Geologic Mapping of Glacial Drift Aquifers in the Greater Chicago Area of Illinois

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Purpose

We conducted geologic mapping within the suburban area northwest of Chicago, in the Wauconda 7.5-minute Quadrangle, so that state and local officials could identify important groundwater resources in a rapidly growing area and protect them. Previously, little was known about the succession of glacial drift aquifers in the subsurface. The population of this region has increased rapidly since the 1940s, and, between 1980 and 2000, local population growth was greater than 40% (fig.1). A further 70 to 100% increase is predicted for some areas over the next 20 years (fig. 2). Currently, 80% of the region's population (the majority in the city of Chicago; fig. 3) uses the entire allotment of Lake Michigan water for the Chicago metropolitan area. Existing international water export agreements make it extremely unlikely that allocations from the Great Lakes basin will be increased. Therefore, the increasing population in the expanding suburban areas must obtain water supplies predominantly from groundwater from glacial drift aquifers.

Geologic Map

The Wauconda Quadrangle includes portions of western Lake County and eastern McHenry County in northeastern Illinois. Much of the 150 to 350 feet of glacial drift overlying bedrock in the quadrangle is composed of sand and gravel. The Quaternary deposits and topography of the area resulted from cycles of erosion and deposition by continental glaciers and glacial meltwaters of the last (Wisconsin Episode) glaciation, occurring between about 25,000 and 14,000 radiocarbon years before present. Lithologically distinct till units of the Wedron Group intertongue with proglacial fluvial (Henry Formation) and lacustrine (Equality Formation) tongues of the Mason Group (fig. 4). These materials, deposited during three glacial phases of the Lake Michigan Lobe, form three distinct glacigenic sequences that generally offlap successively to the east-northeast in the up-ice direction (figs. 5 and 6).

Using the Geologic Map

The map of surficial geology map (fig. 5) and the associated three-dimensional model (fig. 6) illustrate the following relationships among aquifer units (proglacial fluvial deposits) and surface and subsurface till and lacustrine units:

1. Over the western two-thirds of the map area, a sand and gravel aquifer (surficial aquifer) lies at the surface and locally below silt and clay of the Equality Formation. The unit has been drilled for a water source in only a few places in the western two-thirds of the map area.
2. Over the eastern one-third of the map area, an unnamed sand and gravel tongue (aquifer 3) is present in the subsurface below the Wadsworth till. It is discontinuous and, in most places, infills valleys and depressions on the Haeger till. The unit has been drilled for a water source in a few places.
3. The Beverly Tongue is a uniform and widespread unit of aquifer materials (aquifer 2) in the subsurface that underlies the Haeger till. Many water wells are drilled into this unit, especially over the center of the map area.
4. Sand and gravel of the Ashmore Tongue (aquifer 1) is present in the subsurface infilling valleys and in upland positions on the bedrock surface. Where present, this unit and the fractured dolomite in the upper bedrock form an aquifer.

Mapping of the surface and subsurface aquifer materials illustrates the intertonguing relationships among the till units of the Wedron Group and the sand and gravel units of the Henry Formation (fig. 5). It also identifies connections between the drift aquifers and, in some areas, connections from the drift aquifers to the bedrock. The presence of multiple aquifer units in the subsurface could provide a variety of water resources to accommodate the increasing suburban population. Where present, the Ashmore Tongue appears to be a major source of groundwater, and drilling need not be restricted to paleovalleys, because the unit is also present on some bedrock uplands. Because of intertonguing of the drift aquifer, detailed mapping at a scale of 1:24,000 or larger is needed to define the limits of the sand and gravel deposits.

Conclusions

Three-dimensional geologic mapping is useful to differentiate drift aquifers and determine their extent in the Wauconda Quadrangle. A similar approach to mapping is being undertaken in other parts of northeastern Illinois and the Midwest where multiple ice advances and retreats have deposited a thick glacial drift comprising a complex sequence of proglacial/subglacial successions. Where discontinuities are present between regional sediment units, detailed geologic mapping and modeling incorporating subsurface geologic data provide an opportunity to visualize the connections between glacial deposits at the land surface and buried drift and bedrock aquifers.

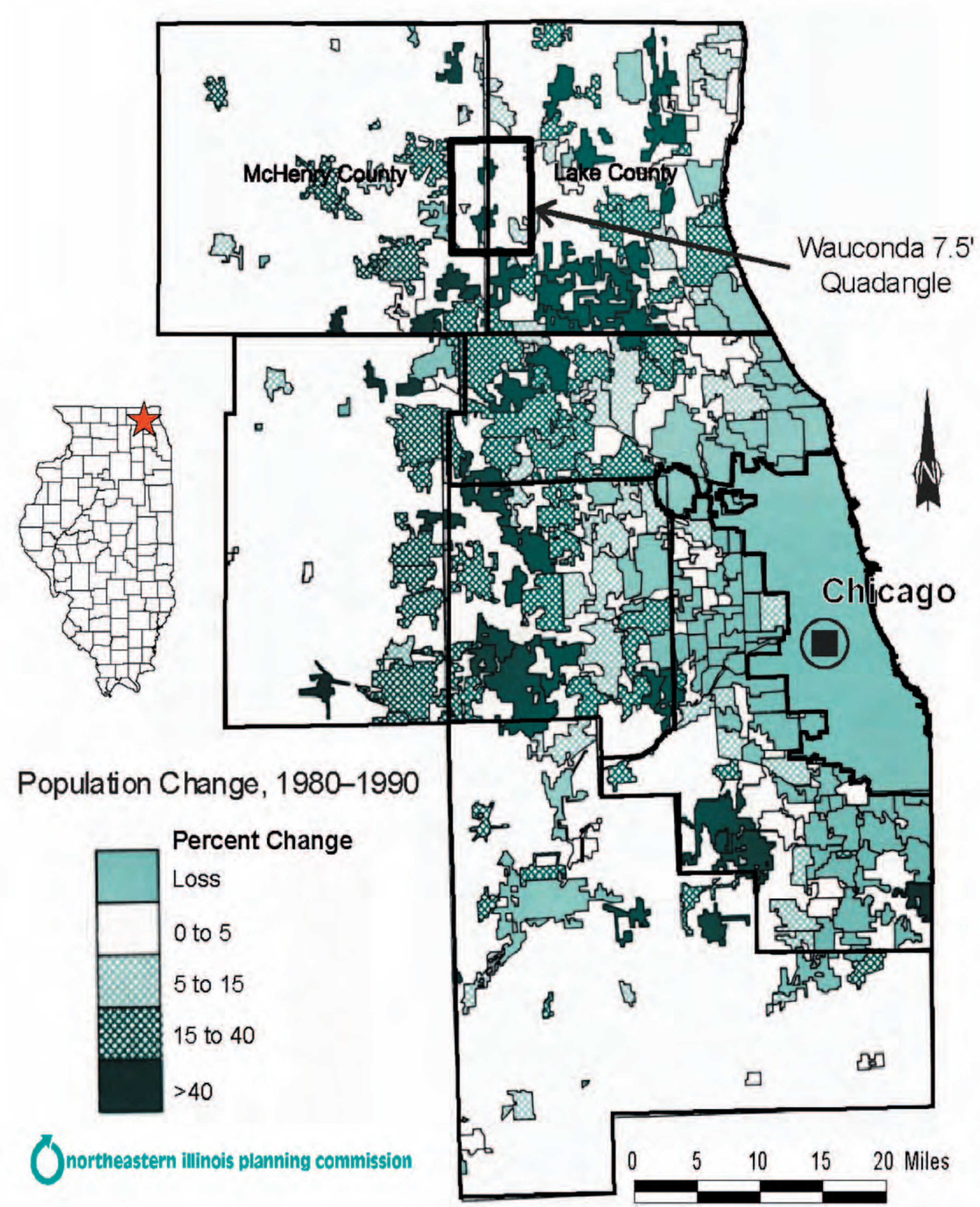


Figure 1 Population change in municipalities of the greater Chicago area between 1980 and 1990. (From the Northeastern Illinois Planning Commission.)

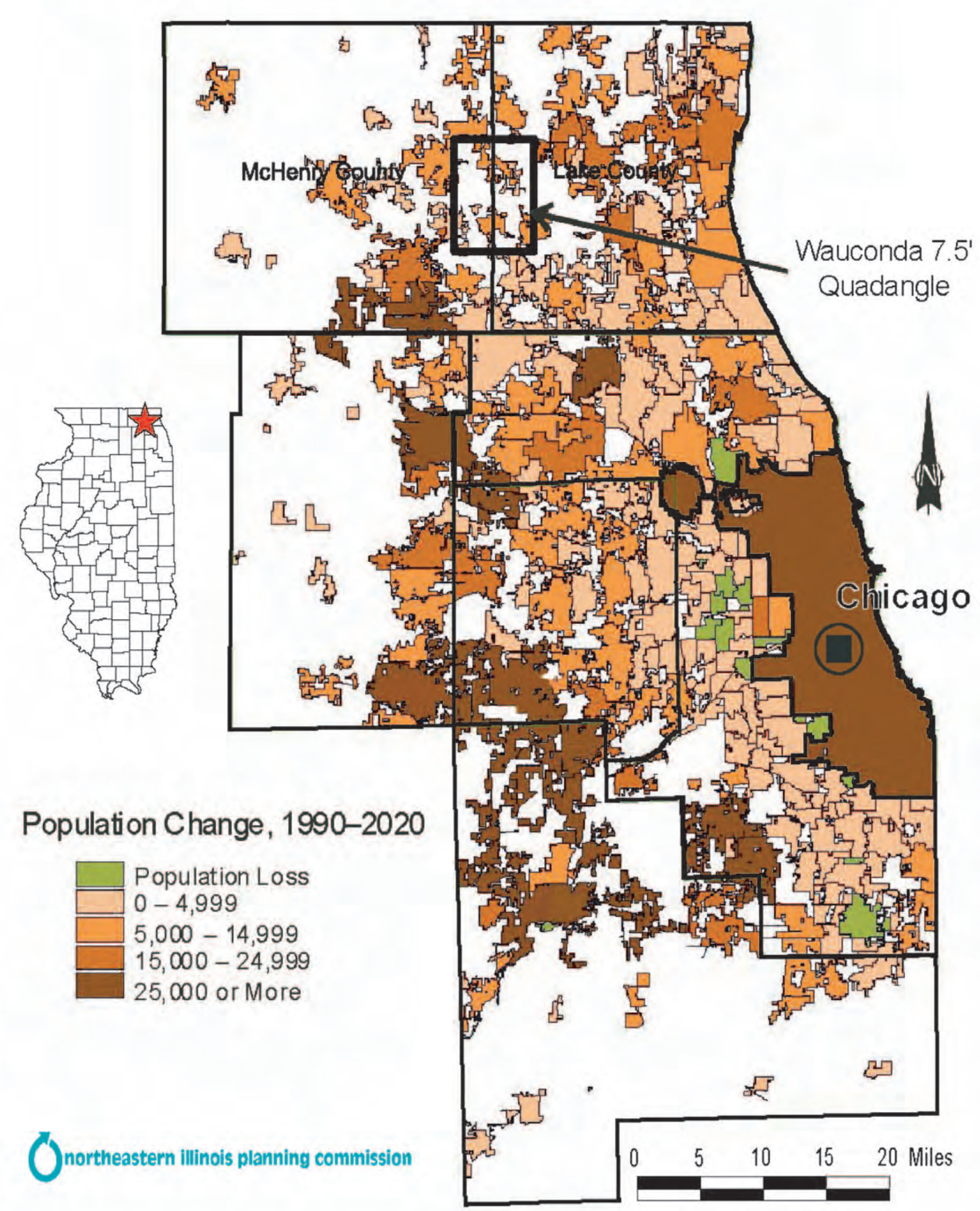


Figure 2 Projected change in population of the greater Chicago area between 1990 and 2020. (From the Northeastern Illinois Planning Commission.)

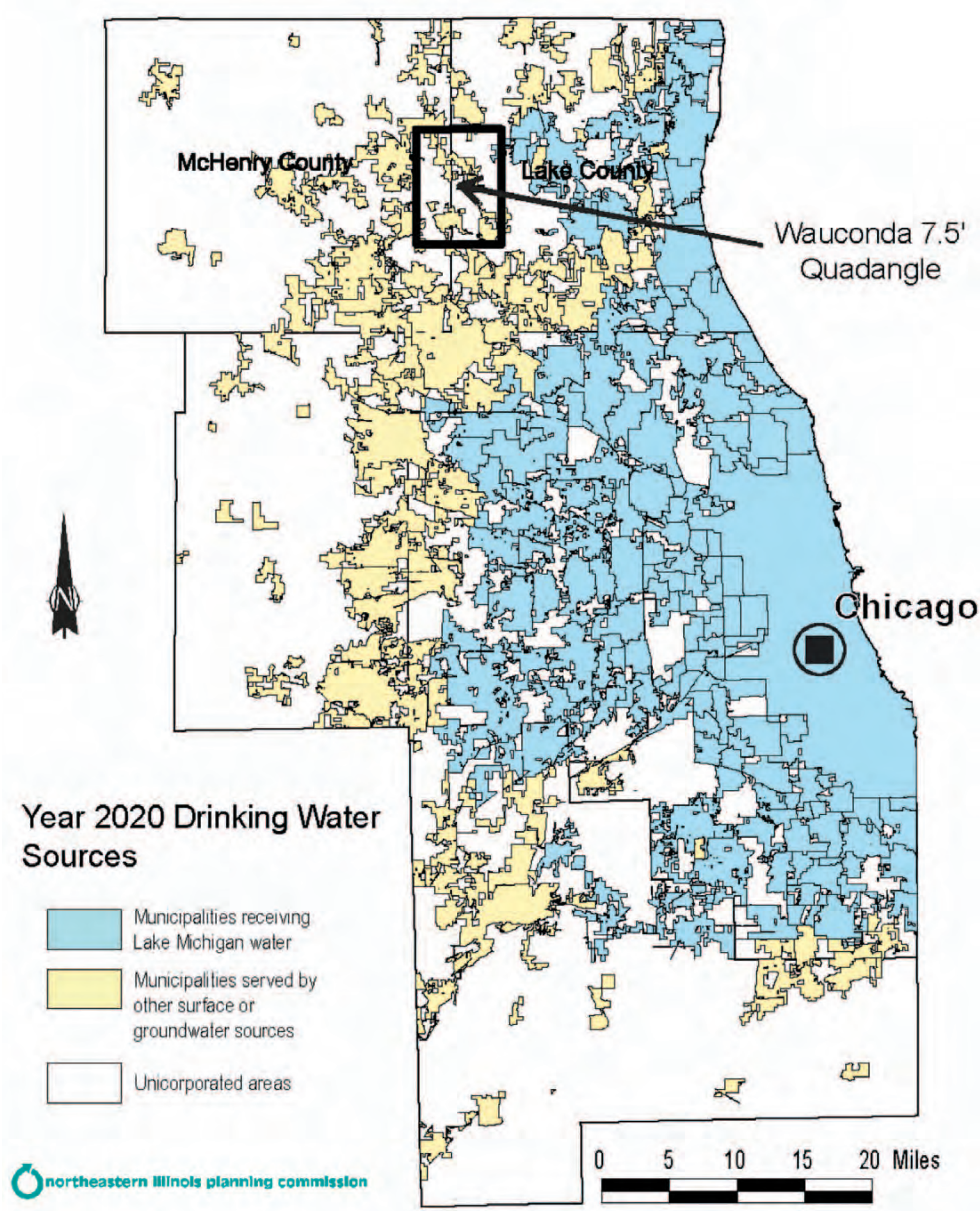


Figure 3 Lake Michigan water allocation to northeastern Illinois municipalities. The map only provides a generalized depiction of the extent of Lake Michigan service. There are several anomalies involving municipalities that receive Lake Michigan water through a private water utility. Also, significant parts of the unincorporated areas also receive Lake Michigan water via private utilities or sanitary districts (not shown). (From the Northeastern Illinois Planning Commission.)

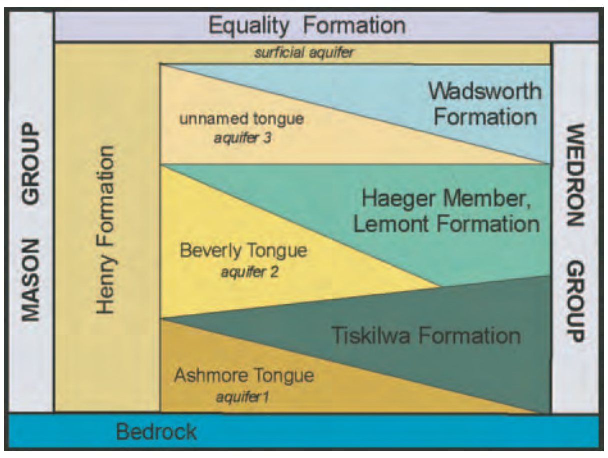
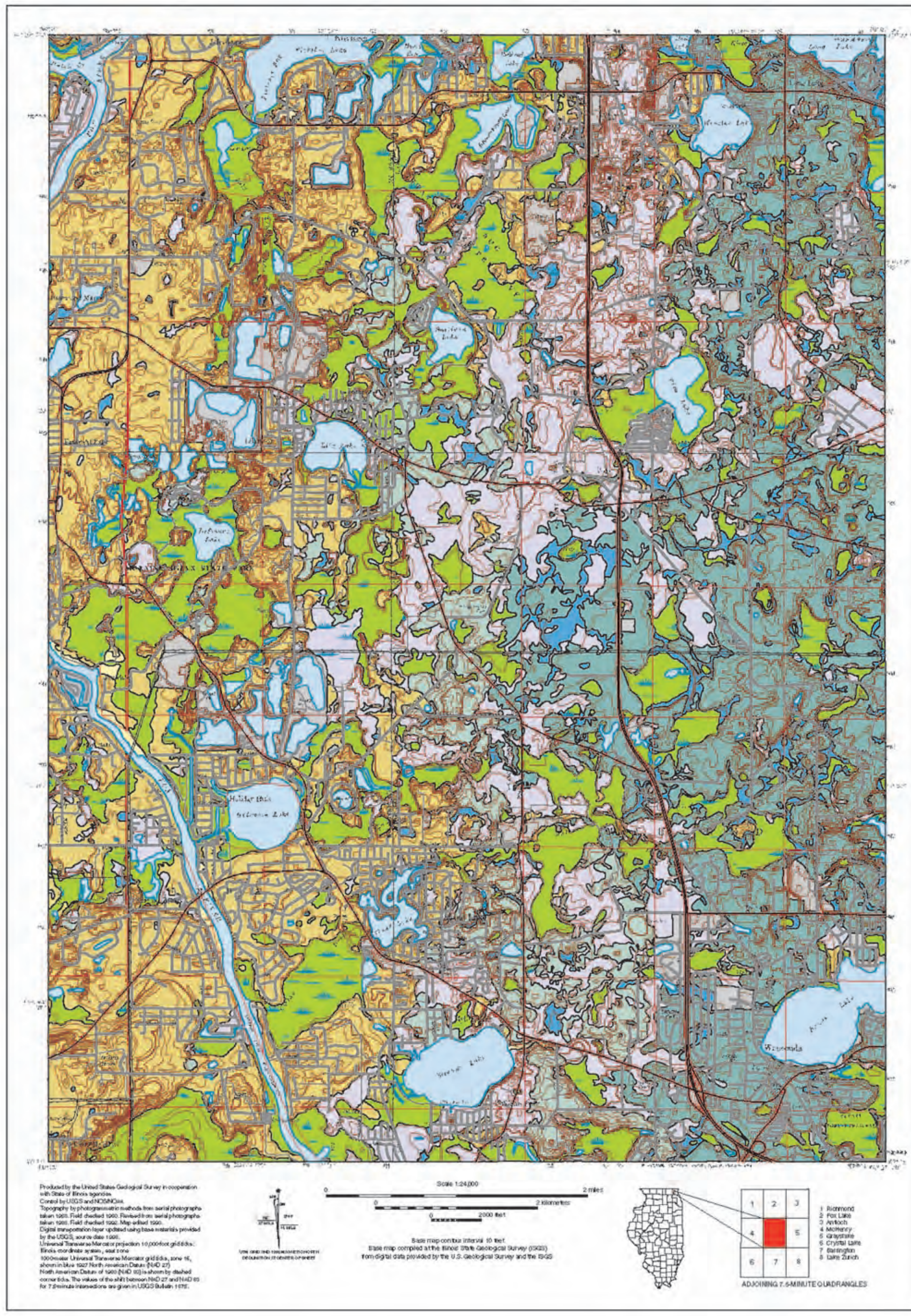


Figure 4 Intertonguing between drift aquifers (yellow and orange) and till units (green).



LITHOSTRATIGRAPHIC UNIT	MATERIAL AND INTERPRETATION
Hudson Episode (postglacial)	
Disturbed Land (Human modified)	Land disturbed by human activities; includes fill for transportation network and excavations such as gravel pits.
Cahokia Formation	Silt and clay with sand lenses; postglacial river and stream sediment found on active floodplains; derived mainly from eroded loess and diamicton. **(Alluvial Deposits)**
Peyton Formation	Silt with varying amounts of sand and clay and occasional pebbles deposited in footslope positions of steeper slopes and in pothole depressions on floodplains and till plains. **(Slope Deposits)**
Grayslake Peat	Peat and muck accumulated in low-lying depressions, drainage ways, and on floodplains. **(Organic Deposits)**
Hudson and Wisconsin Episodes	
Equality Formation	Silt and clay, massive to laminated; post-glacial and glacial lake deposits found at or near land surface along major floodplains and around modern lakes; in the subsurface may be intertongued with diamicton. **(Proglacial Lacustrine Deposits)**
Wisconsin Episode	
Henry Formation surficial aquifer unnamed tongue (Aquifer 3) } only in the subsurface Beverly Tongue (Aquifer 2) } only in the subsurface Ashmore Tongue (Aquifer 1) } only in the subsurface	Fine- to coarse-grained sand and gravel, bedded; glacial meltwater sediment found at the margin of major floodplains and on stream terraces and outwash aprons; thickness ranges from 30 to 100 feet; may be present at the surface, or as a tongue of sand and gravel beneath the Wadsworth till (unnamed tongue), Haeger till (Beverly Tongue) and Tiskilwa till (Ashmore Tongue). **(Proglacial Fluvial Deposits)**
Wadsworth Formation	Silty clay loam to silty clay diamicton with beds of sand or gravel and silty and clayey zones; subglacial till, subglacial channel, and lake deposits, and sediment that melted out on top of the glacier or along the ice margin. **(Till)**
Haeger Member, Lemont Formation	Very cobbly, sandy loam to silt loam diamicton; subglacial and ice marginal deposits; commonly underlain by outwash sand and gravel of the Henry Formation (Beverly Tongue); may be intermixed with finer-textured diamicton of Wadsworth. **(Till)**
Tiskilwa Formation (only in the subsurface)	Reddish brown clay loam to loam diamicton; subglacial and ice marginal deposits; commonly underlain by outwash sand and gravel of the Henry Formation (Ashmore Tongue). **(Till)**
Nonglacial (Pre-Quaternary)	
Silurian dolomite and Ordovician shale	Dolomite with chert lenses; may be overalin by thin shale unit. **(Bedrock)**

Figure 5 Surficial geology of the Wauconda 7.5-minute Quadrangle, Lake and McHenry Counties, Illinois.

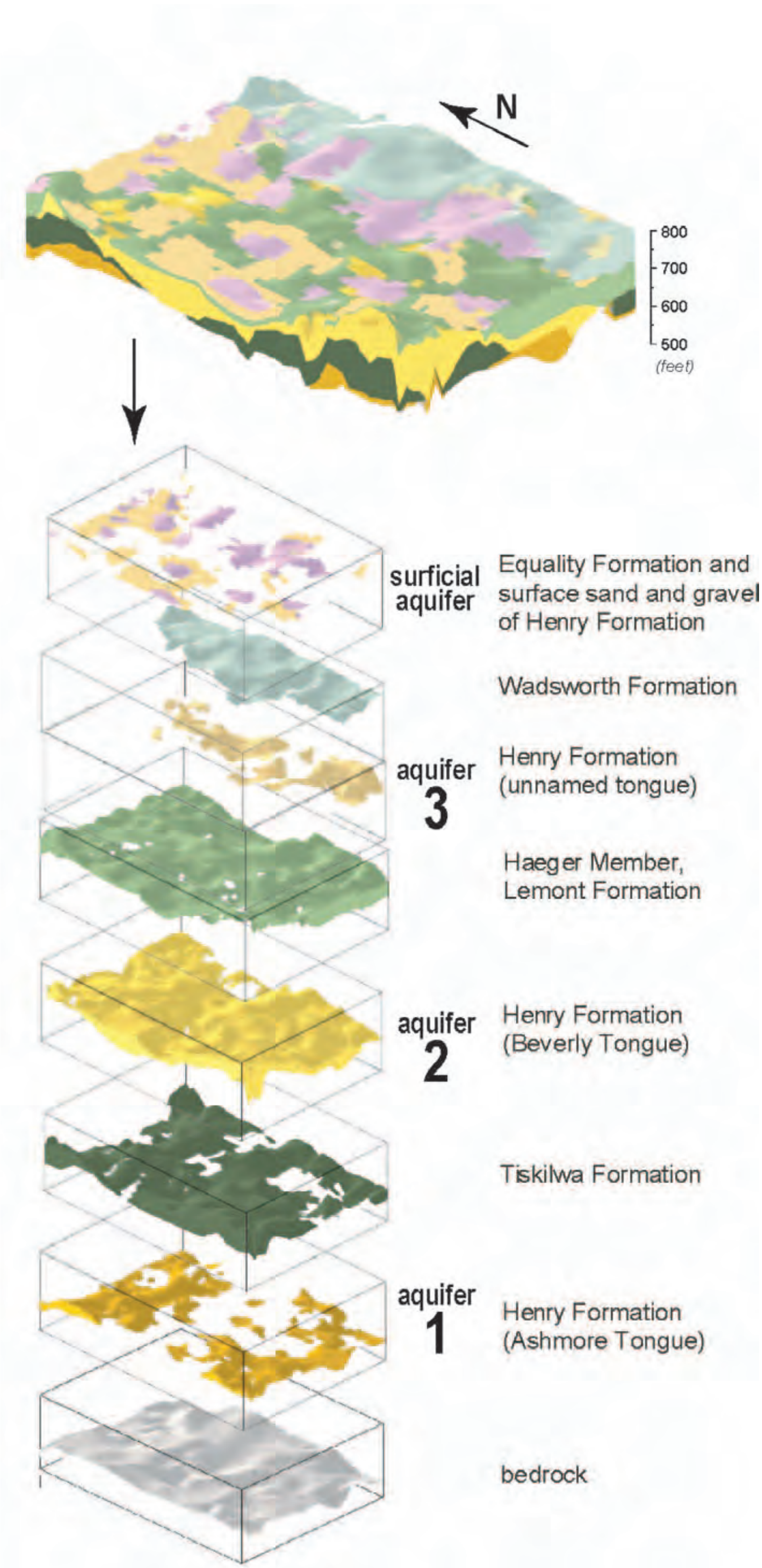


Figure 6 Three-dimensional model of the geology in the Wauconda 7.5-minute Quadrangle. Water-bearing deposits (aquifer units) that wells are set in are noted.