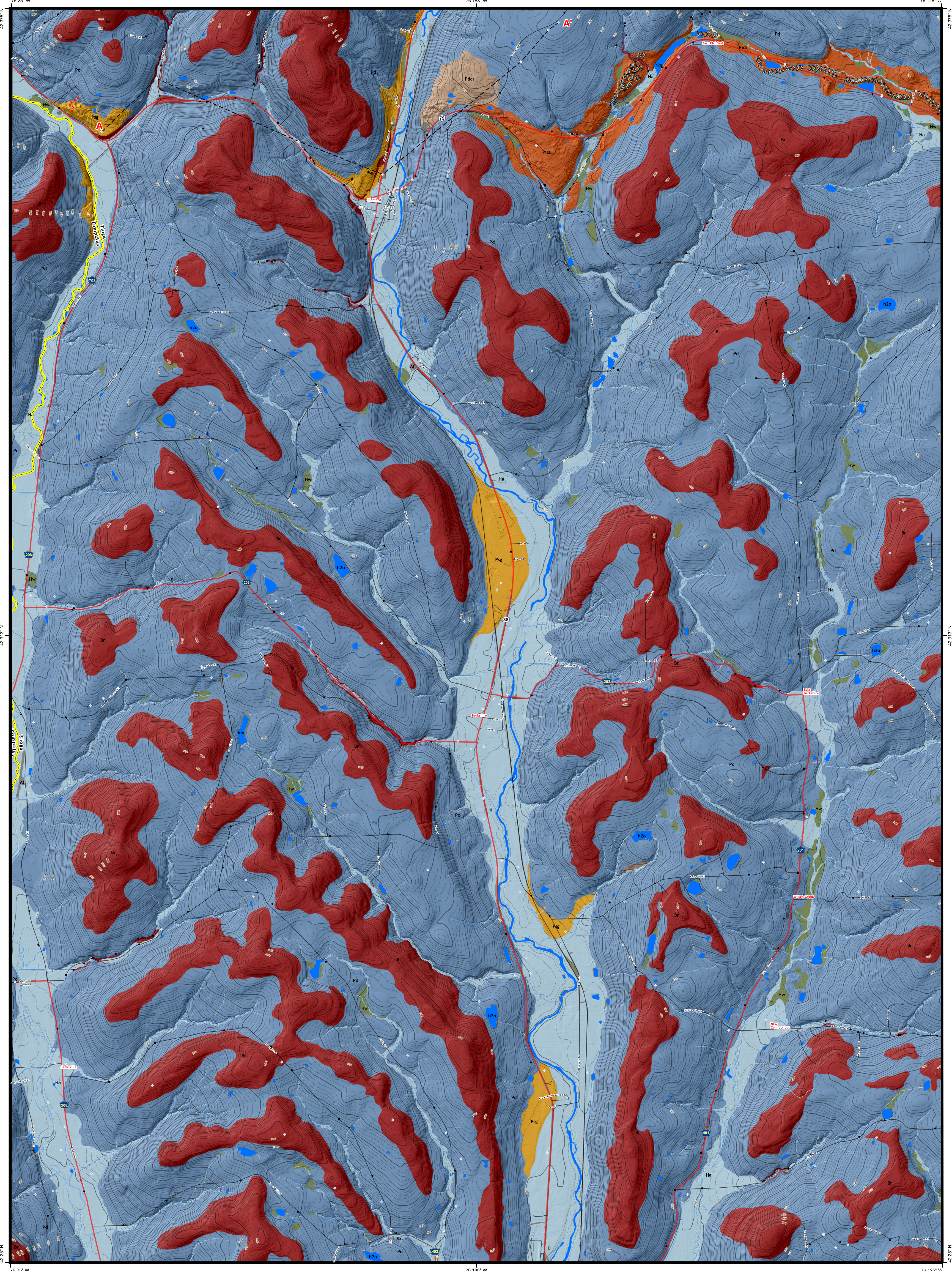

Universal Transverse Mercator, Zone 18 N
North American Datum of 1983

Hydrology, and planimetry layers from the New York State DOT Raster Quadrangle separates for Tioga and Tompkins Counties: (https://gis.ny.gov/gisdata/inventories/member.cfm?OrganizationID=108)

Geographic data layers from 2023 TIGER/Line shapes for transportation and hydrography: (https://www.census.gov/cgi-bin/geo/shapefiles/index.php)

Shaded relief from the FEMA 2019 1-meter lidar data set: (http://gis.ny.gov/elevation/index.cfm)

Magnetic declination from the NOAA online Declination Calculator: (http://www.ngdc.noaa.gov/geomag-web/#declination)

Field map, notes and draft maps available through the NYSGS Open File: (https://www.nysm.nysed.gov/research-collections/geology/collections/open-file)

SCALE 1:24,000

CONTOUR INTERVAL: 10 FEET

Geologic mapping by K. Backhaus, A. Kozlowski and S. Grasing., 2022
Digital data and cartography, K. Backhaus, 2022

UTM GRID AND 2019 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SURFICIAL GEOLOGY OF THE RICHFORD 7.5-MINUTE QUADRANGLE, TIOGA AND TOMPKINS COUNTIES, NEW YORK

Karl J. Backhaus
2022

SURFICIAL GEOLOGY OF THE RICHFORD 7.5-MINUTE QUADRANGLE, TIOGA AND TOMPKINS COUNTIES, NEW YORK

prepared by
Karl J. Backhaus

Supported in part by the U.S Geological Survey Cooperative Agreement Number G21AC10870
National Cooperative Geologic Mapping Program (STATEMAP)

Introduction:
TThe Richford 7.5-Minute Quadrangle was mapped as part of the 2021 National Cooperative Geologic Mapping Program funded STATEMAP project (award #G21AC10870). This quadrangle was one of eighteen quadrangles to mapped as part of the Tioga County Surficial Geologic mapping project currently being undertaken by the NYSGS starting in 2019 and concluding sometime in the mid to late-2020's. The purpose of this map was to identify and delineate various surficial and geologic materials with the intent that this information can guide municipalities in land use, environmental and natural resource decisions across its roughly 55 square mile area.

The Richford quadrangle is located along the north-central and southeastern of Tioga and Tompkins Counties, respectively. It lies within the Finger Lakes Region of New York State about 14 mile east of the City of Ithaca, New York. The Town of Richford, Village of Berkshire and Jenksville are the main municipalities within this quadrangle. This quadrangle is largely rural with large tracts of state-owned forest and private rural farmland. The Potato Hill, Jenksville, Turkey Hill and Andersen Hill State Forests are found in the northern portion of the quadrangle.

This quadrangle is situated within the Alleghany Plateau physiographic province is generally ramping higher elevation ridges to the south of the Town of Newfield with deep valleys between them. There is roughly 905 feet (276 meters) of elevation change between the highest peak just east of Valley View Rd at 1,880 feet above mean sea level (573 meters-amsl) to the southern end of the main valley floors at 976 feet-amsl (298 meters-amsl). The East Branch of the Oswego Creek, the West Branch of the Owego Creek, and Wilson Creek are the major water bodies in the area along with various unnamed ponds at higher elevations.

Bedrock in the area is generally grey shales, siltstones and sandstones that are Devonian in age (Rickard and Fisher, 1970). The predominant bedrock found in the quadrangle were grey to blue shales with intermittent sandstone beds. Limestones were found outcropping in two spots, but relatively thin in size. According to the Finger Lakes sheet of the Geologic Map of New York State, the bedrock in the quadrangle is comprised of the Cashaqua and Middlesex Shales, Beers Hill Shale; Grimes Siltstone, Dun Hill, Millport and Moreland Shales. (Rickard and Fisher, 1970).

The surficial geologic units in this quadrangle were previously mapped at 1:250,000 scale and were reported to be outwash gravels, kame, till, and alluvium (Muller and Cadwell, 1986). Limited mapping has been completed at a higher resolution than that of Muller and Cadwell, (1986).

Methodology:
To create the surficial geology map of the West Danby quadrangle, preliminary field maps were created using the ESRI ArcMap 10.8 software and consisted of all available topographic data (roads, lidar surface terrain and hydrography) to plot all field data on including field stops, bedrock outcrops and important site information. Surficial soil sampling employed the use of a five-and-a-half-foot hand auger to allow sampling below the variably thick organic soil horizon (below the topsoil). Another tool used is an entrenching shovel and pick. This tool was used to remove topsoil and/or eroded sediments from outcrops or exposures to expose fresh sediments for analysis. At each field stop, the coordinates (latitude and longitude in decimal degrees) were taken using a Garmin GPS 66st, descriptive notes on the sediment found, whether a sample and/or a high-resolution, scaled photo were taken, and the time at which the stop was taken were logged into a field notebook (Backhaus_22).

At most of the field sampling sites, a soil sample was taken for grain-size analysis. This employee the use of either one or two processes: dry-sieve or wet-sieve analysis. These processes followed the procedure outlined by Bowles (1978), while only using a seven-tiered sieve stack (#5, #10, #18, #35, #60, #120, #230, and Pan) for both dry- (mechanical) and wet- (hydrometer) sieve analysis. The predominantly cohesive (fine-grain dominant) samples were sorted using the wet-sieve analysis, while the cohesionless (coarse-grain dominant) samples were sorted using the dry-sieve analysis.

The final surficial geologic map, cross-section and elevation maps were produced using the ESRI ArcMap and Adobe Illustrator CS6 programs. The cross-sections were created in ArcMap using the XActo Cross-section 10 tool developed by Jennifer Carell, formerly of the Illinois Geologic Survey, and then exporting the cross-section into Adobe Illustrator to connect the stratigraphic units. The surficial geologic map was created by scanning the mylar sheet (RFD_Backhaus_Mylar_22) drafted from the geologic field map. Polygons were then produced by digitizing this map in ArcMap and colored according to surficial geologic units found within the quadrangle. The final map was drafted in Adobe Illustrator and exported as a PDF file.

Results:
A total of 270 field stops were taken, with 144 samples for grain-size analysis (see Appendix), within the quadrangle. Some stops contained more than one sample as they exhibited stratigraphy either in an exposure or at depth with the hand-auger. The final count for lithologies found during field sampling was: 166 stops were diamicton, 71 were bedrock, 26 were sand and gravel, seven were sand and cobbles, four were alluvium, two were sand, and one was glaciolacustrine sediment. The surficial geologic units found within the quadrangle are as follows:

Artificial Fill (Af)
This unit is generally composed of coarse/fine, large cement mounds and/or crushed rock anthropogenically transported and used for construction purposes. This material is used in artificial dams, built to retain water, and large, raised roadbeds for bridges within the quadrangle.

Holocene Alluvium (Ha) and Holocene Wetland Deposits (Hw)
Post glacial sediments occupy the low areas or land depression throughout the quadrangle. Ha is associated with fluvial process in creek valleys throughout the quadrangle. This lithology generally consists of stratified silt, sand, and gravel. Hw is associated with low areas and depressions in the highlands of the quadrangle where wetlands form due to poor drainage. This lithology consists of peat, marl, clay or sand in these areas of poor drainage.

Diamict Colluvium (Hdc)
Unsorted and unstratified deposit of gravel, sand, silt, clay, with boulders/cobbles possible. Described as a mass-wasting deposit at the base of steep hillslopes and cliffs as part of a slump or hillslope failure. Found along stream beds where undercutting of the hillslope has occurred under diamict deposits causing rotational failures.

Pleistocene Sand and Gravel (Psg)
Characterized as well-sorted and stratified sand and gravel this unit is interpreted to be deposited by glacial meltwater at or very near the glacier and can be found several meters in elevation higher than the present-day river valley floors. Psg is found atop bedrock along State Route 79 in the hamlet of Richford, especially to the East of the Town. Psg is also found as small flat-topped terraces in the Richford Valley in the center of the quadrangle and along State Route 79 in the northwest portion of the quadrangle.

Pleistocene Cobbles to Sand (Pics)
Stratified ice contacted deposits, variable coarse-grained sediment consisting of boulders to sand size particles. Inferred to be deposited with stagnant ice in the form of sand and gravel hummocks with the northeast and northern section of the quadrangle as esker deposits.

Pleistocene Diamicton (Pd)
This unit is a mixture of sediment grains that range from clay to boulders in size. In this quadrangle, all diamicton is interpreted to be glacial till, sediment deposited directly beneath the glacier. It is generally matrix supported, sand-dominant, and tan and reddish brown in color. Diamicton is found throughout the quadrangle independent of elevation and underlies much of the other surficial geologic units within the quadrangle.

Pleistocene Diamicton (Clast-Supported) (Pdcs)
The unit is an admixture of unsorted sediment ranging from clay to boulders. Generally, clast supported, massive and clast rich. Interpreted as till. In this quadrangle identified moraines are comprised of clast supported till ranging from gravel rich in some cases showing hummocky topography just north of State Route 79.

Summary and Conclusions:
The Richford quadrangle lies within the northern most portion of Tioga and the southeastern most point of Tompkins Counties, respectively. The topography of this quadrangle is varied with high elevation "mountaintops" of the dissected Alleghany Plateau and its wide, sinuous valley floors. This topography is the result of millions of years of erosion due to fluvial and glacial processes with the most dramatic occurrences during the Quaternary and Holocene through the advance and retreat of multiple ice sheets and resulting fluvial processes. This can be seen through the many U-shaped valleys with the largest spanning from the Towns of Richford and Newark Valley in the center of the quadrangle. The valleys are mostly diamicton (Pd), interpreted as glacial till following field studies. Its density varied from extremely dense in most of the quadrangle to very loose (Pdcs) near former ice margins in the north-central portion of the quadrangle. The loose nature of this glacial till is interpreted to be from supraglacial till deposits off the ice sheet during the final retreat out of the Richford Valley and is mostly clast-supported. The glacial till is generally mottled to brown in color and is mostly sand dominated. The tills throughout the quadrangle are matrix-supported with clasts ranging from pea size to boulder in size. This sediment is also diagnostic in determining the interaction and extent of glaciation by the Ontario Lobe within the quadrangle based on its sedimentary characteristics. While Pdcs is generally loose, the dense tills (Pd) are characterized as lodgement tills based on their density, bimodal distributions of grains, exotic and local bedrock clasts and lastly faceted clasts showing paleo flow direction. Underlying the diamicton is mostly Paleozoic-age sedimentary bedrock (Br). The bedrock in this quadrangle ranged from brown to grey, interbedded shales, mudstones and sandstones, with sandstone being the predominant rock type. The outcrops of bedrock are also highly fractured sandstones with very fissile to blocky shales and mudstones. The largest outcrop is along State Route 79 near the northwestern corner of the quadrangle all the way into the Town of Richford. At its tallest the outcrop is greater than 40 feet (12.2m) tall and consists of mostly grey shale and sandstone.

Sand and gravel deposits were found in the lower lying valleys atop bedrock or diamicton. These deposits are either fluvial in origin (Psg) or deposits that occurred beneath or adjacent to the ice sheet (Pics). The sand and gravel deposits were found atop bedrock along State Route 79 and represent the retreat out of the quadrangle to the northwest. Other deposits are found in the Richford Valley and represent the retreat of the ice sheet northward. One of these deposits lies just north of the Town of Berkshire has remnant braided stream channels features on its surface. These deposits consist of most medium sand with smaller percentages of coarse/fine sand and medium to coarse gravel with an occasional boulder. The largest deposit of sand and gravel is in the northern and eastern portion of the quadrangle. The deposits of representative of an esker system. This sediment was deposits in a subglacial river system beneath the ice former a sinuous ridge of well stratified, coarser grained sediment. The sediment found in this deposit ranges from medium sand to cobbles and boulders that are subrounded to well-rounded in shape. The higher percentage of coarser grain materials is due to its proximity to the ice-margin and higher energy flow of meltwater in these regions.

Summary and Conclusions Continued....
Since the deposition of these sediment units, they have undergone almost constant erosion and transportation due to fluvial or colluvial processes forming alluvial (Ha) terraces along stream and creek beds. Other areas have impounded water and formed wetlands (Hw) with kettles or former meanders in a creek. Most of these wetlands are found within the Cayuga Inlet and occupy former kettle lakes and ponds. Areas of diamicton have also undergone undercutting by modern stream systems causing areas of rotational failures to occur along stream beds. These slump or debris flow deposits are also known as colluvium (Hdc), and in this quadrangle are mainly flows of diamicton.

Glacial landforms found within this quadrangle reflect proximal deposition and erosion due to the type and sediment makeup of each landform. Of the landforms found, none were as long and apparent as the Lisle Esker System, named by Tarr (1909) and again by Gillespie (1980), in the northeastern corner of the quadrangle. This esker is 80 feet (24.4m) at its tallest and over 5.6 miles (8,970m) in length in the quadrangle alone. Hummocky topography is also found to the west of this esker as well as one small possible ice margin in the northwest corner of the quadrangle.

From these landforms, it can be observed that this area has evidence of at least two separate lobes off the Cayuga sub lobe of the Ontario Lobe of the Laurentide Ice Sheet. One lobe came from the northwestern corner of the quadrangle and flowed south into the Town of Speedsville, while another flowed from the north into the Richford Valleys south towards the Towns of Berkshire and Newark Valley. The sublobe in the Richford Valley possibly flowed south and to the east. Based on the orientation of the Central Lisle Esker system, hummocky topography and Pdcs deposits, it is likely that a separate ice lobe flowed atop the valley ridge and towards the Town of Lisle and upon its retreat to the west, the esker system was deposited below stagnant ice. Upon retreat in the vicinity of State Route 79 and Hogs Hollow Road, the meltwater was able to flow towards the south. This was possible after melting off of the bedrock ridge along Hogs Hollow Road. Upon further retreat, blocks of ice were entrained in sediment atop the ridge between Hogs Hollow Road and State Route 79. Retreating further west and towards the retreating main lobe in the Richford Valley and supraglacial till was deposited at the bend in State Route 79.

Upon completion of field mapping within the Richford quadrangle, the evidence discovered in this area suggests possible multidirectional flow of the ice lobes and possible asynchronous movement of the different lobes in each valley. Future work in this area should include coring of wetlands at high elevations for radiocarbon dating of possible tundra plants in the base of these wetlands. Optically stimulated luminescence, or OSL, dating should be conducted on deposits in the esker and in the sand and gravel deposits in the valleys to obtain a minimum age date on the retreat of the ice lobes in these valleys. A further look into exposed bedrock surfaces at higher elevations for possible striations to determine paleo ice flow directions will need to be conducted.

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Tarr, R.S., 1909, Quaternary System: in Williams, H.S., Tarr, R.S., and Kindle, E.M., 1909, Description of the Watkins Glen-Catatonk District, United State Geological Survey, Folio of the Geologic Atlas, No. 169, pp. 15-28.

DESCRIPTION OF MAP UNITS

Holocene

Af — **Artifical fill (Af)**
This unit is generally comprised of coarse-to-fine materials, such as large cement mounds and/or crushed rock, which have been anthropogenically transported and used for construction purposes.

Ha — **Stratified silt, sand and gravel (Ha)**
Sorted and stratified silt, sand, and gravel, deposited by rivers and streams. May include cobbles and boulders. Inferred as post-glacial alluvium and includes modern channel, over-bank and fan deposits

Hw — **Wetland deposit (Hw)**
Peat, muck, marl, silt, clay or sand deposited in association with wetland environments. Various sediments can be present at transitional boundaries from one facies to another

Hdc — **Diamict colluvium (Hdc)**
Unsorted and unstratified deposit of gravel, sand, silt, and clay, with boulders/cobbles possible. Described as a mass-wasting deposit at the base of steep hillslopes and cliffs that was formed as part of a slump or hillslope failure.

Pleistocene

Psg — **Stratified sand and gravel (Psg)**
Well-sorted and -stratified sand and gravel. May include cobbles and boulders. Inferred to be delta, fan or lag deposits in glacial channels or near former ice margins.

Pics — **Cobbles to sand (Pics)**
Stratified ice contact deposits, variable coarse-grained sediment consisting of boulders to sand size particles. Inferred to have been deposited along an ice-margin. May include, interbedded coarse lenses of gravel and clast supported diamictons (flow tills).

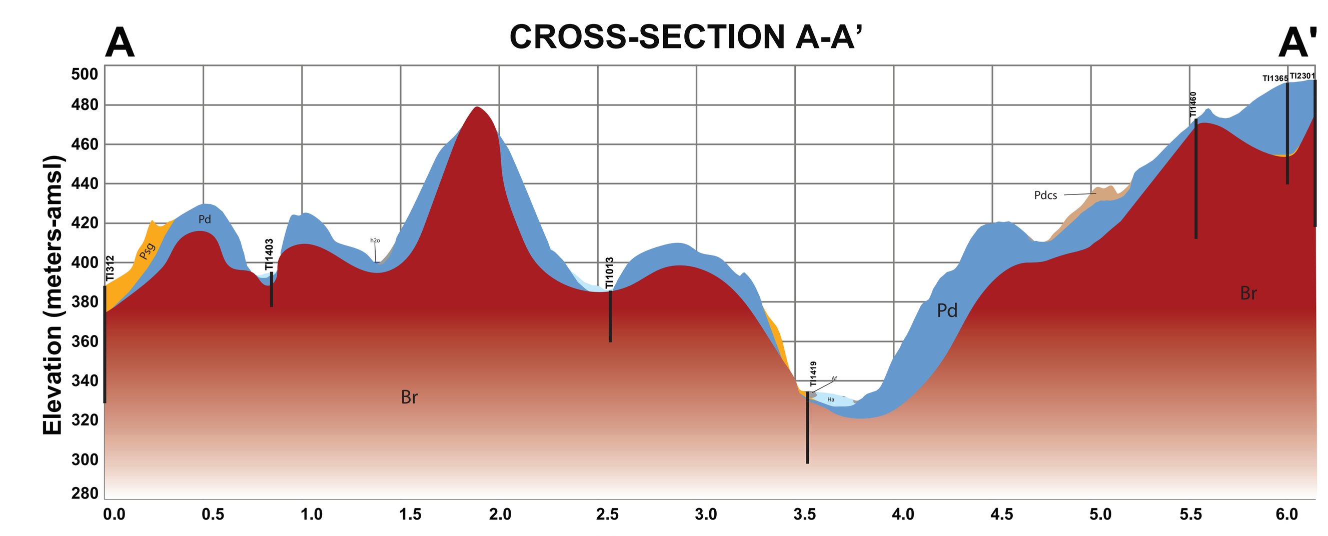
Pd — **Diamicton (Pd)**
An admixture of unsorted sediment ranging from clay to boulders. Generally matrix supported, massive and clast-rich.

Pdcs — **Diamicton (Pdcs)**
An admixture of unsorted sediment ranging from clay to boulders. Generally clast supported, massive and clast-rich.

Pre-Pleistocene

Br — **Bedrock (Br)**
Non-glacially derived, hard rock, pre-Pleistocene in age. May be covered up to a meter in diamicton, sand and gravel, or sand and clay in areas marked as Br.

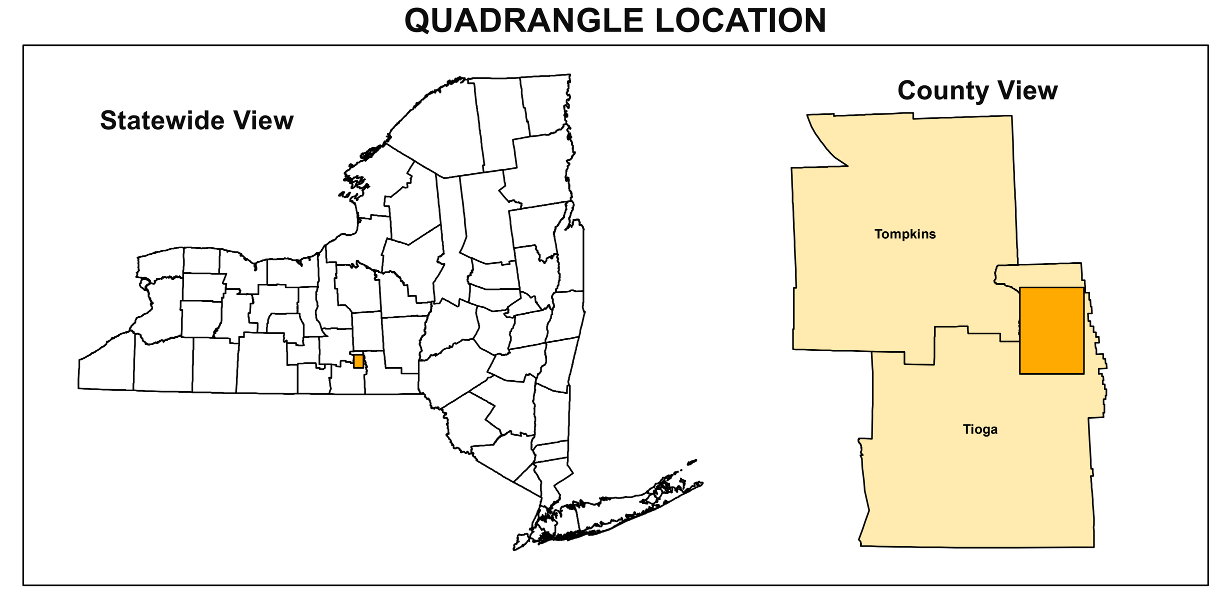
CROSS-SECTION A-A'



SYMBOLS

Street
Highway
Railroad
County Line
Water Body
Stream
Contour
Cross-Section Line
NYSGS Soil Sample Location
NYSDEC Water Well Location
NYSDOT Boring Location
Esker
Ice Margin

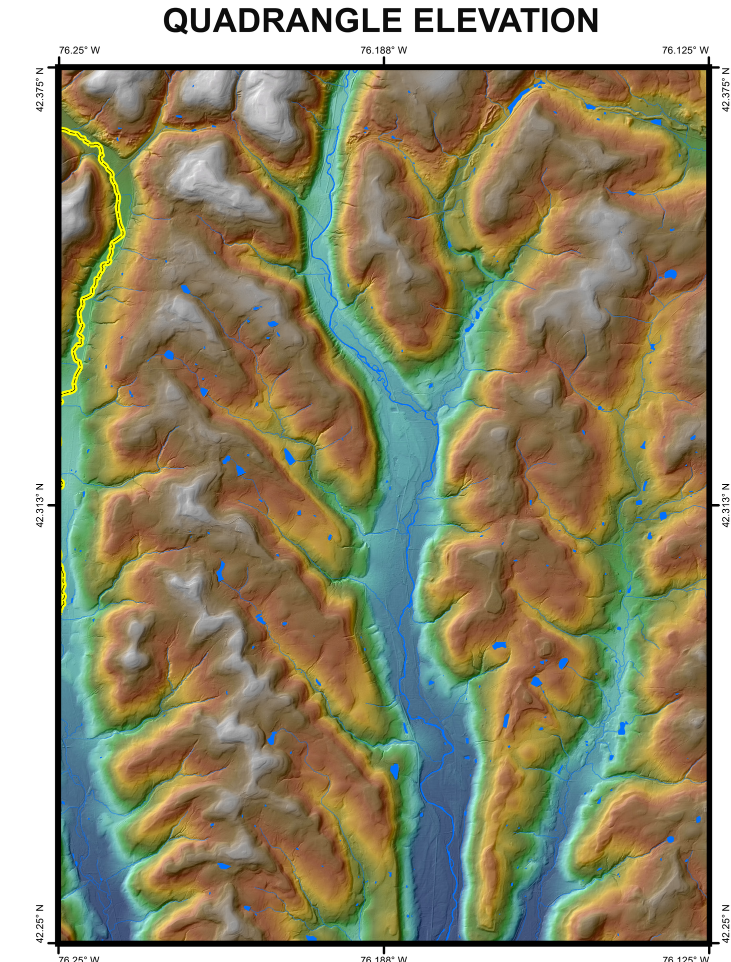
QUADRANGLE LOCATION

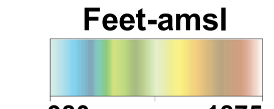


ADJOINING QUADRANGLES

Dryden	Harford	Marathon
Speedsville	Richford	Lisle
Candor	Newark Valley	Maine

QUADRANGLE ELEVATION





1:75,000 scale; 2x vertical exaggeration

Shaded relief and elevation from the FEMA 2019 1-meter lidar data set

New York State Museum Map & Chart No. 154
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