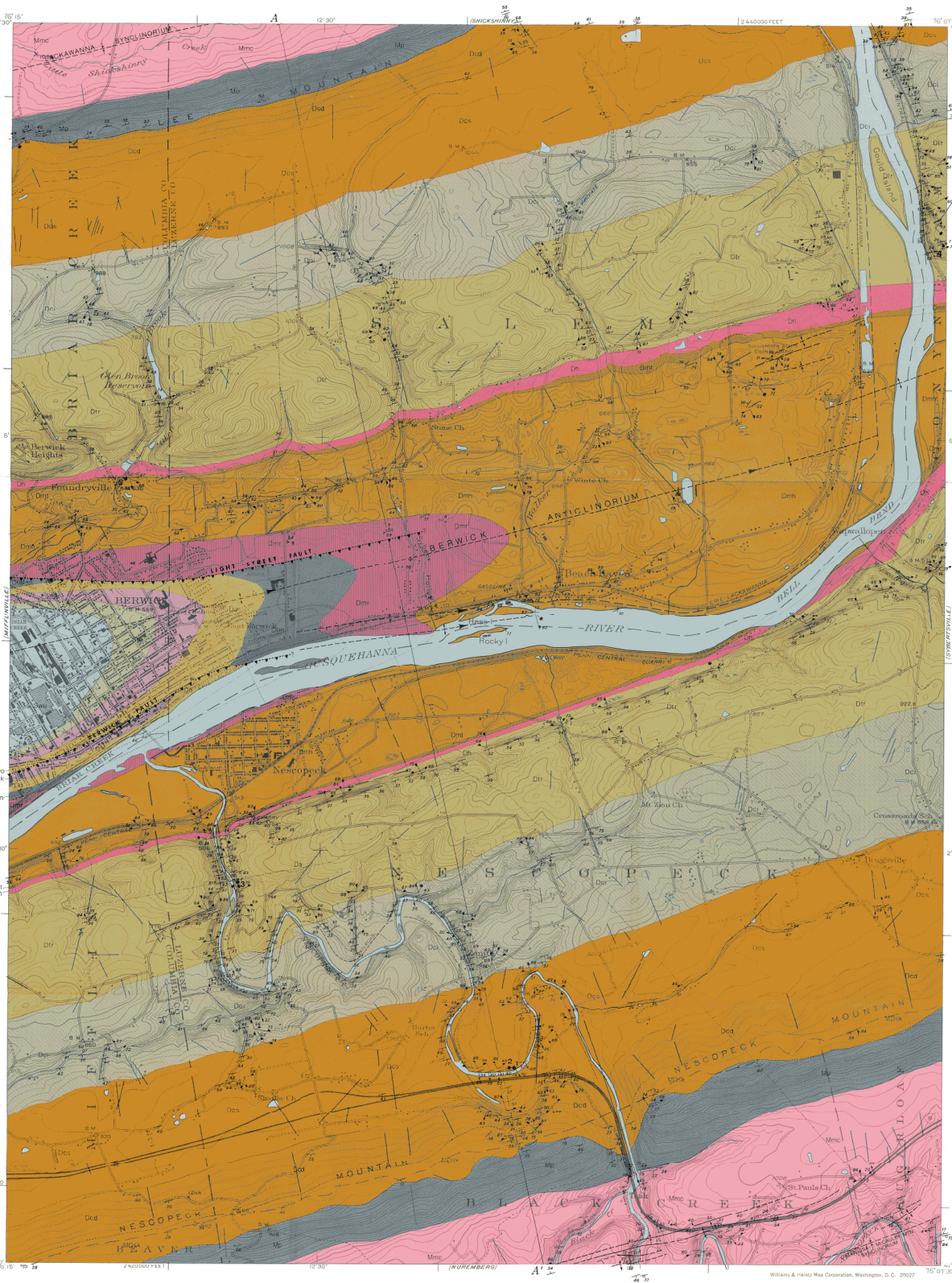

Base map from U.S. Geological Survey Berwick 7½-minute quadrangle.

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Williams & Heintz Map Corporation, Washington, D.C. 20027

Geology based on field mapping during 1975-76.
Albert E. VanOlden, Cartographer

BEDROCK GEOLOGIC MAP OF THE BERWICK QUADRANGLE, LUZERNE AND COLUMBIA COUNTIES, PENNSYLVANIA

BY JON D. INNERS

1978

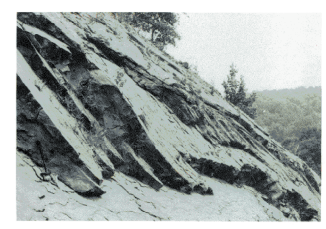


Figure 1. Large-scale planar crossbeds in greenish-gray medium-grained sandstone, Sherman Creek Member of Catskill Formation. Channel change of Nescopeck Creek, 200 feet (61 m) north of Interstate 80, Nescopeck Township, Luzerne County (41°01'10"N/76°10'55"W). Bedding and crossbedding both dip southeast. Hammer is 11.5 inches (29.2 cm) long.

Figure 2. Rubble slide in moderately dipping sandstone, Sherman Creek Member of Catskill Formation. Channel change of Nescopeck Creek, 200 feet (61 m) north of Interstate 80, Nescopeck Township, Luzerne County (41°01'10"N/76°10'57"W). Beds, which dip about 40 degrees to the southeast, were undercut during excavation of new channel. Note prominent strike (s) and dip (d) joints.

APPROXIMATE MEAN DECLINATION, 1969

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

LOCATION OF AREA

SYMBOLS

Contact — Dashed where approximately located; dotted where inferred.

High-angle fault (approximately located)

Major reverse fault (inferred)

Strike and dip of minor fault

Inclined — Approximate — Approximately horizontal — Generalized attitude of undulating beds

Strike and dip of beds
In all cases, the strike-and-dip symbol is on the exact location where data were obtained. Other structural symbols based on readings at the same point are grouped as near as possible to the bedding symbol location.

Inclined — Vertical — Multiple joint system

Strike and dip of joint

Fine — Coarse
Strike and dip of cleavage

Anticlinal — Synclinal
Strike and plunge of mappable fold
Dashed where approximately located.

Anticlinal — Synclinal
Strike and plunge of minor fold

Azimuth and plunge of slickenline on bedding and fault planes

Fracture trace

Location of photograph shown on this plate
Number corresponds to figure number.

Mine adit

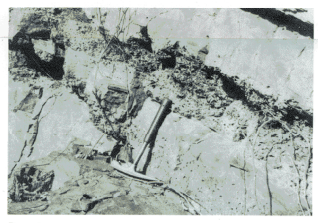


Figure 3. Calcareous fossil-shell (brachiopod) lenses in middle part of Trimmers Rock Formation. Exposure along L.R. 40017, 1 mile (1.6 km) south of Nescopeck, Luzerne County (41°02'18"N/76°13'09"W). These are the thickest such beds observed in the quadrangle. Bedding dips southeast. Hammer is 11.5 inches (29.2 cm) long.

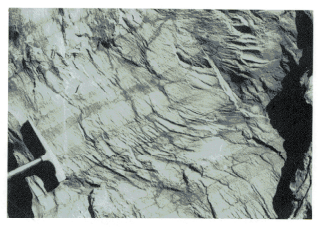
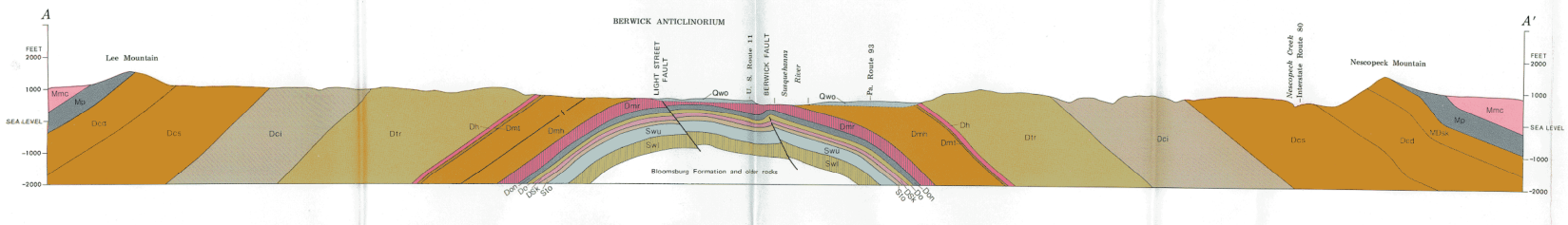


Figure 4. Siltstone beds, some distinctly graded, in lower part of Trimmers Rock Formation. Abandoned quarry on bluff overlooking Pa. Route 239 and the Susquehanna River, 1.9 miles (3.0 km) north of Wapwallopen, Luzerne County (41°06'09"N/76°07'32"W). Hammer head is 7.75 inches (19.7 cm) long.

Figure 5. Coarse cleavage in argillaceous, micritic limestone, Tully Member of Mahantango Formation. Exposure on south side of L. R. 19046, Foundryville, Columbia County (41°04'44"N/76°14'04"W). Cleavage (prominent parting) dips 47 degrees to the southeast (left), and bedding (obscure) dips 39 degrees to the northwest (right). Hammer is 11.5 inches (29.2 cm) long.

CROSS SECTION

(Horizontal scale same as map scale; no vertical exaggeration)



EXPLANATION

	GEOLOGIC DESCRIPTION	UNIT	ENVIRONMENTAL CHARACTERISTICS
MISSISSIPPIAN	Interbedded grayish-red silty claystone and siltstone (50 percent) and very fine to fine-grained sandstone (49 percent), with locally prominent units of greenish-gray to grayish-red, medium-grained to finely conglomeratic sandstone (1 percent). Silty claystone and siltstone in beds 1/2 inch to 4 feet (1 cm to 1.2 m) thick; laminated to massive; micaceous, commonly calcareous; cleavage often prominent; weathers to platy, chippy, and hackly fragments. Sandstone and conglomeratic sandstone in beds 2 inches to 4 feet (5 cm to 1.2 m) thick, planar and crossbedded; poorly to well indurated; micaceous; joints common; cleavage locally well developed; weathers to slabby, blocky, and rubbly fragments. Predominantly alluvial-plain deposits with some coarse channel sandstones. Low to moderate resistance to weathering. Forms upland areas of low to moderate relief. Total thickness in northern outcrop belt is 1,000 to 1,200 feet (305 to 370 m) (White, 1883), of which approximately the lower 500 feet (150 m) is present in the extreme northwest corner of the Berwick quadrangle; estimated total thickness in southern outcrop belt is about 2,500 feet (760 m), of which only about the lower 1,000 feet (305 m) is exposed in the mapped area.	MAUCH CHUNK FORMATION Mmc	Moderate to high infiltration capacity along steeply dipping joints and low- to moderately dipping bedding planes; some weakly cemented sandstone beds probably have fair intergranular permeability. Sandstones have good to excellent aquifer potential and should be encountered in most wells. Supplies adequate for domestic and, locally, for industrial and municipal usage. Domestic wells can be expected to yield in excess of 10 gpm (0.63 l/s) of good-quality soft water from depths of 100 to 200 feet (30 to 60 m).[1] Low to moderate stability in cut slopes greater than 25 degrees; cleaved claystones and siltstones are particularly unstable; thick sandstone units may stand in slopes greater than 25 degrees, but intersection of joints, cleavage, and bedding in sandstone can create instability leading to block falls. Easy (claystone) to difficult (sandstone) excavation with heavy machinery; blasting probably required where well-indurated sandstone is encountered. Moderate to high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock. Fast to moderate drilling rates. Suitability for septic systems and sanitary landfills depends on thickness and permeability of soil and broken rock mantle; areas underlain by thick claystone beds may have inadequate permeability for septic systems, but may be suitable for landfills. Claystone may have some potential for brick clay (untested). Hard sandstone may have potential for coarse aggregate (untested).
	Very light to medium-gray, medium-grained to conglomeratic, quartzitic sandstone and conglomerate (90 percent), with thin lenses of dark-gray to olive-gray clay shale, sand-silt-clay laminites, and black coaly shale (10 percent). Sandstone in beds 2 inches to 3 feet (5 cm to 1 m) thick, commonly combined into units 20 feet (6 m), or more, thick; crossbedded; pebbles mostly quartz, rounded to subrounded, 1/4 to 3/4 inch (5 to 20 mm) in diameter; micaceous, locally pyritic; joints common; weathers to blocky, rubbly, and slabby fragments; ledges often show evidence of intense frost riving. Conglomerate in lenses up to 1.5 feet (0.5 m) thick; pebbles mostly quartz, rounded to subrounded, to 3 inches (8 cm) in diameter, but also include medium-gray chert, dark-gray clay shale, and angular brownish-black limonite clasts; best developed at or near base of formation. Clayey, silty, and coaly units very poorly exposed, probably in lenticular beds less than 5 feet (1.6 m) thick. Fossiliferous: carbonized plant fragments. Mostly braided-river deposits; coaly sediments formed in small swamps. Strongly resistant to weathering; forms mountains of high relief having moderate to steep slopes. Thickness calculated at about 600 to 650 feet (180 to 200 m).	POCONO FORMATION Mp	Moderate infiltration capacity along steeply dipping joints and moderately dipping bedding planes. Good aquifer potential, but many wells will have to be more than 200 feet (60 m) deep because of high relief of terrain underlain by formation. Most domestic wells will probably yield in excess of 10 gpm (0.63 l/s) from depths of 200 to 400 feet (60 to 120 m). Water is of good quality and soft, but some wells may encounter high iron content or hydrogen sulfide (from pyrite).
	Medium-light-gray and light-olive-gray, medium-grained to conglomeratic sandstone and conglomerate (80 percent), with some medium-light-gray and olive-gray siltstone and claystone, and grayish-red pebbly siltstone (20 percent). Sandstone in beds 3 inches to 3 feet (8 cm to 1 m) thick; mostly planar bedded, locally crossbedded; well indurated; pebbles predominantly quartz, subrounded to rounded, 1/4 to 3/4 inch (5 to 20 mm) in diameter; commonly micaceous and pyritic; joints common; weathers to blocky, slabby, and rubbly fragments; ledges often show evidence of intense frost riving. Conglomerate in discontinuous beds less than 1 foot (0.3 m) thick; pebbles mostly quartz, rounded to subrounded, having maximum diameter of about 2 inches (5 cm). Pebbly siltstone occurs as several lenticular beds, to 3 feet (1 m) thick, mostly in lower part of formation. Siltstone and claystone, very poorly exposed in mapped area, are known to form significant portion of formation in cut on Interstate 81 at crest of Nescopeck Mountain, 7.5 miles (12.0 km) to northeast (41°03'48"N/75°59'20"W, Freeland quadrangle) (Sevon, 1969). Probably mixed estuarine subaqueous mudflow and shoreline deposits and braided-river deposits (Sevon, 1969). Strongly resistant to weathering; forms mountains of high relief having moderate to steep slopes. Thickness calculated at about 575 feet (175 m) on Nescopeck Mountain. Absent on Lee Mountain.	SPECHTY KOPE FORMATION MDsk	Generally high stability in cut slopes greater than 25 degrees. Block falls likely where dipping beds are undercut, especially if resistant sandstone overlies weak siltstone or claystone. Very difficult excavation with heavy machinery; blasting usually required. High foundation support strength, suitable for heavy structures if excavated to sound bedrock. Slow drilling rates. Unsuitable for septic systems and sanitary landfills because of steep slopes, shallow depth to bedrock, and relatively high permeability of soil mantle and fractured bedrock. Good local source of riprap. Coaly shale in lower part of Pocono Formation on Nescopeck Mountain may have very limited potential for home furnace fuel.
DEVONIAN	Light-olive-gray, greenish-gray, and grayish-red, fine- to coarse-grained sandstone (40 percent) and grayish-red siltstone and silty claystone (60 percent), arranged in repetitive, asymmetrical, fining-upward sequences, 30 to 150 feet (9 to 45 m) thick. Sandstone in beds 4 inches to 2 feet (10 cm to 0.6 m) thick; crossbedded; ripples common; moderately well indurated; micaceous; lenses of olive-gray and grayish-red claystone clasts, with scattered quartz pebbles, occur in erosional scours at base of cycles; joints common; forms slabby, blocky, and rubbly fragments; units to 100 feet (30 m) thick. Siltstone and silty claystone in beds 1 inch to 10 feet (2.5 cm to 3 m) thick; locally calcareous; mudcracks, root traces, and burrows in claystone; often micaceous; moderate to strong cleavage development; form hackly, chippy, and platy fragments; in units to 50 feet (15 m) thick. Fossiliferous: carbonized plant fragments. Fluvial deposits of meandering streams; probably formed on alluvial plain at considerable distance upstream from shoreline (Glaeser, 1974). Moderately resistant to weathering; claystone and siltstone less resistant than sandstone; forms moderately steep scarp slopes of mountains. Thickness calculated at about 1,100 feet (335 m) on Lee Mountain and 1,350 feet (410 m) on Nescopeck Mountain.	DUNCANNON MEMBER Dcd	Moderate to high infiltration capacity along steeply dipping joints and moderately to steeply dipping bedding planes. Sandstones have good aquifer potential and are likely to be encountered in most wells. Siltstone and claystone beds transmit water much less readily. For domestic wells yields of 5 to 20 gpm (0.32 to 1.2 l/s) can be anticipated from depths of 125 to 300 feet (40 to 90 m) in the Duncannon and Sherman Creek Members; yields of 5 to 15 gpm (0.32 to 0.95 l/s) from depths of 100 to 175 feet (30 to 53 m) are characteristic of the Irish Valley.
	Medium-gray, greenish-gray, and grayish-red, fine- to medium-grained sandstone (50 percent) and mostly grayish-red, locally greenish-gray, siltstone and silty claystone (50 percent), often arranged in asymmetric fining-upward sequences 25 to 125 feet (8 to 40 m) thick. Sandstone in beds 1 inch to 2 feet (2.5 cm to 0.6 m) thick; planar and crossbedded (Figure 1); ripples common; moderately to well indurated; micaceous, often calcareous; numerous lenses of conglomerate containing fish bones, carbonate nodules, and claystone clasts, 2 inches to 2 feet (5 cm to 0.6 m) thick; joints common; weathers to slabby, blocky, and rubbly fragments; units to 100 feet (30 m) thick. Siltstone and silty claystone in beds 1 inch to 4 feet (2.5 cm to 1.2 m) thick; laminated to massive; mudcracks, root traces, and burrows in claystone; commonly micaceous and/or calcareous; moderate cleavage development; weather to hackly, chippy, and platy fragments; units to 75 feet (25 m) thick. Lenticular zones of greenish-gray silty claystone and siltstone up to 2 feet (0.6 m) thick frequently interbedded with gray sandstone. Fossiliferous: carbonized plant fragments and phosphatic fish scales and bones. Mostly fluvial deposits of meandering streams, probably formed on upper delta plain (Glaeser, 1974). Moderately resistant to erosion; forms uplands of low to moderate relief. Thickness calculated at 2,200 feet (670 m) on north side of Berwick anticlinorium and 2,500 feet (750 m) on south side.	SHERMAN CREEK MEMBER Dcs	Low to high stability in cut slopes greater than 25 degrees; sandstones generally are able to stand at steeper angle than claystones and siltstones. Block falls and rubble slides are likely to occur where dipping beds are undercut; e.g., channel change of Nescopeck Creek in south-central part of quadrangle (Figure 2). Easy (claystone and clay shale) to difficult (sandstone) excavation with heavy machinery; blasting required where well-indurated sandstone is encountered. Moderate to high foundation support strength, suitable for heavy structures if excavated to sound bedrock. Fast to moderate drilling rates. May be suitable for septic systems if ground slope is flat or gentle and permeability of soil and broken rock mantle is moderate. Areas underlain by thick claystone units may be suitable for sanitary landfills. Thick sandstones and siltstones may have potential for coarse aggregate (untested). Claystones may have potential for common brick (untested).
	Medium-gray, light-olive-gray, and bluish-gray, very fine to fine-grained sandstone (30 percent), greenish-gray and grayish-red siltstone (20 percent), grayish-red silty claystone (30 percent), and greenish-gray silty clay shale (20 percent), commonly arranged in lithic cycles, i.e., marine-nonmarine alternations (Irish Valley motifs of Walker and Harms, 1971) in lower part and nonmarine fining-upward sequences in upper part. Sandstone mostly in beds 1 inch to 2 feet (2.5 cm to 0.6 m) thick; planar and crossbedded; ripples and burrows common; frequently has load casts, ball-and-pillow structures, slump structures, and calcareous fossil-shell lenses; moderately to well indurated; often micaceous; joints common; forms platy, slabby, and rubbly fragments; units to 30 feet (10 m) thick. Siltstone, in beds 2 inches to 3 feet (2.5 cm to 1 m) thick; mostly laminated or ripple bedded; joints frequent; cleavage poorly developed; forms platy, chippy, and rubbly fragments; units 1 to 10 feet (0.3 to 3 m) thick. Silty claystone in beds 6 inches to 4 feet (15 cm to 1.2 m) thick; massive, with root traces and burrows common; cleavage well developed; forms chippy and hackly fragments; in units up to 25 feet (8 m) thick. Silty clay shale in beds 5 to 10 feet (1.5 to 3 m) thick. Fossiliferous: marine invertebrates and carbonized plant fragments. Marginal-marine deposits formed on coastal fringe of prograding shoreline; meandering-stream deposits probably formed on lower delta plain. Moderately resistant to weathering; forms upland areas of low to moderate relief. Thickness calculated at 2,500 feet (700 m) in northern outcrop belt and 2,500 to 2,900 feet (760 to 890 m) in southern. Variation in thickness due, in part, to interfingering with underlying Trimmers Rock Formation.	IRISH VALLEY MEMBER Dci	Moderate to high infiltration capacity along steeply dipping joints and moderately dipping bedding planes. Fair aquifer potential, with supplies adequate for domestic usage. Most domestic wells yield 5 to 10 gpm (0.32 to 0.63 l/s) from depths of 50 to 250 feet (15 to 75 m). Water of fair to good quality; generally hard; may have high iron content or contain hydrogen sulfide. Low to moderate stability in cut slopes greater than 25 degrees. Intersection of bedding, joint, and cleavage planes can create instability leading to rock slides and block falls; undermining of shaly or thinly laminated beds by seepage of water along fractures was observed in cliffs developed in upper part of formation along Walker Run (41°06'07"N/76°10'36"W) and on east side of Susquehanna River opposite Gould Island (41°06'44"N/76°07'38"W). Moderately easy to difficult excavation with heavy machinery; blasting required where thick siltstone and sandstone beds are encountered. Moderate to high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock. Suitable for septic systems if residual soil and/or surficial deposits are sufficiently thick to moderate infiltration into fractured bedrock. Sanitary landfills could be successfully developed in areas where thick residual soil or surficial deposits can be used as relatively impermeable liner and cover material. Used locally for riprap and common fill; good potential for crushed stone (tested), at least within interval 300 to 1,000 feet (90 to 300 m) above base.
	Medium- to medium-dark-gray, very fine to fine-grained sandstone (25 percent), medium- to dark-gray siltstone and silt shale (60 percent), and medium-dark- to dark-gray silty clay shale (15 percent). Sandstone occurs mostly in upper 2,300 to 2,500 feet (700 to 750 m) in beds 2 inches to 5 feet (5 cm to 1.6 m) thick; planar and crossbedded; commonly has load casts, ball-and-pillow structures, slump structures, and calcareous fossil-shell lenses (Figure 3); locally contains discoidal medium-gray claystone clasts to 1.5 inches (3.8 cm) at bases of beds; joints common; weathers to slabby and blocky fragments. Siltstone and silt shale in beds 1 inch to 3 feet (2.5 cm to 1 m) thick; sometimes massive, often laminated; locally has profuse ripples; graded beds conspicuous, especially in lower 500 feet (150 m) (Figure 4); joints common; cleavage moderately developed; forms platy, chippy, and rubbly fragments. Silty clay shale in beds 2 inches to 4 feet (5 cm to 1.2 m) thick; thicker in lower part; locally pyritic; fissile; cleavage moderately developed; forms splintery and platy fragments. Fossiliferous: marine invertebrates and carbonized plant fragments. Proximal-turbidite and shallow-shelf deposits in upper part; distal-turbidite deposits in lower 500 feet (150 m). Moderately resistant to weathering; underlies upland terrain of moderate relief; forms steep escarpments on north and south sides of Susquehanna Valley. Thickness calculated at 3,000 feet (915 m) on north side of anticlinorium and 2,800 to 3,000 feet (850 to 915 m) on south side (variation in thickness due, in part, to interfingering with overlying Irish Valley Member of Catskill Formation).	TRIMMERS ROCK FORMATION Dtr	Moderate to high infiltration capacity along steeply dipping joints and moderately dipping bedding planes. Fair aquifer potential, with supplies adequate for domestic usage. Most domestic wells yield 5 to 10 gpm (0.32 to 0.63 l/s) from depths of 50 to 250 feet (15 to 75 m). Water of fair to good quality; generally hard; may have high iron content or contain hydrogen sulfide. Low to moderate stability in cut slopes greater than 25 degrees. Intersection of bedding, joint, and cleavage planes can create instability leading to rock slides and block falls; undermining of shaly or thinly laminated beds by seepage of water along fractures was observed in cliffs developed in upper part of formation along Walker Run (41°06'07"N/76°10'36"W) and on east side of Susquehanna River opposite Gould Island (41°06'44"N/76°07'38"W). Moderately easy to difficult excavation with heavy machinery; blasting required where thick siltstone and sandstone beds are encountered. Moderate to high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock. Suitable for septic systems if residual soil and/or surficial deposits are sufficiently thick to moderate infiltration into fractured bedrock. Sanitary landfills could be successfully developed in areas where thick residual soil or surficial deposits can be used as relatively impermeable liner and cover material. Used locally for riprap and common fill; good potential for crushed stone (tested), at least within interval 300 to 1,000 feet (90 to 300 m) above base.
	Dark-gray to grayish-black clay shale and silty clay shale. Noncalcareous, locally carbonaceous; pyritic; frequent light-gray, lenticular silt laminations to about 1/2 inch (1 cm) thick in upper part; joints frequent; cleavage moderately developed; forms splintery and platy fragments. Weathered surfaces commonly covered by efflorescent masses of secondary sulfate minerals, particularly pickeringite. Poorly oxygenated, basinal marine deposits. Low resistance to weathering, forms swale at foot of escarpments developed on lower part of Trimmers Rock Formation. Thickness measured at 120 feet (36 m).	HARRELL FORMATION Dh	Low infiltration capacity along steeply dipping joints. Poor to fair aquifer potential. Domestic wells can be anticipated to yield less than 10 gpm (0.63 l/s) from depths of 100 to 150 feet (30 to 45 m). Water of fair quality; may contain iron or hydrogen sulfide. Low stability in cut slopes greater than 25 degrees. Generally moderately easy excavation with heavy machinery, but blasting may be required in deep cuts. Moderately high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock. Fast drilling rates. Possible difficulties with sewage systems because of shallow development and low permeability of residual soil mantle (in areas not covered by surficial deposits). Residual soil and bedrock may have suitable drainage characteristics for sanitary landfills, but outcrop belt is frequently blanketed by surficial cover. Used locally for common fill; good potential for structural clay products (tested).
	Medium-dark- to dark-gray, silty to very silty claystone (95 percent), with some argillaceous, fine-grained limestone (5 percent) in uppermost part. Claystone generally in poorly defined beds 3 to 10 feet (1 to 3 m) thick; massive, often with profuse burrows; noncalcareous to very calcareous; medium-dark-gray, pyritic siderite and limestone nodules, 1 to 4 inches (2.5 to 10 cm) in diameter, are locally abundant and often form distinct bands; several calcareous, fossiliferous horizons (1), 3 to 10 feet (1 to 3 m) thick and abounding in marine invertebrates, can be traced locally. Tully Member (Dmt) at top is medium dark gray (light gray where weathered), fossiliferous, argillaceous, fine-grained limestone and calcareous clay shale, 50 to 75 feet (15 to 23 m) thick. Joints frequent; intense cleavage development (Figure 5); forms splintery, chippy, slabby, and rubbly fragments. Marine shallow-subtidal-shelf deposits. Low to moderate resistance to weathering; forms lowland terrain, with knobs and ridges of moderate relief underlain by very silty and calcareous beds. Thickness calculated at 1,500 feet (458 m).	MAHANTANGO FORMATION: TULLY MEMBER Dmt; Dmh	Low to moderate infiltration along steeply dipping joints and cleavage planes. Poor to fair aquifer potential; supplies adequate for domestic use. Most domestic wells yield less than 10 gpm (0.63 l/s) from depths of 100 to 200 feet (30 to 60 m). Water of fair quality and hard; high in iron and other dissolved solids; may have hydrogen sulfide odor. Low to moderate stability in cut slopes greater than 25 degrees; frost riving and chemical weathering along closely spaced cleavage planes can generate considerable fragmented rock at base of bare slopes. Moderately easy excavation with heavy machinery, but blasting required in deep cuts. High foundation support strength, suitable for heavy structures if excavated to sound bedrock. Moderate to fast drilling rates. Possible difficulties with septic systems because residual soil mantle is generally very thin in areas where formation is not covered by surficial deposits; residual soil and bedrock probably have satisfactory infiltration properties. Suitable for sanitary landfills in areas overlain by or adjacent to glacial till deposits, which can be used as relatively impermeable liner and cover material. Used locally for common fill; good potential for structural clay products (tested); marginal potential for lightweight aggregate (tested).
	Dark-gray to black clay shale. Slightly silty in upper part; noncalcareous to slightly calcareous, pyritic, carbonaceous; intense cleavage development; forms splintery and platy fragments. Some medium-gray, very fine grained limestone nodules, 1 to 2 inches (2.5 to 5 cm) in diameter, near base of formation. Poorly oxygenated, basinal marine deposits. Low resistance to weathering; underlies lowlands, but forms several low knobs on crest of anticlinorium east of Berwick; completely covered by glacial outwash and alluvium north and south of borough. Thickness estimated at 350 feet (105 m).	MARCELLUS FORMATION Dmr	Low infiltration capacity along steeply dipping cleavage planes. Poor aquifer potential, but supplies are adequate for domestic use. Wells with yields of less than 5 gpm (0.32 l/s) may have to be drilled 200 to 300 feet (60 to 90 m) deep to create adequate reservoir. Water of fair to good quality; may contain appreciable iron and have odor of hydrogen sulfide. Low stability in cut slopes greater than 25 degrees due to closely spaced cleavage planes. Generally moderately easy to excavate with heavy machinery, but blasting may be required in deep cuts. Moderate to high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock. Fast drilling rates. Possible difficulties with septic systems because residual soil mantle is very thin over areas where formation is not covered by surficial deposits; bedrock itself has low permeability. Outcrop area is probably too limited to be considered for sanitary landfill sites. Low resource potential due to limited area of outcrop. Possible source of common fill and surfacing material for driveways and secondary roads.
	Medium-dark-gray, argillaceous, fine-grained limestone, with interbeds of medium-dark-gray calcareous clay shale (upper part, Selingrove Limestone Member); medium- to dark-gray, calcareous, slightly silty clay shale (lower part, Needmore Shale Member). Percentage of lithologies unknown. Limestone of upper member generally in beds 2 inches to 2 feet (5 cm to 0.6 m) thick; pyritic; shale interbeds 1 inch to 1 foot (2.5 cm to 0.3 m). Few limestone beds of similar character in lower member. Fossiliferous: marine invertebrates. Marine shallow-subtidal-shelf deposits. Outcrops covered by terrace deposits and alluvium; known only from cores for Berwick-Nescopeck bridge (new Pa. Route 93) (41°03'12"N/76°13'57"W). Thickness of formation estimated at 175 feet (53 m).	ONONDAGA FORMATION Don	Probably fair aquifer potential, but no data available. Water probably hard and may have hydrogen sulfide odor. Easy to moderately difficult excavation with heavy machinery; blasting may be required where limestone of upper member is encountered. Moderate to high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock; shale may be deeply weathered to 10 feet (9 m) below surface, limestone should be investigated for sinkholes. Moderate to fast drilling rates. Resource potential cannot be evaluated due to surficial cover over outcrop, but is probably poor.
	Dark-gray argillaceous fine-grained limestone; medium- to dark-gray, calcareous clay shale; and medium-gray, silty, cherty, fine-grained limestone (in descending stratigraphic order). Percentages of lithologies unknown. Cleavage moderately developed. Fossiliferous: marine invertebrates. Shallow-subtidal and nearshore-marine deposits. Outcrop mostly covered by terrace deposits and alluvium; known only from a few ledges exposed near north shore of Susquehanna River at Berwick and from cores for Berwick-Nescopeck bridge. Thickness estimated at 100 to 150 feet (30 to 45 m).	OLD PORT FORMATION Do	Good to excellent aquifer potential. Limited data from domestic wells indicate that adequate supplies can be obtained from depths of 100 to 150 feet (30 to 45 m). Several municipal and industrial wells drilled in Borough of Berwick have large yields from this interval, e.g., new municipal wells drilled along the river at the old Berwick-Nescopeck bridge (41°03'16"N/76°13'56"W) yield up to 500 gpm (31.5 l/s) from depths of 87 to 160 feet (26 to 49 m). However, one well drilled to depth of 515 feet (157 m) was dry. Water of good quality but hard. Moderately difficult excavation with heavy machinery; blasting required for deep cuts. Moderate to high foundation support strength, generally suitable for heavy structures if excavated to sound bedrock; limestone should be investigated for sinkholes and pinnacle topography. Moderate to fast drilling rates. Resource potential not evaluated because of thick surficial cover over most of outcrop.
SILURIAN	Medium- to dark-gray, fine- to coarse-grained limestone; nodular, platy, and laminated; minor interbeds of dark-gray calcareous clay shale. Percentages of lithologies unknown. Fossiliferous: marine invertebrates. Shallow-subtidal-shelf and lagoonal deposits. Outcrop covered by terrace deposits and alluvium; known only from cores for Berwick-Nescopeck bridge and appurtenant retaining walls. Thickness estimated at 125 feet (38 m).	KEYSER FORMATION DSk	
	Medium- to medium-dark-gray, laminated, fine-grained limestone. Interbeds of medium-gray calcareous clay shale increase in abundance and thickness toward base. Percentages of lithologies unknown. Intertidal and lagoonal deposits. Presence in Berwick quadrangle inferred, as outcrop is completely covered by terrace deposits. Thickness estimated at about 100 feet (30 m) in adjoining Mifflinville quadrangle.	TONOLOWAY FORMATION Sto	
	Yellowish-gray to light-greenish-gray, calcareous, silty clay shale and light- to medium-gray, laminated, argillaceous, fine-grained dolostone and dolomitic limestone. Percentages of lithologies unknown. Intertidal, lagoonal, and supratidal deposits. Outcrop is completely covered by terrace deposits; known only from samples from deep industrial wells. Thickness estimated at about 350 feet (107 m) (White, 1883).	WILLS CREEK FORMATION: UPPER MEMBER Swu	Poor to fair aquifer potential. Water of poor to fair quality and hard; may have high sulfate content. Unlikely to be encountered in excavations. Moderate to fast drilling rates. Resource potential not evaluated because of surficial cover over outcrop.
	Predominantly greenish-gray, grayish-red-purple, and grayish-red, calcareous, slightly silty clay shale, with some interbedded grayish-red sandstone and bluish-gray fine grained limestone. Percentages of lithologies unknown. Intertidal, lagoonal, and supratidal deposits. Encountered by some deep industrial wells in subsurface beneath upper member; shown only on cross section. Thickness estimated at about 400 feet (122 m) (White, 1883).	WILLS CREEK FORMATION: LOWER MEMBER Swl	

[1] Groundwater information from Lowman (1937), Newport (1977), data for State Water Plan assembled by E. Shuster (formerly with Pennsylvania Geological Survey) and L. Taylor (Pennsylvania Geological Survey), and Water Well Inventory of Pennsylvania Geological Survey.

NOTE: Within any given formation water yield depends upon depth of well, well completion procedure, well stimulation techniques, location relative to topography, and proximity to fractures.