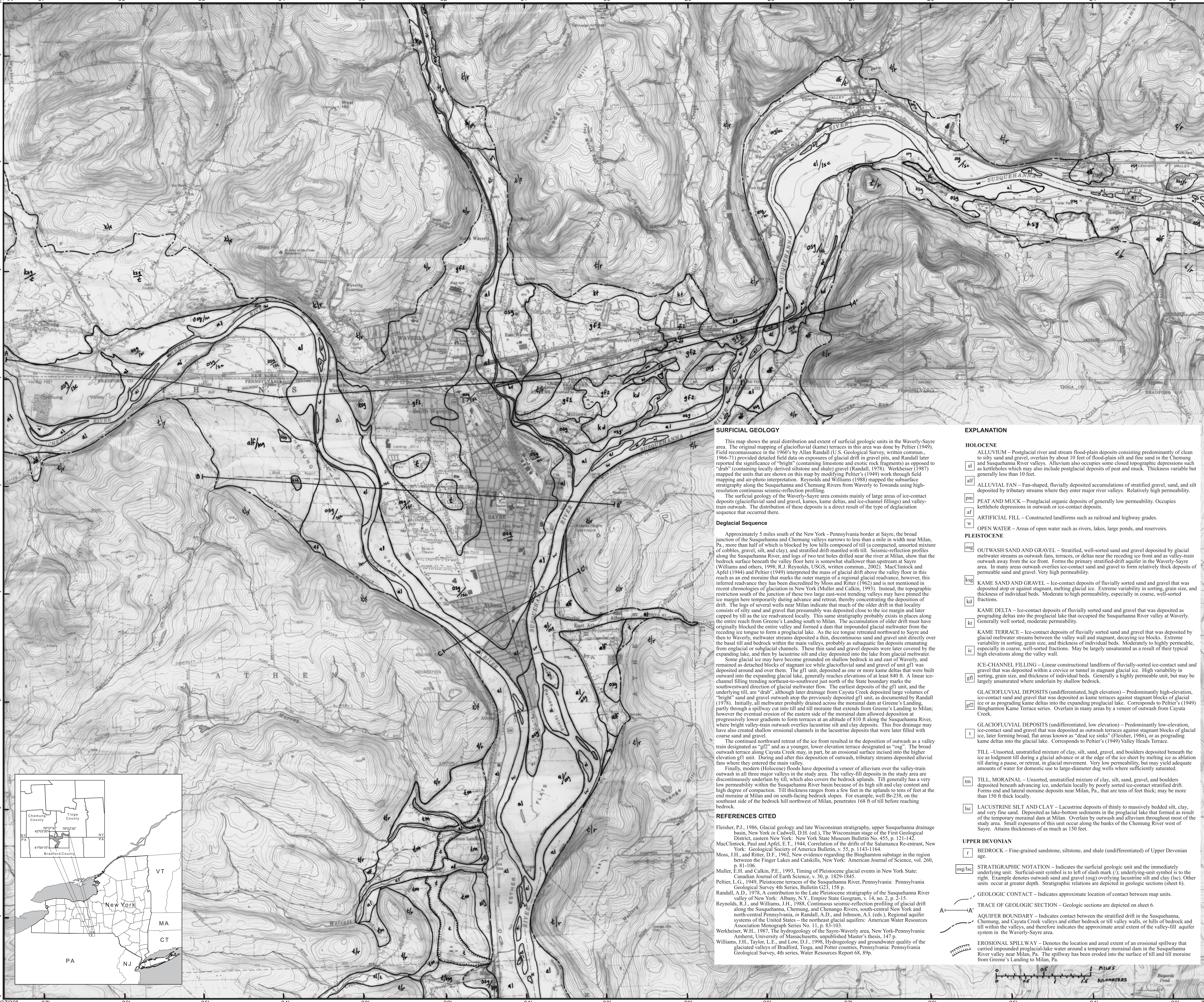
Reynolds, R.J., 2003, Hydrogeology of the Waverly-Sayre area in Tioga and Chemung Counties, New York and Bradford County, Pennsylvania: U.S. Geological Survey Open-File Report 02-284, 6 sheets, 1:24,000 scale



SURFICIAL GEOLOGY

This map shows the areal distribution and extent of surficial geologic units in the Waverly-Sayre area. The original mapping of glaciofluvial (kame) terraces in this area was done by Peltier (1949). Field reconnaissance in the 1960's by Allan Randall (U.S. Geological Survey, written commun., 1966-71) provided detailed field data on exposures of glacial drift in gravel pits, and Randall later reported the significance of "bright" (containing limestone and exotic rock fragments) as opposed to "drab" (containing locally derived siltstone and shale) gravel (Randall, 1978). Werkheiser (1987) mapped the units that are shown on this map by modifying Peltier's (1949) work through field mapping and air-photo interpretation. Reynolds and Williams (1988) mapped the subsurface stratigraphy along the Susquehanna and Chemung Rivers from Waverly to Towanda using high-resolution continuous seismic-reflection profiling.

The surficial geology of the Waverly-Sayre area consists mainly of large areas of ice-contact deposits (glaciofluvial sand and gravel, kames, kame deltas, and ice-channel fillings) and valley-train outwash. The distribution of these deposits is a direct result of the type of deglaciation sequence that occurred there.

Deglacial Sequence

Approximately 5 miles south of the New York - Pennsylvania border at Sayre, the broad junction of the Susquehanna and Chemung valleys narrows to less than a mile in width near Milan, Pa., more than half of which is blocked by low hills composed of till (a compacted, unsorted mixture of cobbles, gravel, silt, and clay), and stratified drift mantled with till. Seismic-reflection profiles along the Susquehanna River, and logs of two test holes drilled near the river at Milan, show that the bedrock surface beneath the valley floor here is somewhat shallower than upstream at Sayre (Williams and others, 1998; R.J. Reynolds, USGS, written commun., 2002). MacClintock and Apfel (1944) and Peltier (1949) interpreted the mass of glacial drift above the valley floor in this reach as an end moraine that marks the outer margin of a regional glacial readvance, however, this inferred readvance they has been discredited by Moss and Ritter (1962) and is not mentioned in recent chronologies of glaciation in New York (Muller and Calkin, 1993). Instead, the topographic restriction south of the junction of these two large east-west trending valleys may have pinned the ice margin here temporarily during advance and retreat, thereby concentrating the deposition of drift. The logs of several wells near Milan indicate that much of the older drift in that locality consists of silty sand and gravel that presumably was deposited close to the ice margin and later capped by till as the ice readvanced locally. This same stratigraphy probably exists in places along the entire reach from Greene's Landing south to Milan. The accumulation of older drift must have originally blocked the entire valley and formed a dam that impounded glacial meltwater from the receding ice tongue to form a proglacial lake. As the ice tongue retreated northward to Sayre and then to Waverly, meltwater streams deposited a thin, discontinuous sand and gravel unit directly over the basal till and bedrock within the main valleys, probably as subaquatic fan deposits emanating from englacial or subglacial channels. These thin sand and gravel deposits were later covered by the expanding lake, and then by lacustrine silt and clay deposited into the lake from glacial meltwater.

Some glacial ice may have become grounded on shallow bedrock in and east of Waverly, and remained as detached blocks of stagnant ice while glaciofluvial sand and gravel of unit gf1 was deposited around and over them. The gf1 unit, deposited as one or more kame deltas that were built outward into the expanding glacial lake, generally reaches elevations of at least 840 ft. A linear ice-channel filling trending northeast-to-southwest just north of the State boundary marks the southwestward direction of glacial meltwater flow. The earliest deposits of the gf1 unit, and the underlying till, are "drab", although later drainage from Cayuta Creek deposited large volumes of "bright" sand and gravel outwash atop the previously deposited gf1 unit, as documented by Randall (1978). Initially, all meltwater probably drained across the morainal dam at Greene's Landing, partly through a spillway cut into till and till moraine that extends from Greene's Landing to Milan; however the eventual erosion of the eastern side of the morainal dam allowed deposition at progressively lower gradients to form terraces at an altitude of 810 ft along the Susquehanna River, where bright valley-train outwash overlies lacustrine silt and clay deposits. This free drainage may have also created shallow erosional channels in the lacustrine deposits that were later filled with coarse sand and gravel.

The continued northward retreat of the ice front resulted in the deposition of outwash as a valley train designated as "gf2" and as a younger, lower elevation terrace designated as "osg". The broad outwash terrace along Cayuta Creek may, in part, be an erosional surface incised into the higher elevation gf1 unit. During and after this deposition of outwash, tributary streams deposited alluvial fans where they entered the main valley.

Finally, modern (Holocene) floods have deposited a veneer of alluvium over the valley-train outwash in all three major valleys in the study area. The valley-fill deposits in the study area are discontinuously underlain by till, which also covers the bedrock uplands. Till generally has a very low permeability within the Susquehanna River basin because of its high silt and clay content and high degree of compaction. Till thickness ranges from a few feet in the uplands to tens of feet at the end moraine at Milan and on south-facing bedrock slopes. For example, well Br-238, on the southeast side of the bedrock hill northwest of Milan, penetrates 168 ft of till before reaching bedrock.

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EXPLANATION

HOLOCENE

al — ALLUVIUM – Postglacial river and stream flood-plain deposits consisting predominantly of clean to silty sand and gravel, overlain by about 10 feet of flood-plain silt and fine sand in the Chemung and Susquehanna River valleys. Alluvium also occupies some closed topographic depressions such as kettleholes which may also include postglacial deposits of peat and muck. Thickness variable but generally less than 10 feet.

alf — ALLUVIAL FAN – Fan-shaped, fluvially deposited accumulations of stratified gravel, sand, and silt deposited by tributary streams where they enter major river valleys. Relatively high permeability.

pm — PEAT AND MUCK – Postglacial organic deposits of generally low permeability. Occupies kettlehole depressions in outwash or ice-contact deposits.

af — ARTIFICIAL FILL – Constructed landforms such as railroad and highway grades.

w — OPEN WATER – Areas of open water such as rivers, lakes, large ponds, and reservoirs.

PLEISTOCENE

osg — OUTWASH SAND AND GRAVEL – Stratified, well-sorted sand and gravel deposited by glacial meltwater streams as outwash fans, terraces, or deltas near the receding ice front and as valley-train outwash away from the ice front. Forms the primary stratified-drift aquifer in the Waverly-Sayre area. In many areas outwash overlies ice-contact sand and gravel to form relatively thick deposits of permeable sand and gravel. Very high permeability.

ksg — KAME SAND AND GRAVEL – Ice-contact deposits of fluvially sorted sand and gravel that was deposited atop or against stagnant, melting glacial ice. Extreme variability in sorting, grain size, and thickness of individual beds. Moderate to high permeability, especially in coarse, well-sorted fractions.

kd — KAME DELTA – Ice-contact deposits of fluvially sorted sand and gravel that was deposited as prograding deltas into the proglacial lake that occupied the Susquehanna River valley at Waverly. Generally well sorted; moderate permeability.

kt — KAME TERRACE – Ice-contact deposits of fluvially sorted sand and gravel that was deposited by glacial meltwater streams between the valley wall and stagnant, decaying ice blocks. Extreme variability in sorting, grain size, and thickness of individual beds. Moderately to highly permeable, especially in coarse, well-sorted fractions. May be largely unsaturated as a result of their typical high elevations along the valley wall.

ic — ICE-CHANNEL FILLING – Linear constructional landform of fluvially-sorted ice-contact sand and gravel that was deposited within a crevice or tunnel in stagnant glacial ice. High variability in sorting, grain size, and thickness of individual beds. Generally a highly permeable unit, but may be largely unsaturated where underlain by shallow bedrock.

gf1 — GLACIOFLUVIAL DEPOSITS (undifferentiated, high elevation) – Predominantly high-elevation, ice-contact sand and gravel that was deposited as kame terraces against stagnant blocks of glacial ice or as prograding kame deltas into the expanding proglacial lake. Corresponds to Peltier's (1949) Binghamton Kame Terrace series. Overlain in many areas by a veneer of outwash from Cayuta Creek.

gf2 — GLACIOFLUVIAL DEPOSITS (undifferentiated, low elevation) – Predominantly low-elevation, ice-contact sand and gravel that was deposited as outwash terraces against stagnant blocks of glacial ice, later forming broad, flat areas known as "dead ice sinks" (Fleisher, 1986), or as prograding kame deltas into the glacial lake. Corresponds to Peltier's (1949) Valley Heads Terrace.

t — TILL –Unsorted, unstratified mixture of clay, silt, sand, gravel, and boulders deposited beneath the ice as lodgment till during a glacial advance or at the edge of the ice sheet by melting ice as ablation till during a pause, or retreat, in glacial movement. Very low permeability, but may yield adequate amounts of water for domestic use to large-diameter dug wells where sufficiently saturated.

tm — TILL, MORAINAL – Unsorted, unstratified mixture of clay, silt, sand, gravel, and boulders deposited beneath advancing ice, underlain locally by poorly sorted ice-contact stratified drift. Forms end and lateral moraine deposits near Milan, Pa., that are tens of feet thick; may be more than 150 ft thick locally.

lsc — LACUSTRINE SILT AND CLAY – Lacustrine deposits of thinly to massively bedded silt, clay, and very fine sand. Deposited as lake-bottom sediments in the proglacial lake that formed as result of the temporary morainal dam at Milan. Overlain by outwash and alluvium throughout most of the study area. Small exposures of this unit occur along the banks of the Chemung River west of Sayre. Attains thicknesses of as much as 150 feet.

UPPER DEVONIAN

r — BEDROCK – Fine-grained sandstone, siltstone, and shale (undifferentiated) of Upper Devonian age.

osg/lsc — STRATIGRAPHIC NOTATION – Indicates the surficial geologic unit and the immediately underlying unit. Surficial-unit symbol is to left of slash mark (/); underlying-unit symbol is to the right. Example denotes outwash sand and gravel (osg) overlying lacustrine silt and clay (lsc). Other units occur at greater depth. Stratigraphic relations are depicted in geologic sections (sheet 6).

GEOLOGIC CONTACT – Indicates approximate location of contact between map units.

A — A' TRACE OF GEOLOGIC SECTION – Geologic sections are depicted on sheet 6.

AQUIFER BOUNDARY – Indicates contact between the stratified drift in the Susquehanna, Chemung, and Cayuta Creek valleys and either bedrock or till valley walls, or hills of bedrock and till within the valleys, and therefore indicates the approximate areal extent of the valley-fill aquifer system in the Waverly-Sayre area.

EROSIONAL SPILLWAY – Denotes the location and areal extent of an erosional spillway that carried impounded proglacial-lake water around a temporary morainal dam in the Susquehanna River valley near Milan, Pa. The spillway has been eroded into the surface of till and till moraine from Greene's Landing to Milan, Pa.

Base from U.S. Geological Survey
1:24,000 Series: Waverly, NY-PA (1978);
Sayre, PA-NY (1969), Litchfield, PA-NY (1978)
Barton, NY-PA (1976)

HYDROGEOLOGY OF THE WAVERLY–SAYRE AREA IN TIOGA AND CHEMUNG COUNTIES, NEW YORK AND BRADFORD COUNTY, PENNSYLVANIA

By
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2003
Sheet 2 - Surficial Geology

Geology modified from Peltier (1949), Randall (1978), and Werkheiser (1987) by R. J. Reynolds, 2001.

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