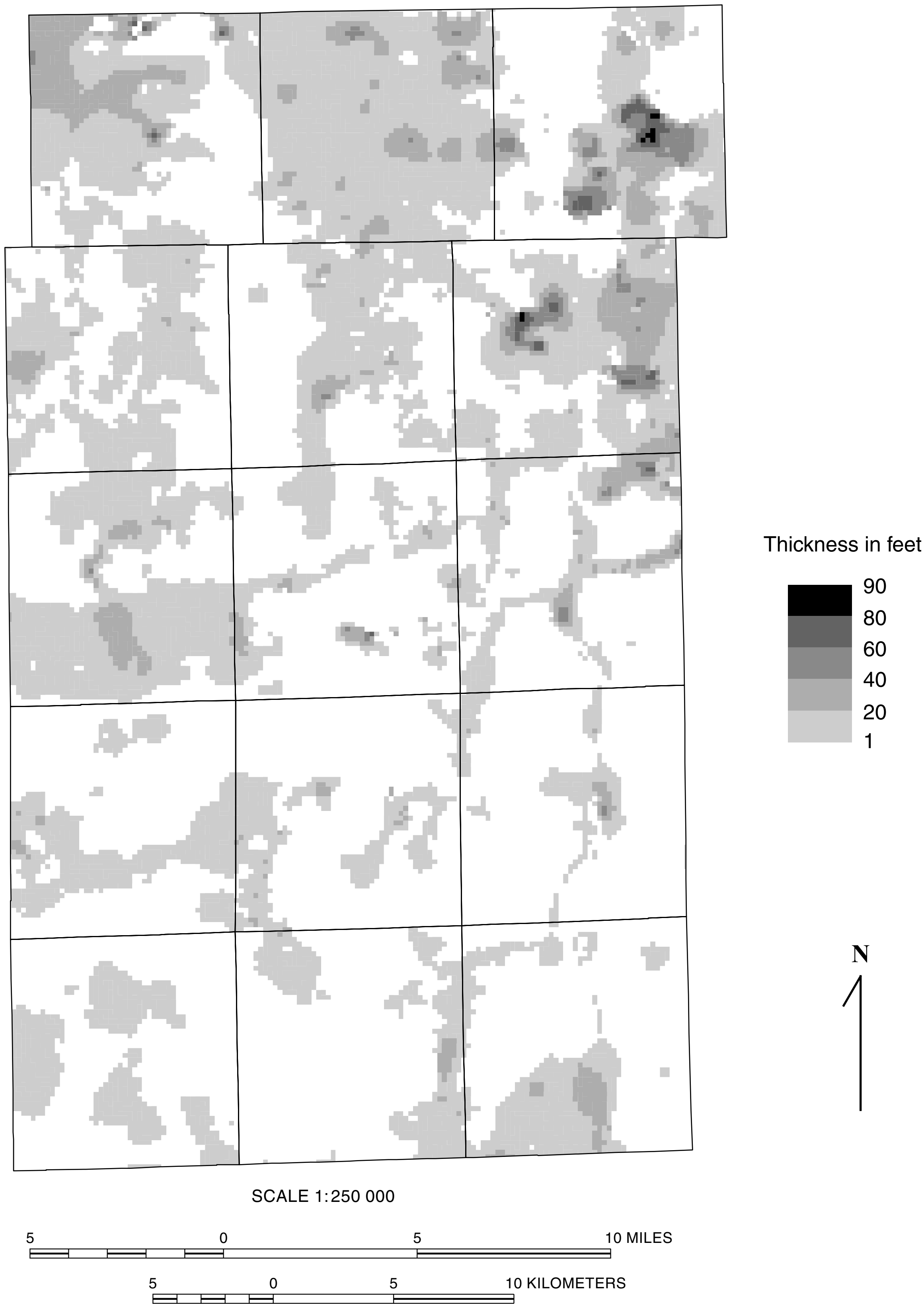

Figure A2 *Isopach map of surficial sand and gravel of the Henry Formation in Kane County.*

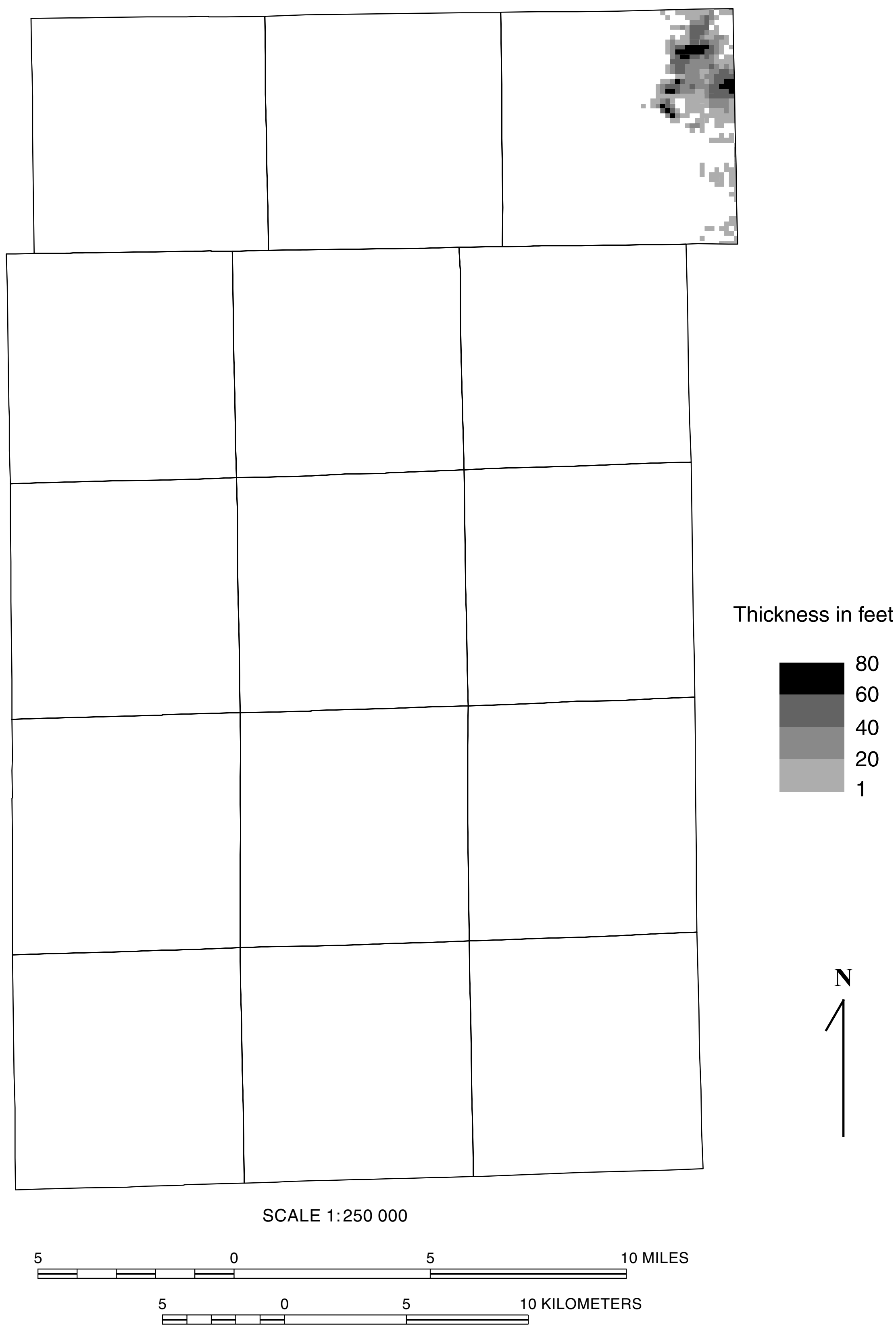

Figure A3 *Isopach map of diamicton of the Haeger Member, Lemont Formation, in Kane Count.y*

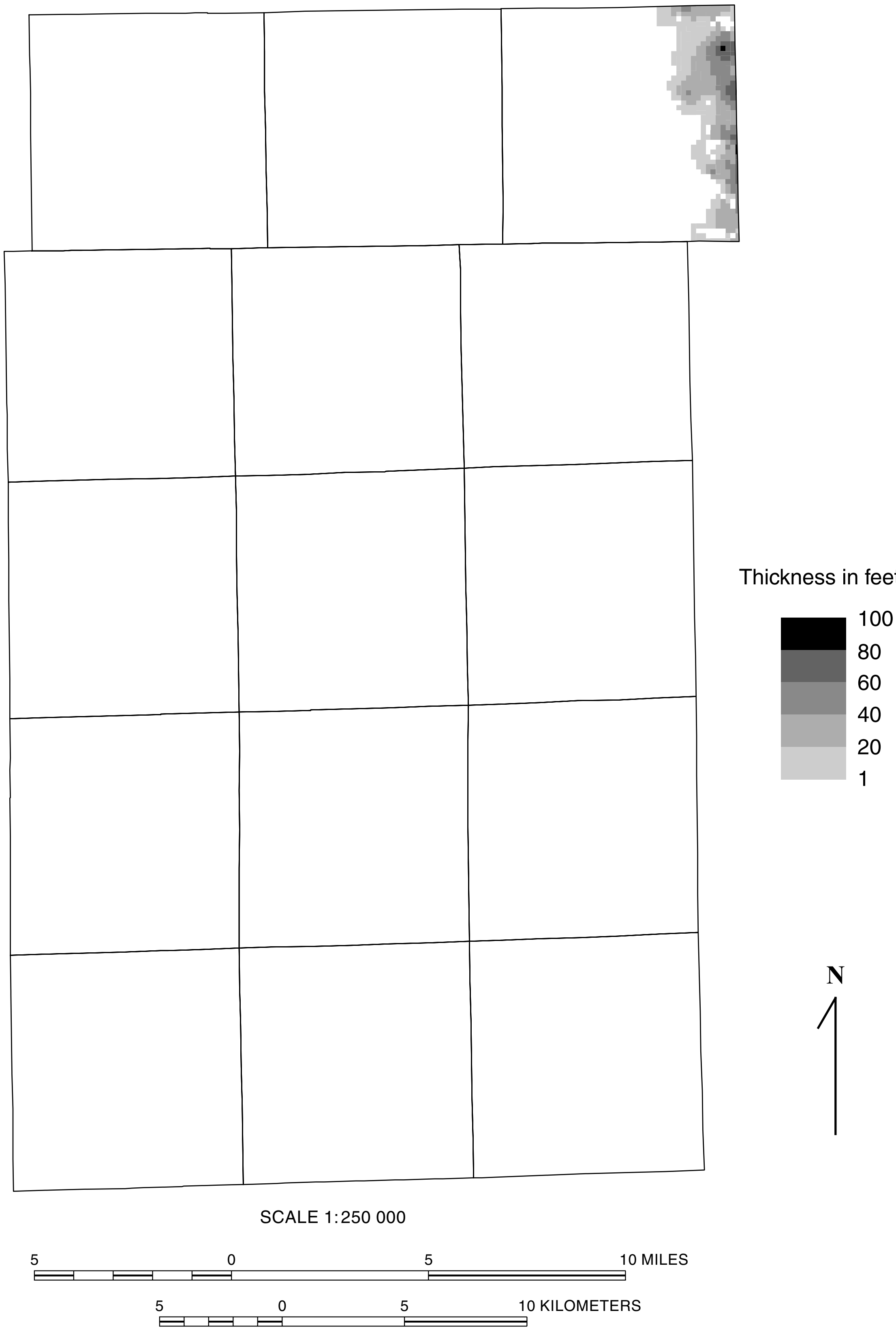

Figure A4 *Isopach map of proglacial sand and gravel associated with the Haeger Member, Lemont Formation, known as the Beverly Tongue of the Henry Formation in Kane County.*

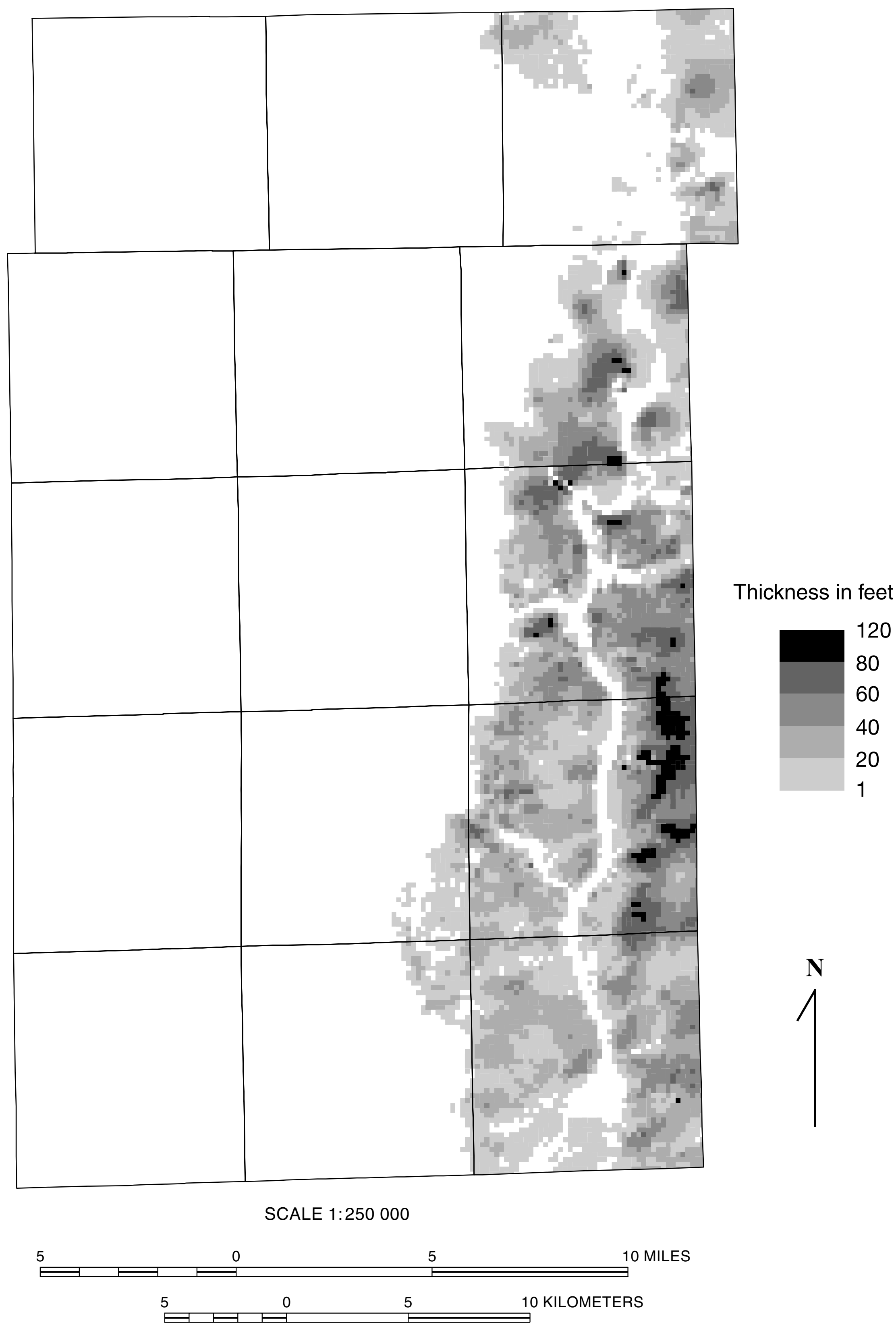

Figure A5 *Isopach map of diamicton of the Yorkville Member, Lemont Formation, in Kane County.*

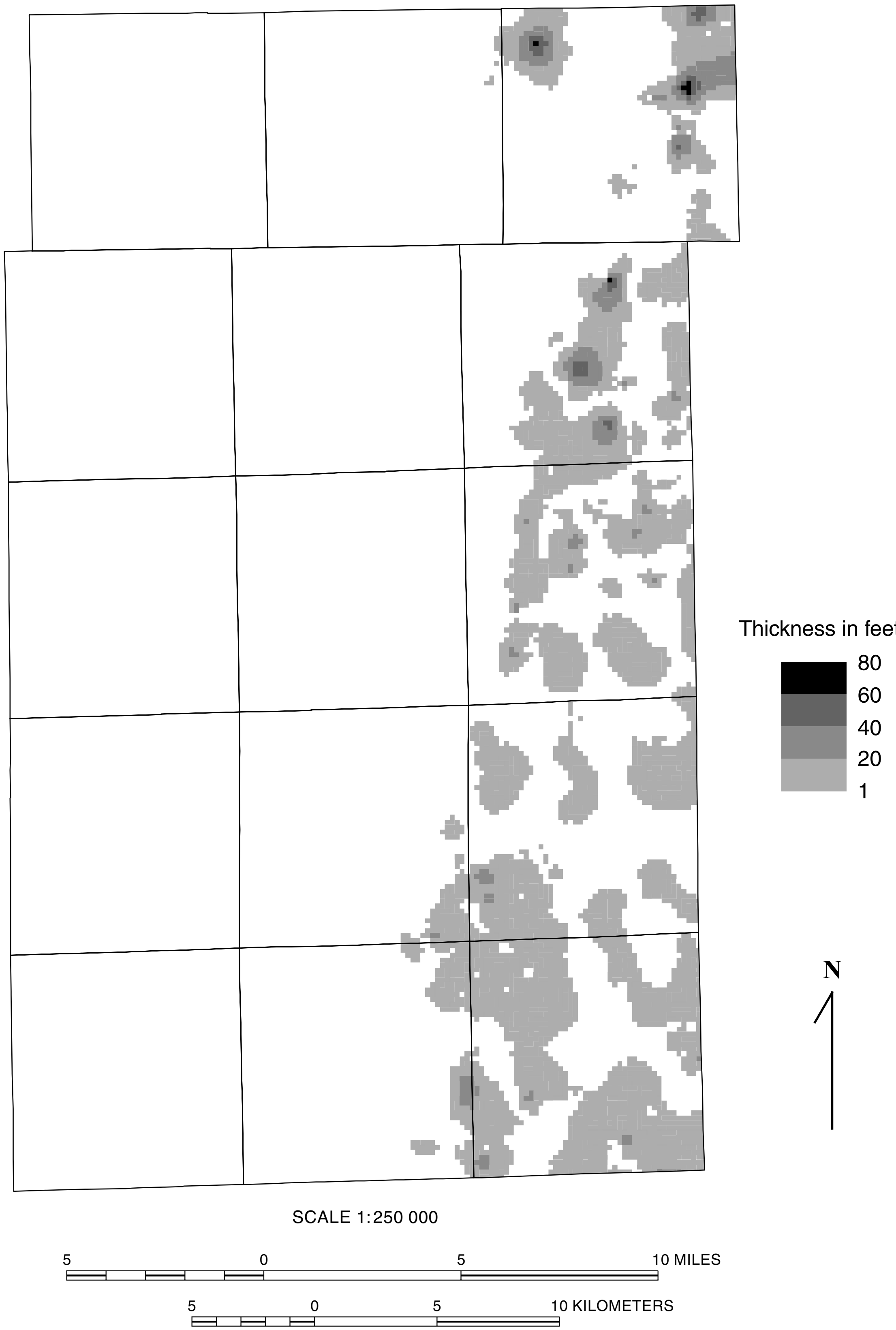

Figure A6 *Isopach map of basal sand and gravel associated with the Yorkville Member, Lemont Formation, in Kane County.*

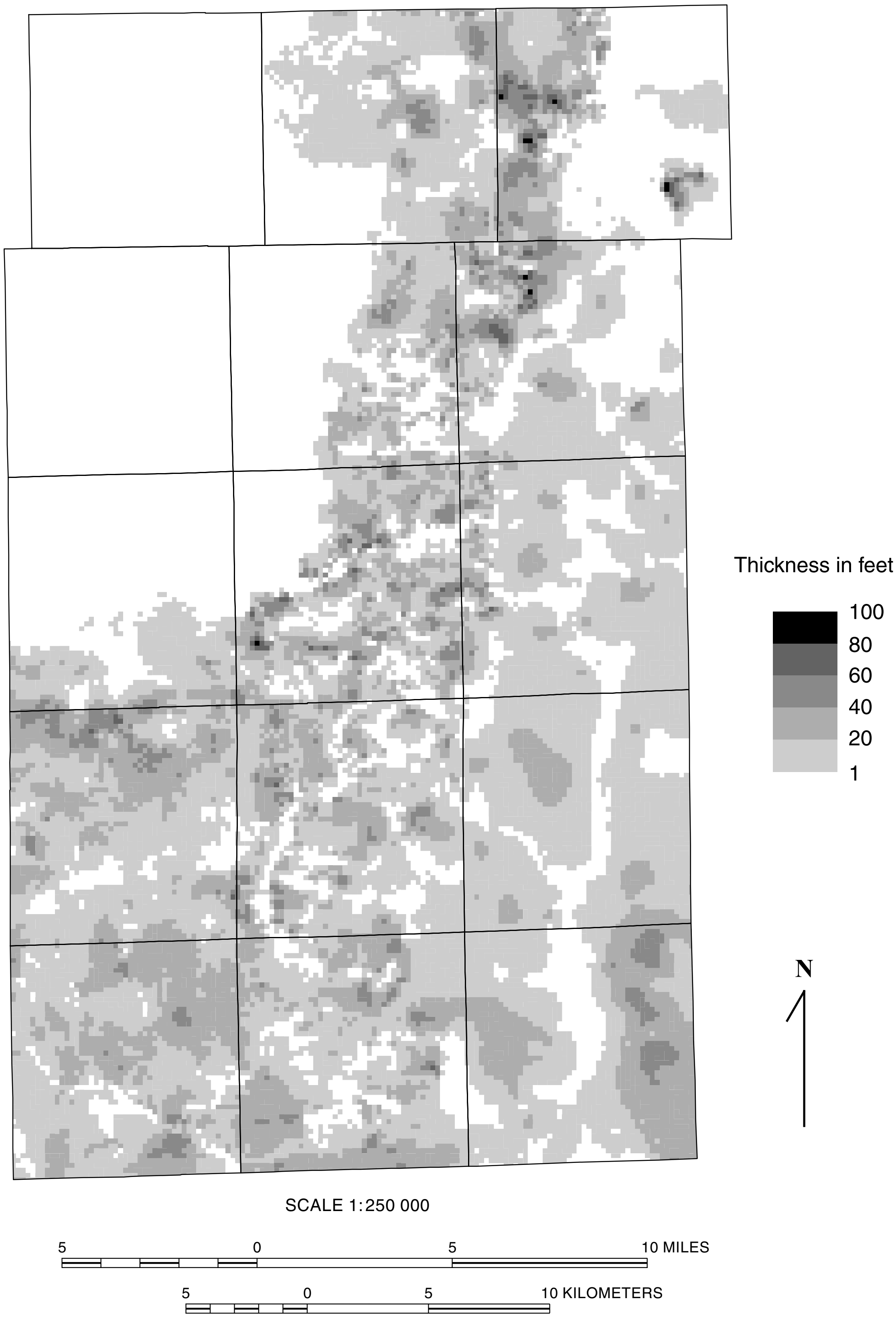

Figure A7 *Isopach map of diamicton of the Batestown Member, Lemont Formation, in Kane County.*

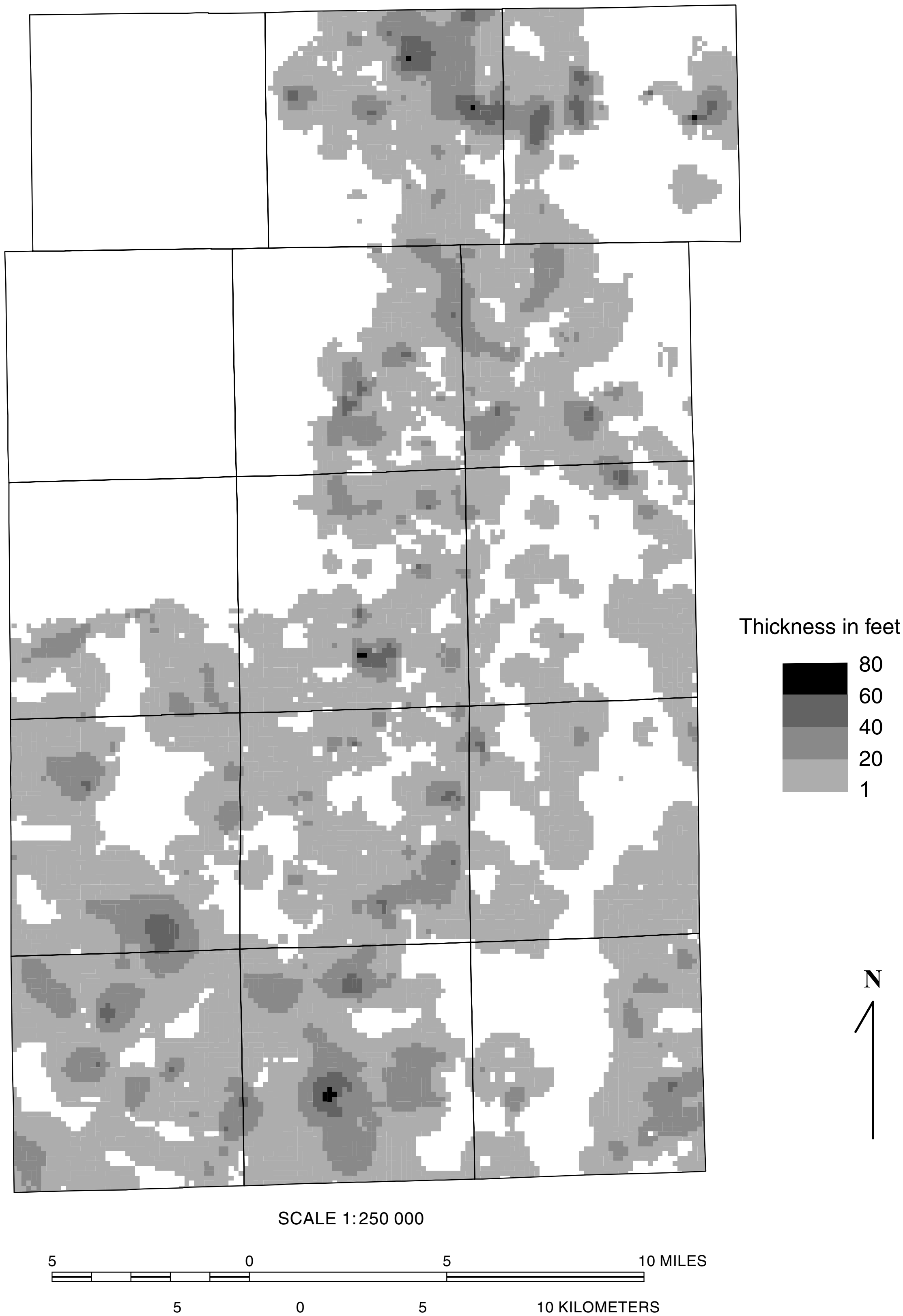

Figure A8 *Isopach map of basal sand and gravel associated with the Batestown Member, Lemont Formation, in Kane County.*

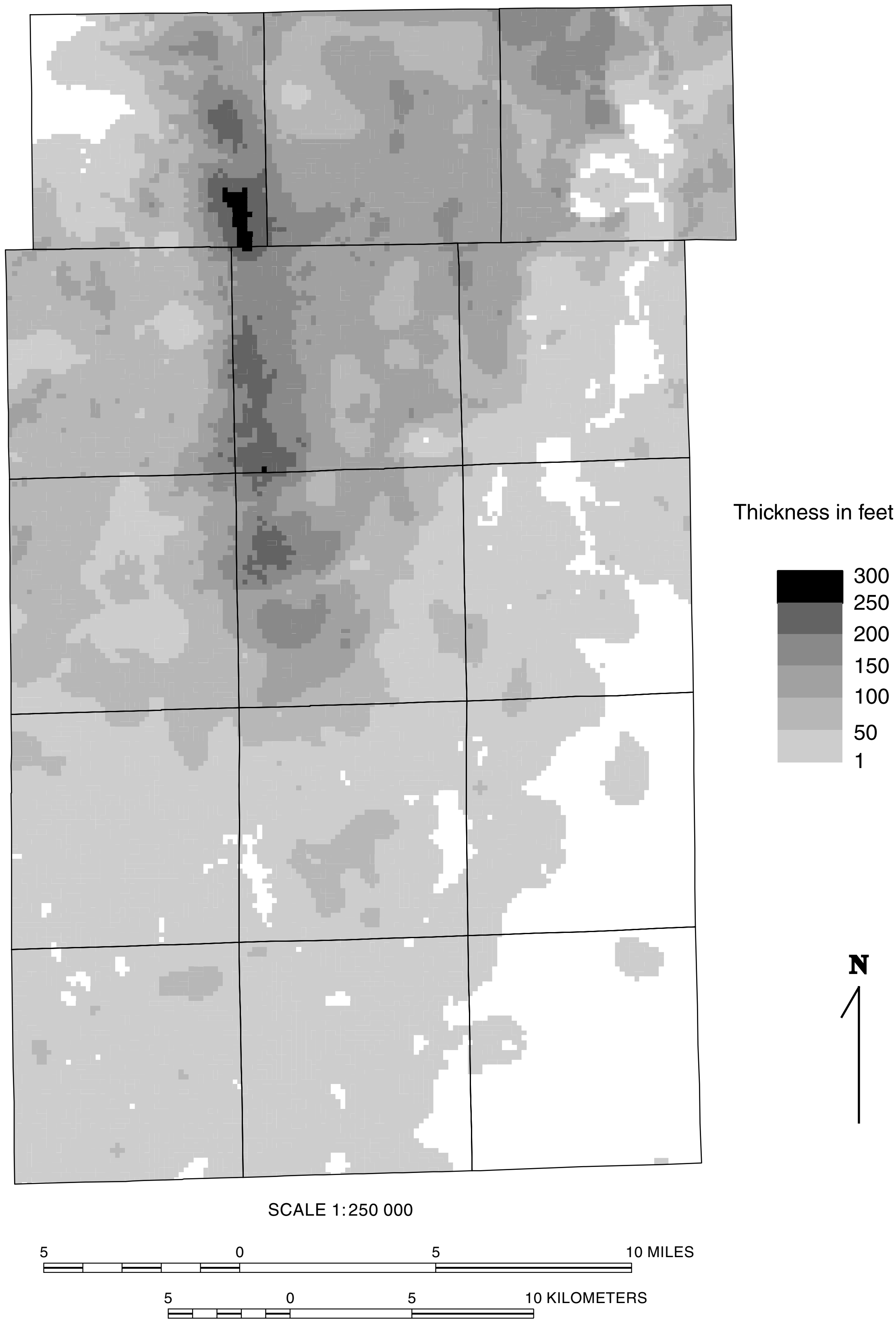

Figure A9 *Isopach map of diamicton of the Tiskilwa Formation in Kane County.*

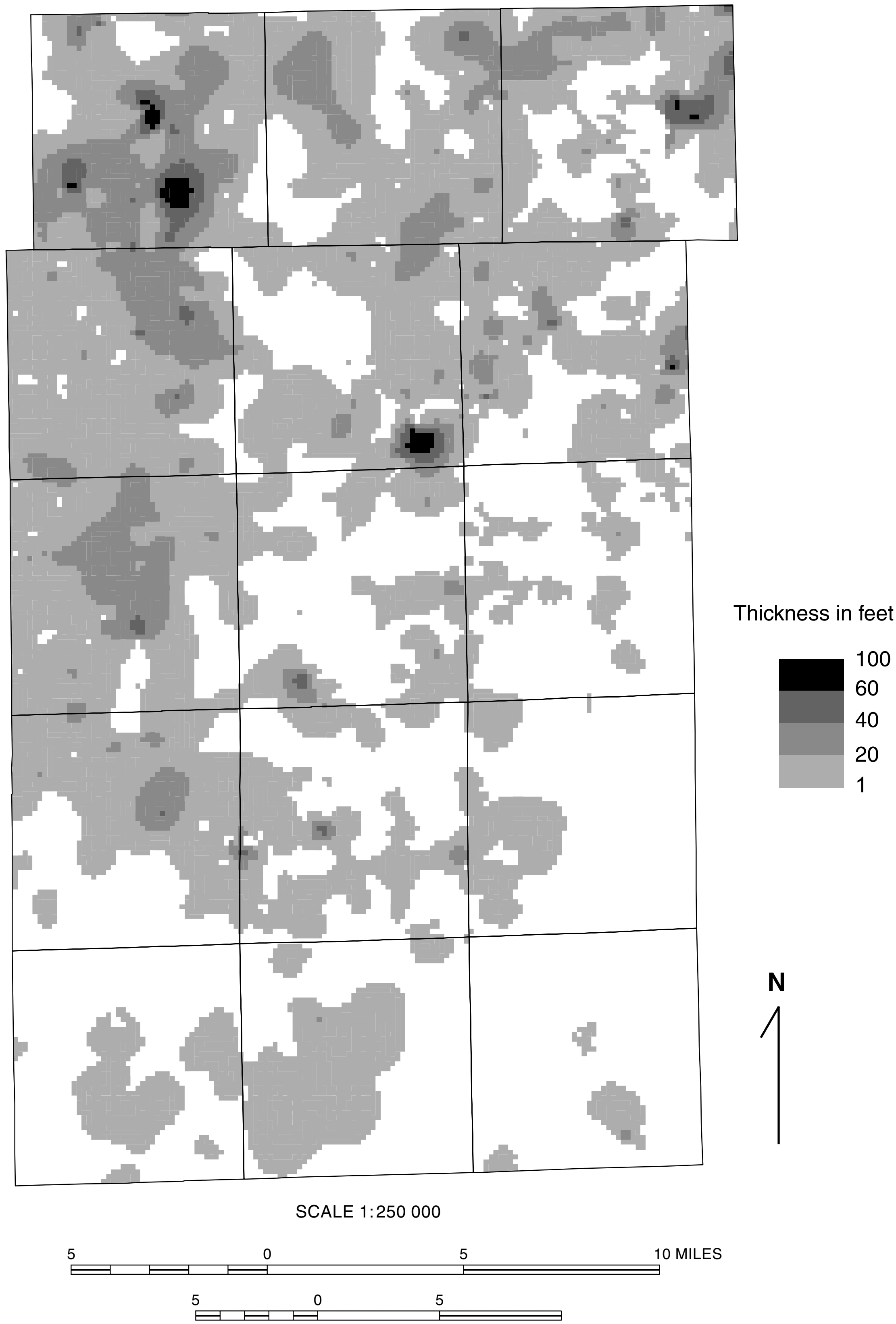

Figure A10 *Isopach map of the proglacial sand and gravel associated with the Tiskilwa Formation known as the Ashmore Tongue of the Henry Formation.*

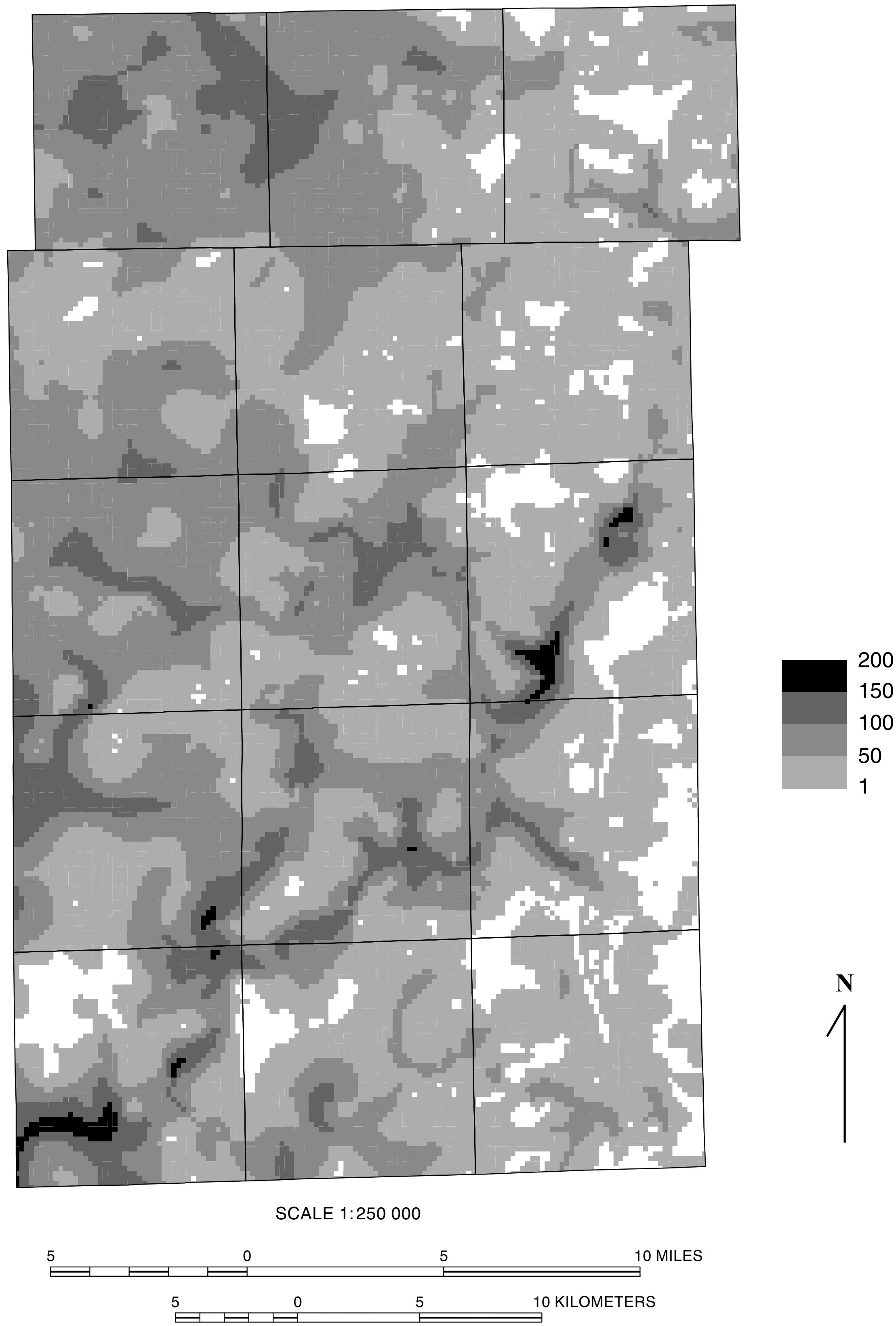

Figure A11 *Isopach map of various deposits (diamicton, silt and clay, and sand and gravel) of the Glasford Formation in Kane County.*

APPENDIX B

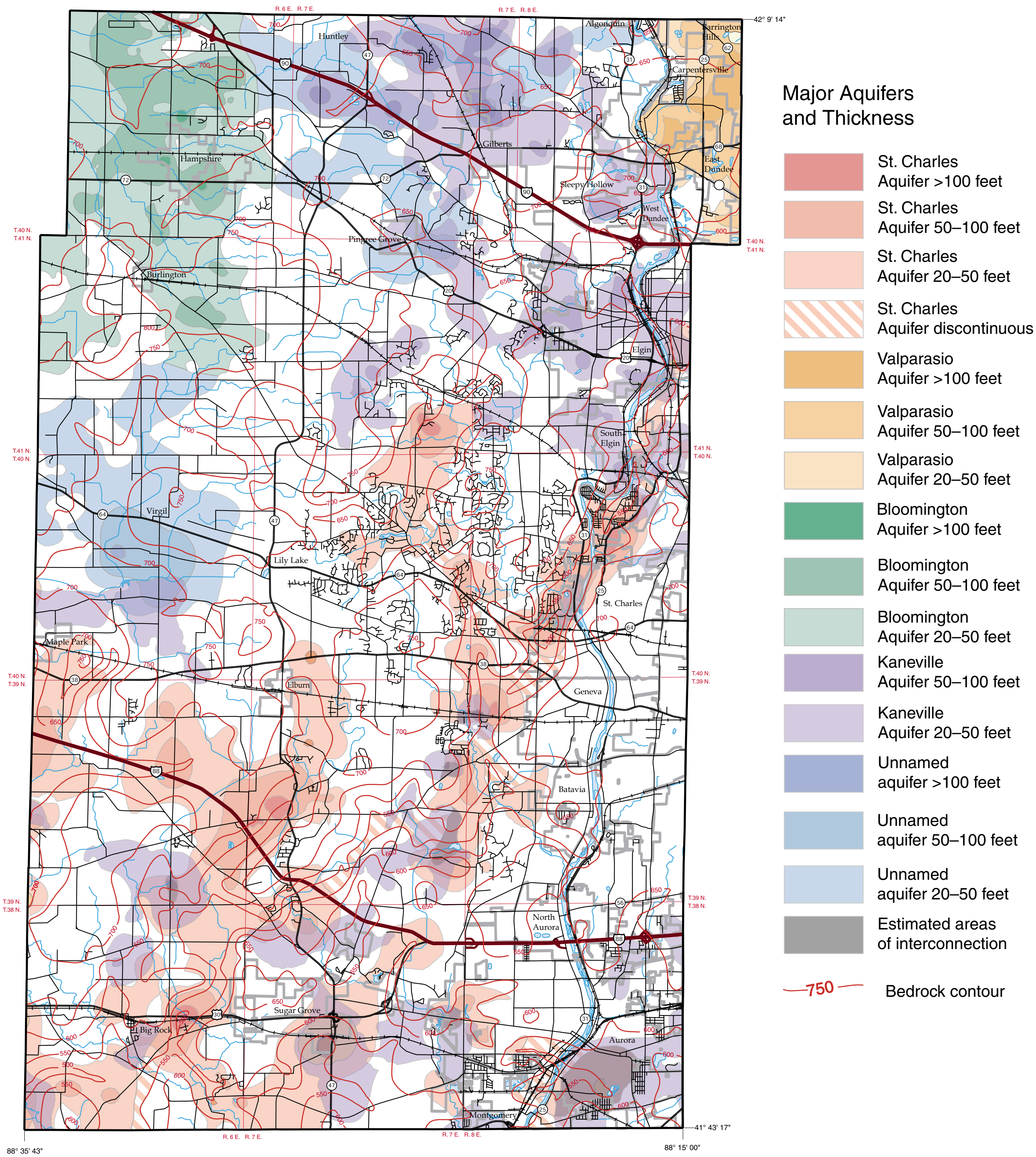

Figure B1 Interim map of major Quaternary aquifers, Kane County, Illinois.

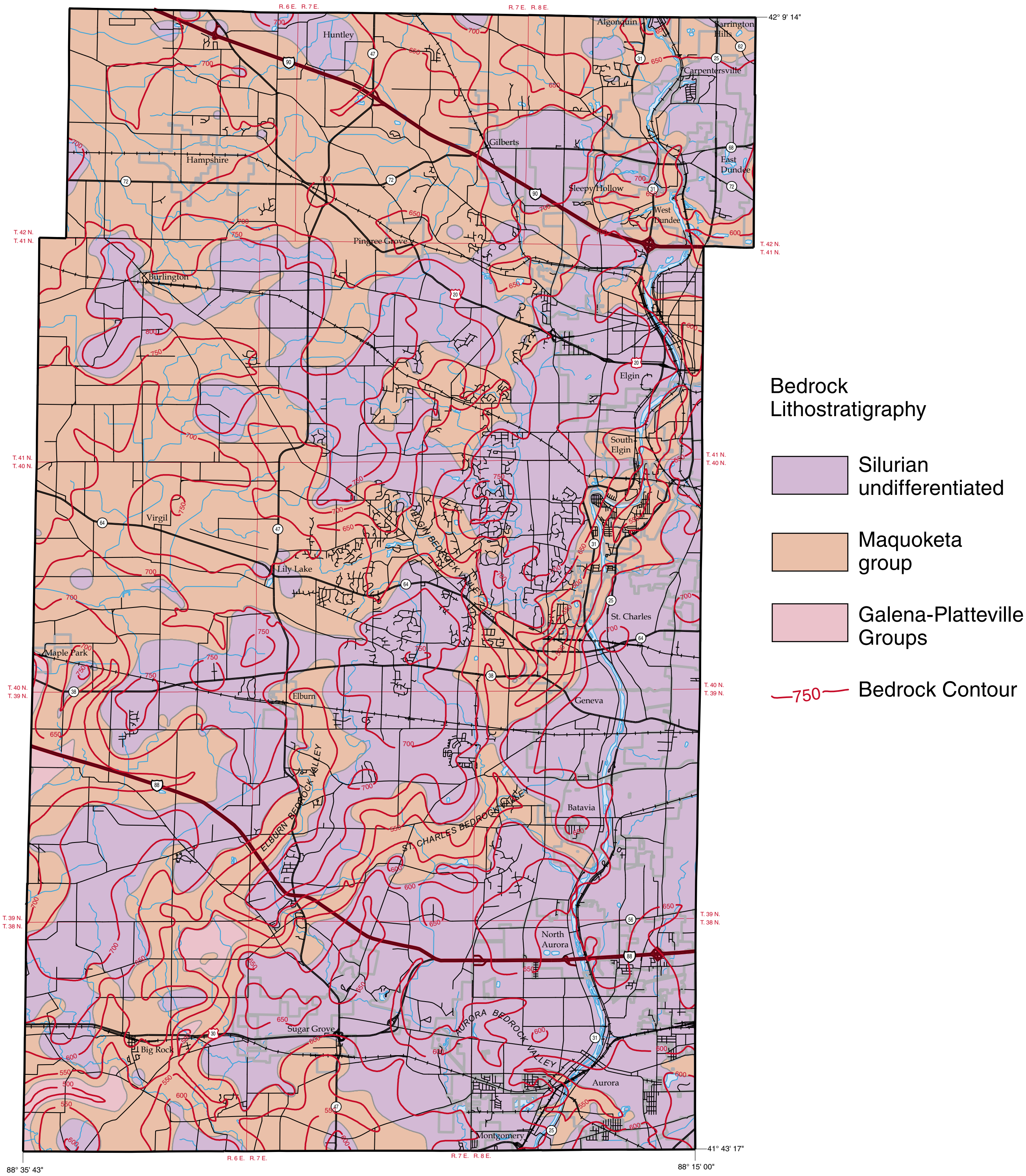

Figure B2 *Interim map of bedrock geology, Kane County Illinois.*