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LIDAR SURFACE TOPOGRAPHY OF LAKE COUNTY, ILLINOIS

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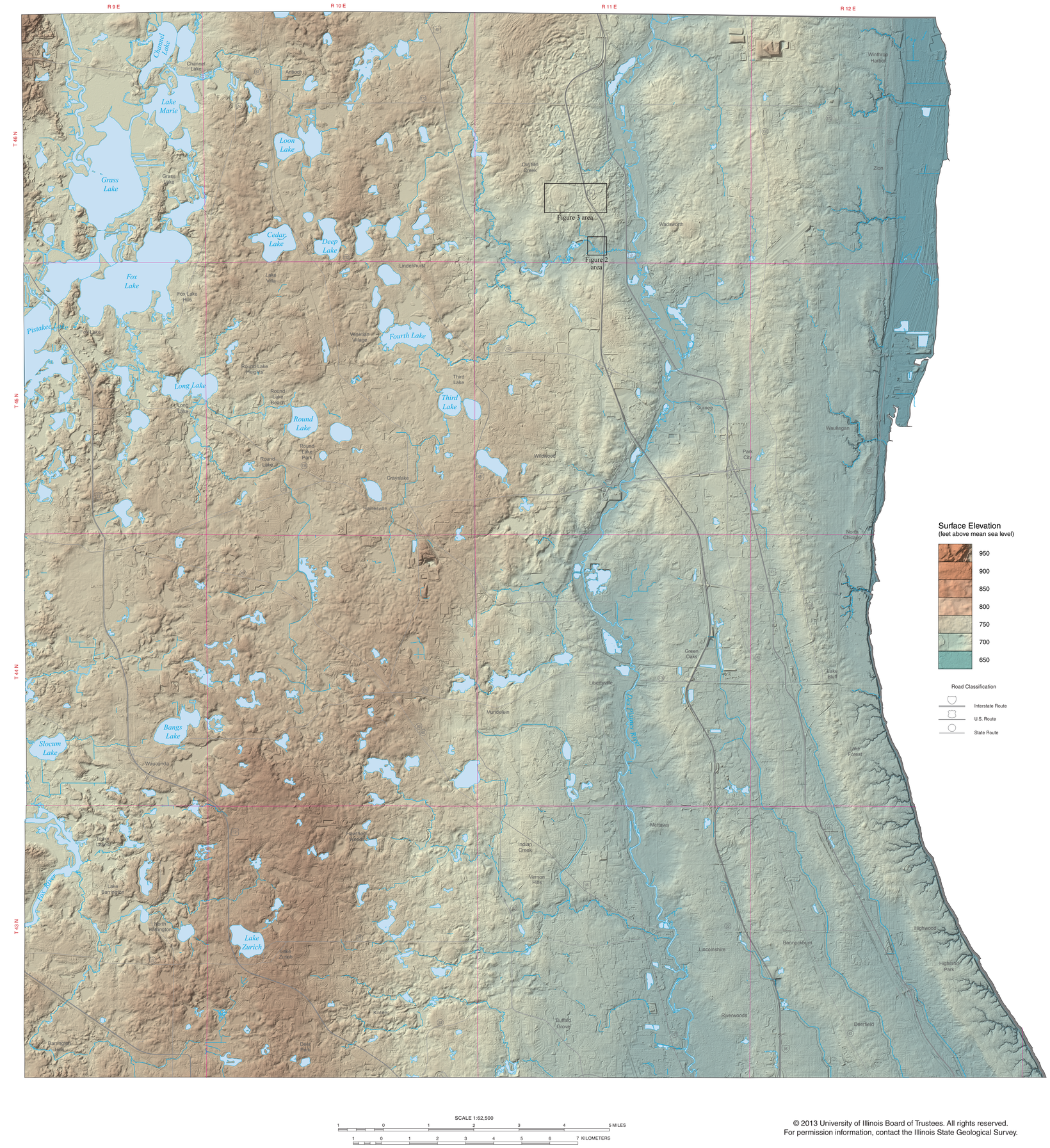
2013

Illinois County Geologic Map
ICGM Lake-ST



Surface Elevation
(feet above mean sea level)

950
900
850
800
750
700
650

Road Classification

Interstate Route
U.S. Route
State Route

SCALE 1:62,500

1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 KILOMETERS

LiDAR Elevation Data

This surface topography map was created from enhanced elevation data acquired using airborne LiDAR (light detection and ranging) technology. This active remote sensing technique uses a pulsating laser sensor to scan the Earth's surface, and the intended application determines the sensitivity of the laser sensor used for data acquisition. For terrestrial applications such as topographic mapping, the principal wavelength selected for most airborne laser sensors is 1,064 nm, which is within the near-infrared band of the electromagnetic spectrum.

The first object contacted by a laser pulse and reflected back to the sensor is designated as a "first return," which may be a hard target, such as a building rooftop or the ground surface, or a soft target, such as vegetation. When a laser pulse encounters a soft target, for example, a tree, a portion of the laser beam continues downward and reflects from the underlying branches and trunk, providing additional returns recorded by the laser sensor (fig. 1). The reflected light pulses are detected by instruments that record the accurate location of each return pulse in three dimensions—(x) and (y) horizontal coordinates and (z) elevation values. The processed returns, which number in the billions for a typical county area, are termed a "point cloud."

A portion of the processed returns represent the ground surface and are referred to as the "bare earth" point cloud. To maximize the probability of acquiring sufficient ground returns in vegetated terrain, LiDAR is collected in the Midwest during the leaf-off portion of the year when deciduous tree canopies are barren, crops are absent, and most other vegetation types are dormant. However, wherever filtered daylight can pass through vegetated canopy, a portion of the laser pulses will likely reach the surface and produce ground returns.

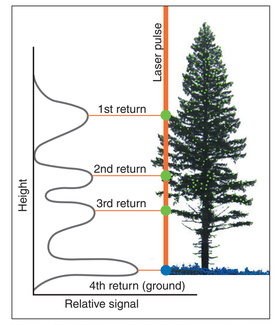


Figure 1 Simplified illustration of a single laser pulse interacting with a soft target (the tree). A maximum of four returns are possible from each pulse, and current airborne systems can emit more than 150,000 pulses per second. The waveform data collected from the target are processed into a LiDAR point cloud (colored dots), which is used to generate a three-dimensional representation of the target (revised from Mangold and Van Sickle 2008).

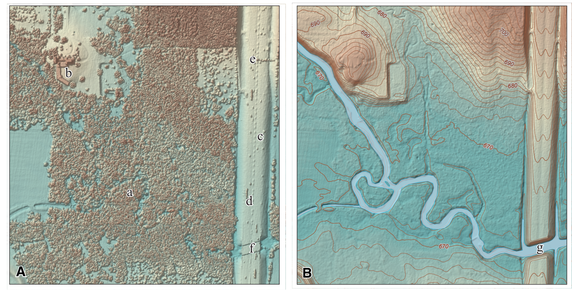


Figure 2 Comparison of the landscape features characteristic of (A) a digital surface model (DSM) and (B) a digital terrain model (DTM), both produced from the processing of a LiDAR point cloud containing all returns. Whereas a DSM portrays both the ground surface and aboveground features, a DTM represents only the ground surface. See discussion for additional explanation. (A) a, forest and woodland cover; b, buildings; c–e, signage; f, I-94 bridge deck. (B) g, meandering stream course. Scale 1:6,000.

Figure 3 Digital terrain model (DTM) for an area of approximately one square mile west of Wadsworth, Illinois, adjacent to Interstate 94 (a). The surface topography of Lake County has largely resulted from the action of continental glaciers and glacial meltwaters during the Wisconsin Episode, which occurred in northeastern Illinois approximately 30,000 to 16,000 years ago. The prominent circular landform shown on the left half of this DTM is an ice-walled lake plain, a type of landscape feature that formed as the glacial ice stagnated (Barnhardt 2009). Measuring 0.6 mile across and 0.25 square mile in area, this particular ice-walled lake plain exhibits a noticeable raised outer rim (b) that stands 15 feet above the surrounding land surface. Although they can be subtle landforms when viewed at the ground level, LiDAR-derived DTMs have shown ice-walled lake plains to be a conspicuous landscape feature in northeastern Illinois. Scale 1:10,000.

Processing all the returns in the LiDAR point cloud produces a digital surface model (DSM) that characterizes both the ground surface and aboveground landscape features (fig. 2A). Forest and woodland cover (a) and buildings (b) are apparent on the DSM; cars, trucks, and highway signage (c, d, e) are also easily discernable along the portion of Interstate 94 shown in figure 2A. When only the ground returns in the classified point cloud are processed, a digital terrain "bare earth" model (DTM) is created (figs. 2B and 3). In contrast to the DSM, the returns representing aboveground features are filtered from the classified point cloud to create the DTM. The obscuring wooded cover (a) and the I-94 bridge deck (f) in figure 2A have been removed, revealing the underlying meandering stream course (g). All aboveground features have been filtered from the point cloud to produce a detailed view of the ground surface. The airborne LiDAR data collected for Lake County and the surrounding area (fig. 4) average at least one return for each square meter (approximately 9 square feet) of land surface. This point density, coupled with the exceptional vertical accuracy of enhanced elevation data, meets the National Standard for Spatial Data Accuracy for creation of 2-foot contours (fig. 2B).

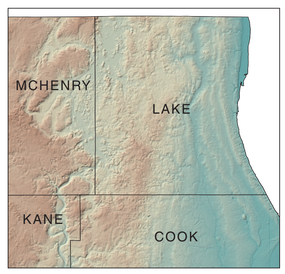


Figure 4 Generalized surface topography for a portion of northeastern Illinois produced from the U.S. Geological Survey, one-third arc second resolution National Elevation Dataset (U.S. Geological Survey 2013).

References

Barnhardt, M.L., 2009, Surficial Geology of Zion Quadrangle, Lake County, Illinois and Kenosha County, Wisconsin: Illinois State Geological Survey, USGS-STATEMAP contract report, 2 sheets, 1:24,000.

Mangold, R., and J. Van Sickle, 2008, Points of light, *in* Point of Beginning, February 1, 2008, http://www.pobonline.com (accessed March 29, 2013).

U.S. Geological Survey, 2013, The National Map Viewer and Download Platform, http://viewer.nationalmap.gov/viewer/ (accessed March 29, 2013).

APPROXIMATE MEAN DECLINATION, 2013

2007 LiDAR data for Lake County, Illinois, made available through the U.S. Geological Survey, the Lake County GIS Department, and the Illinois Height Modernization Program (http://www.isgs.illinois.edu/nsdi-home/webdocs/ilhmp/). Universal Transverse Mercator, zone 16. North American Datum of 1983 (NSRS2007), North American Vertical Datum of 1988. Vector base data from 2009 TIGER/Line Shapefiles provided by the United States Census Bureau; hydrography provided by the Lake County GIS Department.

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