

**GEOLOGIC SECTIONS**

Hydrogeologic data obtained from drillers' logs, logs of test holes, consultants' reports, an unpublished thesis (Werkheiser, 1987), and a published USGS report (Randall, 1972) were used to construct three geologic sections showing the thickness of aquifer material and the stratigraphic relations among the various types of valley-fill deposits in the Waverly-Sayre area. The geologic sections are presented at a horizontal scale of 1:24,000 with a vertical exaggeration of 20 for legibility. The traces of these sections are shown on sheets 1 and 2.

**Section A-A'** This section extends approximately 9 miles eastward across the study area from Chemung, N.Y. to Liverpool, N.Y., and shows the stratigraphic relations among the surficial outwash (osg), the high- and low-elevation glaciofluvial deposits (gf1 and gf2), and the lacustrine confining unit (lsc). At the eastern end of the section, outwash sand and gravel overlies a kame delta deposit, and both overlie fine-grained lacustrine silt and sand (lss) and lacustrine silt and clay (lsc). These two fine-grained units together form 90 feet of lacustrine confining unit in the Susquehanna River valley. This lacustrine unit was deposited against and atop ice-contact sand and gravel and till (ksg), which attains a thickness of 86 feet at test boring 20-53b (Randall, 1972). This deposit is probably a combination of silty ice-contact sand and gravel and till, but the contrasts among samples (as reported by Randall, 1972) were too slight to clearly establish an alternation of till and silty gravel. To the west, this ice-contact unit is overlain by high-elevation glaciofluvial deposits (gf1). The presence of a high-elevation till within unit gf1 (boreholes 24-51b and 24-50b) appears to confirm its proximal ice-contact depositional environment. Further to the west is a deposit of low-elevation glaciofluvial sand and gravel (gf2), more than 100 ft thick, that consists mainly of silty gravel and sand with interbedded layers of clay and silt in the lower sections. These interbedded clay and silt layers seem to indicate that the lower part of this unit may consist partly of subaquatic fan deposits. Even farther westward, the high-elevation glaciofluvial unit (gf1) is banked against the till and bedrock hill near the State boundary, but sparse drill-hole data here reveal little about its stratigraphy. South of the bedrock and till hill and into Pennsylvania, outwash sand and gravel from the Cayuta Creek valley fills a channel that was eroded by Cayuta Creek into the lacustrine silt and clay after the proglacial lake had drained. Sandwiched between the lacustrine silt and clay and the underlying till is a thin glaciofluvial fan deposit (fd), that probably consists of subaquatic fan deposits of sand and gravel. A similar, slightly thicker unit is seen further west in this section in the Chemung River valley and forms a confined sand and gravel aquifer in this area. Spanish Hill, at the eastern edge of the Chemung River valley, consists of ice-contact sand and gravel and overlies a ridge in the underlying bedrock surface. Throughout the Chemung River valley, thick outwash sand and gravel overlies equally thick deposits of lacustrine silt and clay; for example, test boring 03-16b (Randall, 1972) penetrates 51 feet of gravel overlying 43 feet of silt and clay. Near the village of Chemung, the outwash and lacustrine silt and clay overlie buried ice-contact silty sand and gravel (ksg), as indicated by the log of test boring 01-11b (Randall, 1972).

**Section B-B'** This section, which extends 4 miles eastward across the village of Sayre, shows the remnant bedrock ridge that separates the Chemung River valley on the west, from the Susquehanna River valley on the east. Thick till caps this ridge and crops out at land surface, and the ridge is flanked by the high-elevation glaciofluvial deposits (gf1). The main stratigraphic feature of the Susquehanna River valley along B-B' is the thick body of lacustrine silt and clay, which attains a thickness of almost 150 ft in places. This lacustrine silt and clay unit is capped by thick outwash that emanated mostly from the Cayuta Creek valley during deglaciation. Within the lacustrine unit is a 10- to 15-foot thickness of medium-to-course sand that may represent the distal end of an outwash delta produced by meltwater flow through the Cayuta Creek valley. A similar, slightly thicker unit is seen further west in this section in the Chemung River valley and forms a confined sand and gravel aquifer in this area. The western end of the section depicts the large alluvial fan of Tulew Creek overlying kame sand and gravel that crops out at land surface.

**Section C-C'** This section extends eastward for about 1.5 miles through Athens, Pa., and shows a thick deposit of outwash sand and gravel overlying the lacustrine silt and clay. Here the outwash attains a thickness of about 65 feet and overlies as much as 85 feet of lacustrine silt and clay. Underlying the lacustrine silt and clay is 10 to 15 feet of glaciofluvial sand and gravel, which forms the confined sand and gravel aquifer throughout the area. Part of the thickness of this confined aquifer here may consist of washed or reworked till. Continuous seismic-reflection data (Reynolds and Williams, 1988) were used to determine the altitude of the bedrock surface beneath the Chemung and Susquehanna Rivers on this section.

**REFERENCES CITED**

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 Pelter, L.G., 1949. Pleistocene terraces of the Susquehanna River, Pennsylvania: Pennsylvania Geological Survey, 4<sup>th</sup> Series, Bulletin 62, 158 p.  
 Randall, A.D., 1972. Records of wells and test borings in the Susquehanna River Basin, New York: New York State Department of Environmental Conservation Bulletin 69, 92 p.  
 Reynolds, R.J., and Williams, J.H., 1988. Continuous seismic-reflection profiling of glacial drift along the Susquehanna, Chemung, and Chenango Rivers, south-central New York and north-central Pennsylvania. In Randall, A.D., and Johnson, A.L. (eds.), Regional Aquifer Systems of the United States: the northeast glacial provinces: American Water Resources Association Monograph Series No. 11, p. 83-103.  
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**EXPLANATION**

**HOLOCENE**

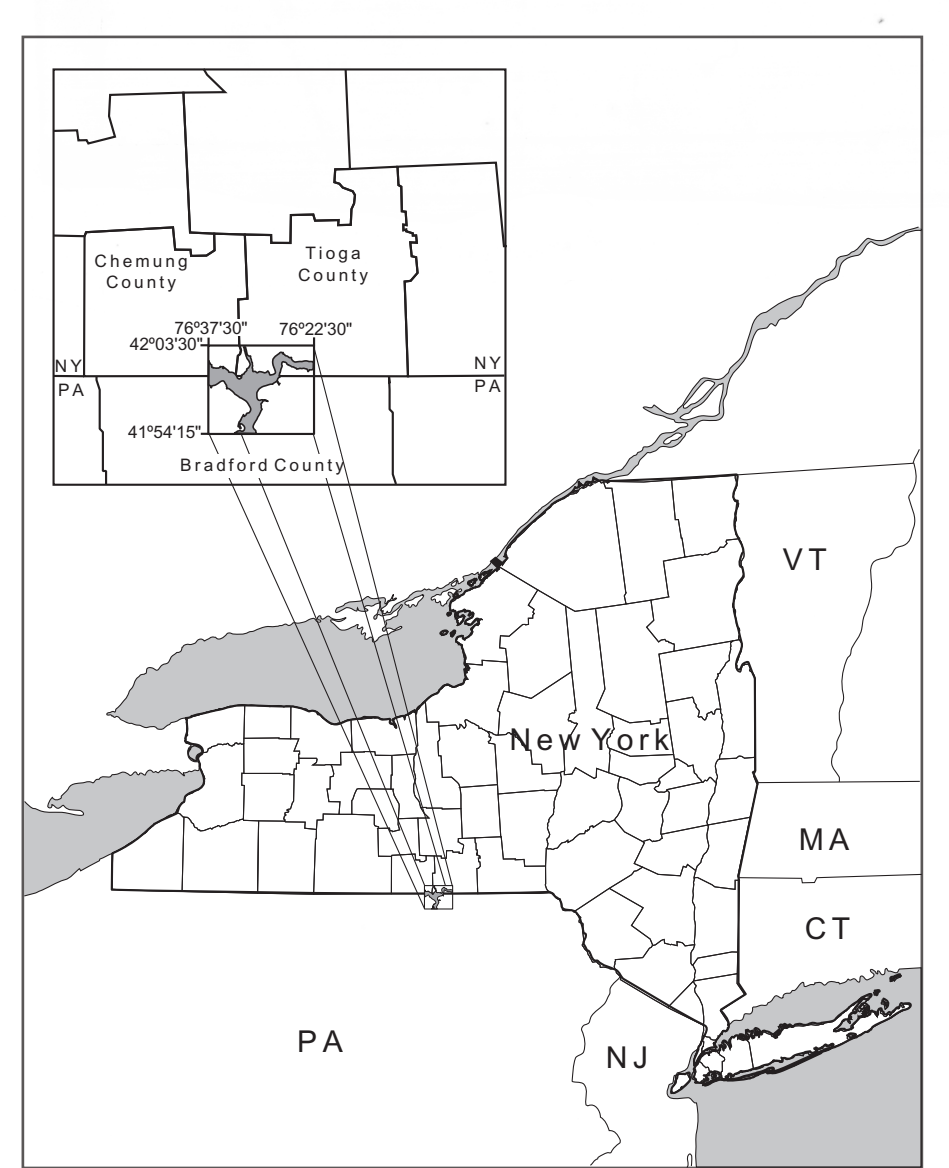
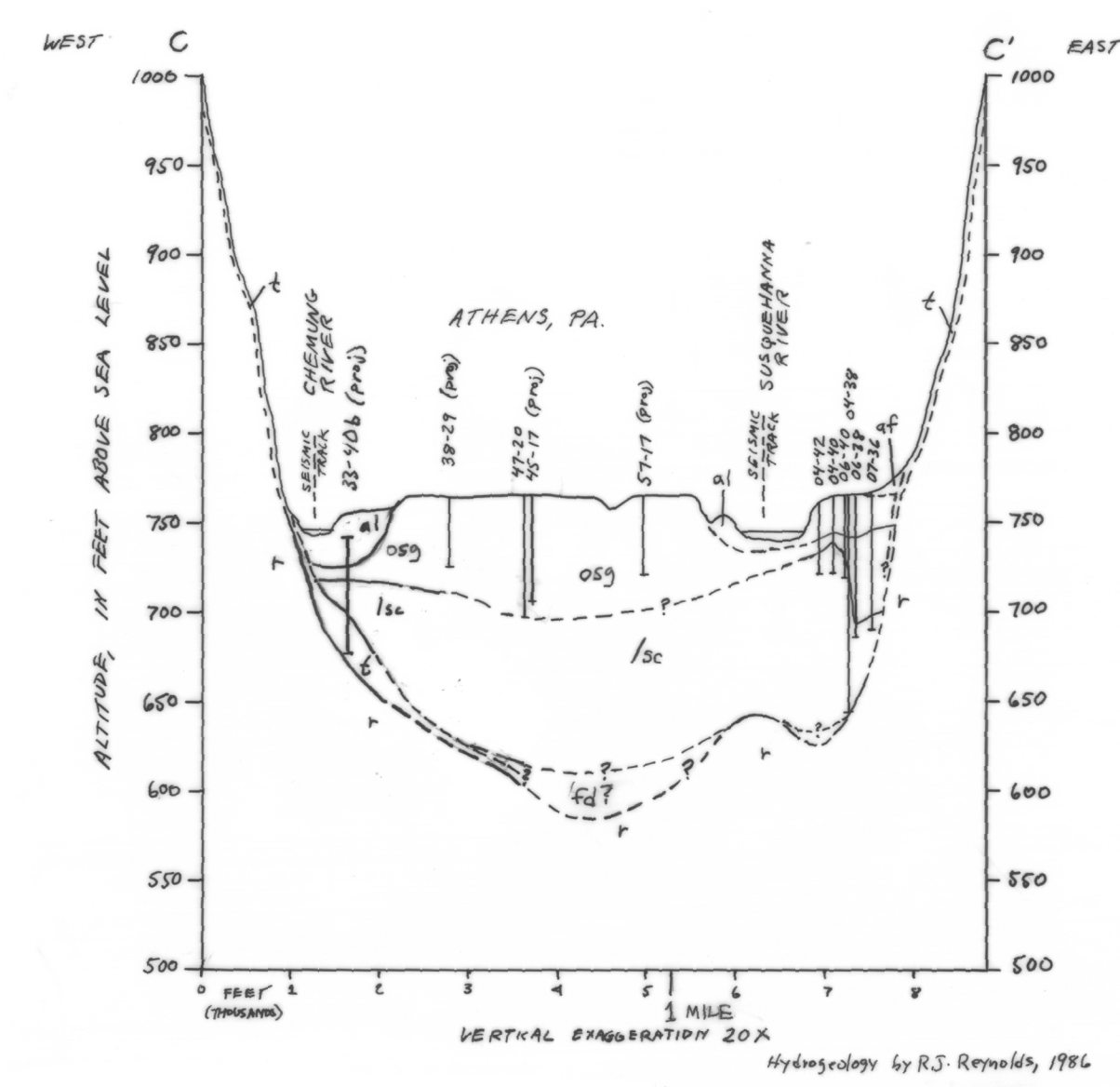
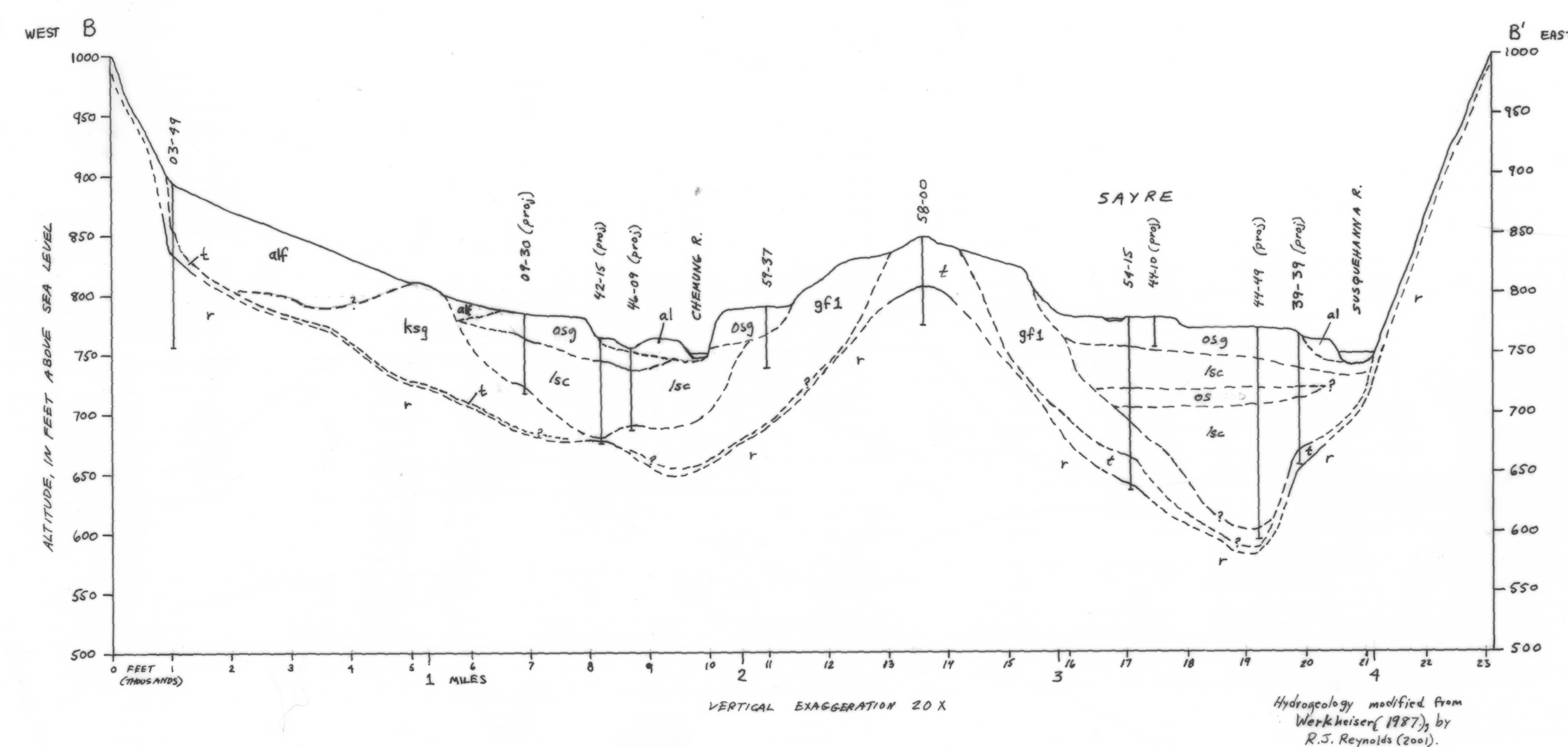
- [al] ALLUVIUM—Postglacial river and stream flood-plain deposits consisting predominantly of silt and gravel, commonly overlain by flood-plain silt and fine sand of variable thickness in major river valleys. Thickness variable.
- [alf] ALLUVIAL FAN—Fan-shaped, fluviially deposited accumulations of stratified gravel, sand, and silt deposited by tributary streams where they enter major river valleys. Relatively high permeability.
- [af] ARTIFICIAL FILL—Constructed landforms such as railroad and highway grades.

**PLEISTOCENE**

- [osg] OUTWASH SAND AND GRAVEL—Stratified, well-sorted sand and gravel deposited by fluvial meltwater streams as outwash fans, terraces, and 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. Underlain in the main valleys by lacustrine silt and clay. Very high permeability.
- [os] OUTWASH SAND—Well-sorted, medium-to-course sand, possibly deposited as part of an outwash delta produced by meltwater from Cayuta Creek.
- [gf1] GLACIOFLUVIAL DEPOSITS (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 Pelter's (1949) Binghamton Kame Terrace series. Overlain in some places by a thin veneer of outwash from Cayuta Creek.
- [gf2] GLACIOFLUVIAL DEPOSITS (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 proglacial lake. Corresponds to Pelter's (1949) Valley Heads Terrace. Overlain in many areas by a veneer of alluvium.
- [ksg] KAME SAND AND GRAVEL—Ice-contact deposits of fluviially sorted sand and gravel that were deposited atop or against stagnant, melting glacial ice. Extreme variability in sorting, grain size, and thickness of individual beds. Moderately to highly permeable, especially in coarse, well-sorted fractions.
- [kd] KAME DELTA—Ice-contact deposits of fluviially-sorted sand and gravel that was deposited as prograding deltas into the proglacial lake that occupied the Susquehanna River valley at Waverly, N.Y. Generally well sorted, moderate permeability.
- [fd] GLACIOFLUVIAL FAN DEPOSIT—Subaquatic fan deposits of sand and gravel deposited by meltwater issuing from the receding glacial ice beneath the proglacial-lake surface. May also consist partly of washed or reworked till. Forms a discontinuous confined aquifer throughout the Waverly-Sayre area. Thickness ranges from 5 to 30 ft. Moderately permeable.
- [lss] LACUSTRINE SAND AND SILT—Lacustrine deposits of fine to very fine sand and silt deposited as lake-bottom sediments by meltwater streams entering the proglacial lake in the Susquehanna River valley. Underlain by lacustrine silt and clay. Together these units attain thicknesses of as much as 150 feet in the Susquehanna River valley.
- [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 in the Susquehanna and Chemung River valleys as a result of the temporary moraine dam at Milan, Pa. Exposed at land surface only along the banks of the Chemung River west of Sayre. This unit, together with the overlying lacustrine sand and silt (where present), attains a thickness of as much as 150 ft in the main valleys.
- [t] TILL—An unsorted mixture of clay, silt, sand, gravel, and boulders deposited beneath the ice (as lodgment till) during glacial advance, or at the edge of the ice sheet (as ablation till) by melting ice during a pause or retreat in glacial movement. Also includes layers of "flow tills" deposited as mudflows within the large ice-disintegration complex (unit gf1) in the Waverly area. Very low permeability.

**UPPER DEVONIAN**

- [r] BEDROCK—Fine-grained sandstones, siltstones, and shales (undifferentiated) of Upper Devonian age.
- GEOLOGIC CONTACT—Indicates approximate location of contact between stratigraphic units; dashed where inferred.
- WELL—From which geologic information was obtained to construct geologic section. Hyphenated number is well number, representing seconds of latitude and longitude; "proj." indicates that the log of a nearby well is projected to the trace of the section.
- TEST BORING—Boring or exploratory well from which geologic information was obtained to construct geologic section. Hyphenated number is well number, representing seconds of latitude and longitude; suffix "B" indicates test boring. Logs of test borings in New York are listed in Randall (1972).



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

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 Sheet 6 - Geologic Sections

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