DEPARTMENT OF ENVIRONMENTAL PROTECTION
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SURFICIAL GEOLOGY OF THE BERNARDSVILLE QUADRANGLE MORRIS AND SOMERSET COUNTIES, NEW JERSEY

OPEN-FILE MAP OFM 74

Pamphlet containing table 1 accompanies map

INTRODUCTION

Surficial deposits in the Bernardsville quadrangle include artificial fill, alluvial, swamp, eolian, and stream-terrace deposits, all of postglacial age; glacial deposits of late Wisconsinan (22,000 to 18,000 years ago), Illinoian (about 150,000 years ago), and pre-Illinoian (some time between 2.1 million and 800,000 years ago) age; and weathered-rock material and hillslope deposits that range from early to late Pleistocene in age.

The accompanying map and sections show the surface extent and subsurface relations of these deposits. Their composition and thickness, and the events they record, are described in the *Description of Map Units*. Well and boring data used to construct bedrock-surface-elevation contours and to infer the subsurface distribution of the deposits are provided in table 1 (in pamphlet). The chronologic relationships of the deposits are shown in the *Correlation of Map Units*. The hydrology of the surficial deposits and the history of river drainage in the quadrangle and adjacent areas are briefly described in the two sections below.

HYDROLOGY OF SURFICIAL DEPOSITS

The Bernardsville quadrangle includes the southernmost part of an extensive buried-valley aquifer system in the central Passaic River basin to the west of Second Watchung Mountain. This aquifer system consists of a network of pre-Illinoian fluvial valleys that are filled with and buried by Illinoian and late Wisconsinan glacial sediments. In the Bernardsville quadrangle these buried valleys underlie the Great Swamp lowland and the downstream part of the Dead River valley. The valleys are filled with as much as 100 feet of glaciolacustrine silty and clay (map units Qpl, Qil). Sand and gravel deposits that are aquifers in the buried valleys to the northeast do not extend into the Bernardsville quadrangle. The glaciolacustrine silt and clay are of low permeability and form a confining or semi-confining layer for the underlying bedrock aquifer (Vecchioli and others, 1962). For example, records for wells 214, 216, and 225 (numbered on map) report 70, 76, and 60 feet of casing, respectively, through the silt and clay into shale bedrock. These wells are drilled to total depths of 198, 155, and 170 feet, respectively, into the shale aquifer and record static-water levels of 3, 8, and 6 feet below land surface. These levels are well above the top of bedrock and indicate that the silt and clay act as a confining layer.

Surficial deposits elsewhere in the quadrangle are more permeable but are too thin to be aquifers, although they do transmit water to, and store water for, streams and underlying bedrock aquifers. In the field, seepage commonly emerges from surficial deposits on footslopes and at the margins of floodplains and upland drainages, even during dry periods, indicating storage and movement of water in the surficial material.

Hydraulic conductivity of the surficial deposits may be estimated from aquifer-test and laboratory data on similar deposits elsewhere in New Jersey (Stanford, 2000; Mennel and Canace, 2002). Sand and gravel deposits (parts of units Qps, Qpmb, Qpgb, small areas of Qal and Qst) are highly permeable, having estimated hydraulic conductivities that range from 10^1 to 10^3 feet per day (ft/d). Weathered rock and colluvium with silty sand matrix (parts of Qwg, Qwb, and Qcg) are also permeable, having estimated hydraulic conductivities from 10^{-1} to 10^0 ft/d. Fine-sandy and silty lake-bottom, alluvial, eolian, and wetland deposits (parts of units Qpl, Qal, Qst, Qe, and Qsi), silty to sandy till (parts of Qpt), and silty weathered rock and colluvium (parts of Qwb, Qws, Qwg, Qcb, Qcg, and Qcbl) are somewhat less permeable, having estimated hydraulic conductivities of 10^{-1} to 10^1 ft/d. Silt and clay lake-bottom deposits (parts of units Qpl, Qil, Qpsl), clayey-silt till and colluvium (parts of Qpt, Qcsl, Qcb, and Qcbl), and rock weathered to clay and silt (parts of Qwb and Qws) are of low permeability, having hydraulic conductivities of 10^{-2} to 10^{-3} ft/d. Vecchioli and others (1962) report an average permeability of $3x10^{-4}$ ft/d for several measurements on samples of glaciolacustrine clay from the Great Swamp. Swamp deposits (Qs) and fill have varied hydraulic conductivities that depend on the clay and silt content of the material. Peat with little mineral soil, and fill composed of sand, cinders, gravel, demolition debris, slag, and trash, may be highly permeable.

DRAINAGE HISTORY

The topography of the bedrock surface, taken as the top of weathered rock, is contoured at 50-foot interval from water-well, test-boring, and geophysical-survey data. Contours are shown where the elevation of the bedrock surface is 200 feet or lower. At elevations above 200 feet the bedrock surface corresponds closely to the land surface.

In the Great Swamp lowland and the Dead River valley, the rock surface defines several pre-Illinoian valleys that are filled with glaciolacustrine clay (fig. 1). These valleys are the southernmost part of a pre-Illinoian drainage network buried beneath Illinoian and late Wisconsinan glacial deposits in the central Passaic River basin (Nichols, 1968; Hoffman and Quinlan, 1994; Hoffman and others, in review; Stanford, 2007). This drainage formerly exited the Watchung Mountains through the Short Hills Gap in Second Watchung Mountain, about 12 miles east of Basking Ridge (fig. 1), and then through Millburn Gap in First Watchung Mountain, about 2 miles east of the Short Hills Gap. The Short Hills Gap is now filled with Illinoian and late Wisconsinan glacial deposits (Stanford, 1991), and the Passaic River now exits the basin at Little Falls, about 30 miles northeast of Basking Ridge.

After the Illinoian glaciation, the Great Swamp lowland and the Dead River valley were filled with Illinoian glaciolacustrine clay to an elevation of about 150 feet (sections AA', BB'). The elevation of this fill was such that the Passaic River did not cross Long Hill at Millington (fig. 1) as it does today, but instead flowed northeasterly through the Great Swamp lowland, through the preexisting pre-Illinoian gap in Long Hill at Chatham (9 miles east of Basking Ridge), to the exit point from the basin at the Short Hills Gap. The abandoned valley along Baileys Mill Road north of Logansville is an exposed segment of this northeasterly drainage system, as is the wide valley of Primrose Brook downstream of its junction with this abandoned valley. The rest of the valley system is buried by glaciolacustrine clay. The present Passaic valley downstream from Millington was drained by the Dead River, which joined the Passaic at the Chatham area. After the late Wisconsinan glaciation, moraine deposits blocked the gap in Long Hill at Chatham, preventing northeasterly drainage through the Great Swamp lowland. The Passaic was diverted to a new course, crossing Long Hill via a low gap at Millington, then flowing northeasterly in the former Dead River valley, eventually reaching Little Falls. At Millington, the Passaic eroded through fractured basalt from an elevation of about 260 feet to its present elevation there of just below 220 feet, forming the Millington gorge (fig. 1). This erosion was completed shortly after drainage of the Great Notch stage of Lake Passaic (see below).

DESCRIPTION OF MAP UNITS

Postglacial Deposits--These include man-made fill, stream deposits in fans (Qaf) and modern channels and floodplains (Qal, Qcal), stream and shallow-lake deposits in terraces (Qst), wetland deposits in swamps and marshes (Qs), and windblown sediments (Qe). All were deposited since retreat of the late Wisconsinan glacier about 18,000 yrs B. P (years before present).

ARTIFICIAL FILL--Artificially emplaced sand, gravel, silt, clay, and rock fragments, and man-made materials including cinders, ash, brick, concrete, wood, slag, asphalt, metal, glass, and trash. Color variable but generally dark brown, gray, or black. As much as 20 feet thick. Many small areas of fill are not mapped.

TRASH FILL--Trash mixed and covered with sand, silt, clay, and gravel. As much as 30 feet thick. In solid-waste landfills.

Qal ALLUVIUM--Sand, silt, clay, pebble gravel, locally pebble-to-cobble gravel; dark brown, brown, reddish-brown, yellowish-brown, gray; moderately to well sorted, stratified to unstratified. Contains variable amounts of organic matter. Sand and gravel are deposited in channels. Silt and clay are deposited on levees and overbank areas, chiefly on broad, flat flood plains. Locally, in and downstream from urban areas, alluvium contains demolition debris and trash. As much as 15 feet thick.

Qaf ALLUVIAL FAN DEPOSITS--Sand, pebble-to-cobble gravel, silt; brown, yellowish-brown, gray; moderately sorted, stratified. As much as 15 feet thick (estimated).

Qst STREAM TERRACE DEPOSITS--Silt, very fine-to-fine sand, minor fine-to-coarse sand and pebbly sand, rare pebble-to-cobble gravel; brown, very pale brown, yellowish-brown, light reddish-brown, reddish-brown, light gray; moderately to well sorted, well stratified to unstratified, horizontally laminated in places. As much as 15 feet thick. Forms terraces with surfaces 5-15 feet above modern flood plains and wetlands in the Passaic and Dead River valleys and the Great Swamp lowland. In the Passaic valley and the Great Swamp, and in the Dead River valley downstream from Liberty Corner, the terrace terrace deposits were, in part, laid down in shallow postglacial lakes, including the Stanley and Millington stages of Lake Passaic (see below). The terraces were abandoned and incised as the postglacial lakes lowered and then drained when their dams were eroded by the Passaic River. In the Great Swamp, the postglacial lake drained and the terrace deposits were incised between about 14,000 and 10,000 yrs B. P., based on the age at which peat deposition began in the incised channels (see unit Qs, below). A radiocarbon date of 13,975±240 yrs B.P. (laboratory number QC-1305) on concretions of likely organic origin within the upper 10 feet of the lacustrine silt and clay in boring 224 (GS6 of Reimer, 1984) approximately dates the end of lake deposition. Ground-ice deformation, and, to a lesser extent, wind erosion, reshaped the surface morphology of the terraces after the lakes drained.

Qs SWAMP AND MARSH DEPOSITS--Peat and organic silt, clay, and minor fine sand; black, dark brown, and gray. As much as 20 feet thick, but generally less than 10 feet thick (Waksman and others, 1943). Pine, spruce, and birch pollen in the basal 1.5 feet of a 5-foot core taken in these deposits near Meyersville, about 2 miles east of White Bridge (Meyerson, 1970), indicate that peat began to accumulate here before 9,000 yrs B. P, based on radiocarbon dates elsewhere of the youngest occurrence of these trees in this region (Peteet and others, 1993).

Qcal ALLUVIUM AND COLLUVIUM, UNDIVIDED--Interbedded colluvium as in units Qcg, Qcb, Qcbl, and Qcsl, and alluvium consisting of dark brown to yellowish-brown or reddish-brown silty sand, sandy silt, to clayey silt, with beds and lag veneers of subangular basalt pebbles and cobbles (adjacent to unit Qwb), shale chips and flagstones (adjacent to unit Qws), or subangular to subrounded cobbles and boulders of gneiss (adjacent to unit Qwg). As much as 15 feet thick. Lag deposits dominate in steeper reaches of valleys. Fine sediment, with variable organic matter, dominates in gently sloping reaches.

Qe EOLIAN DEPOSITS--Very-fine-to-fine sand, silty fine sand, yellowish-brown to very pale brown; unstratified to weakly stratified. As much as 5 feet thick. Mapped only where continuous and generally more than 2 feet thick. Thin, patchy windblown silt and fine sand occur elsewhere in the quadrangle, particularly in the Great Swamp lowland and the Dead River valley. Laid down shortly after postglacial lakes drained, when wind entrained newly exposed silt and fine sand from the lake bed and terrace surfaces and deposited it on adjacent uplands.

Glacial Deposits--These include till and stratified sediments. Till is a poorly sorted, unstratified sediment containing gravel and boulders, deposited directly from glacial ice (unit Qpt). The stratified sediments are generally well sorted. They include sand and gravel laid down by glacial meltwater in glacial-lake deltas and fans (Qps) and by wave action on glacial-lake shores (Qpmb, Qpgb), and silt, clay, and fine sand deposited on the bottoms of glacial lakes (Qpsl, Qpl, Qil). All of these deposits are of pre-Illinoian age except Qpl, Qpmb, and Qpgb, which are of late Wisconsinan age, and Qil, which is of Illinoian age.

Pre-Illinoian till occurs as erosional remnants on Second Watchung Mountain northwest of Liberty Corner and on shale bedrock near Bernardsville and Basking Ridge. Till is absent in similar topographic positions south of these locations, indicating that pre-Illinoian ice most likely did not advance beyond the remnants (margin M1 on fig. 1). Pre-Illinoian deposits in New Jersey correlate with magnetically reversed glacial deposits in eastern and central Pennsylvania (Gardner and others, 1994; Sasowsky, 1994), indicating that they were laid down before 788 ka. In New Jersey, pollen associated with the deposits, and their close stratigraphic and geomorphic relation to a Pliocene fluvial deposit, suggest a Pliocene age (Stanford and others, 2001). Following retreat of pre-Illinoian ice there was a long period of erosion and stream incision. Valleys were deepened as much as 60 feet below the level of pre-Illinoian valley bottoms.

At its maximum extent the pre-Illinoian glacier dammed the Dead River valley to form glacial Lake Watchung (fig. 1). Although hillslope and stream erosion have likely lowered parts of Second Watchung Mountain since the pre-Illinoian glaciation, possible spillways for Lake Watchung include one at an elevation of about 430 feet near the junction of Long and Mountain roads, and a lower spillway at an elevation of about 400 feet on the Corys Brook-Stony Brook divide in the Chatham quadrangle, about 2 miles east of Mount Bethel. This latter spillway may have been lowered by slope and stream erosion. The sand and gravel deposit at Bernardsville (Qps) is an erosional remnant of an ice-contact delta deposited in the lake. Exposures show that the Bernardsville deposit has a coarsening-upward, gravel-over-sand structure typical of deltas. Smaller sand and gravel deposits near White Bridge, Loganville, and Van Dorens Mill may be remnants of lacustrine fans laid down at the mouths of subglacial channels on the lake floor. Silt, clay, and fine sand deposits (Qpsl) at the base of the Bernardsville delta, and on shale uplands near Lyons and Van Dorens Mill, are lake-bottom deposits laid down in Lake Watchung.

Smaller pre-Illinoian glacial lakes also occupied the Mine Brook and Chambers Brook valleys, which drained toward, and so were dammed by, the pre-Illinoian glacier (fig. 1). No pre-Illinoian deposits crop out in these valleys, but pre-Illinoian sand and gravel was observed beneath basalt colluvium at one spot in the Mine Brook valley, and both sand and gravel and silt-clay sediments are reported in logs of wells drilled through basalt colluvium just west of the quadrangle boundary in the Chambers Brook valley.

The Illinoian and late Wisconsinan glaciers did not enter the Bernardsville quadrangle. Both advanced to the Morristown-Chatham-Summit area (M3 on fig. 1) and blocked the Short Hills Gap to form both an Illinoian and late Wisconsinan version of glacial Lake Passaic. In the Bernardsville quadrangle, deposits in these lakes include thick silt and clay in the Great Swamp and Dead River lowlands laid down on the lake bottom (units Qil, Qpl), and some small sand and gravel lakeshore sediments (units Qpmb, Qpgb).

The late Wisconsinan version of Lake Passaic included three glacial stages and three postglacial stages (Stone and others, 2002; Stanford, 2007). All three glacial stages, and two of the three postglacial stages, extended into the Bernardsville quadrangle. The glacial stages existed from about 21,000 yrs B. P. to about 18,000 yrs B. P. This duration is based on a radiocarbon date of 20,100±500 (QC-1304) from concretions of likely organic origin in lacustrine clay and silt, combined from depths of 58 and 93 feet in boring 215 (GS1 of Reimer, 1984). This date is a rough estimate of the onset of deposition in Lake Passaic. Seven-hundred and fifty varves were counted above the lower concretions in this boring and in a test boring near Green Village, about 6 miles east of Basking Ridge (GS5 of Reimer, 1984). Overlying microvarves in these borings indicate a minimum of 450 additional years of accumulation (Reimer, 1984), some or most of which may have been deposited in the glacial lake stages, indicating that the 750 varve years may be a minimum. The postglacial Millington stage persisted from 18,000 to about 14,000 yrs B. P., based on a radiocarbon date of 13,975±240 yrs B. P. (QC-1305) from concretions of likely organic origin in the upper 10 feet of lacustrine silt and clay in boring 224 (Reimer, 1984). The Stanley stage, because it was dammed by moraine sediment rather than the resistant basalt bedrock that floored the spillway for the Millington stage, likely drained before the Millington stage, although there are no radiocarbon dates from the Stanley stage deposits. Details of the history of lake stages are provided in the following description of map units. Names of the Chatham, Moggy Hollow, and Great Notch stages follow those of Stone and others (2002). The postglacial Millington and Stanley stages are named after informal reference in Salisbury and Kummel (1895, p. 317). Lake elevations are based on an uplift gradient of 2.1 feet/mile to the N21°E for Lake Passaic (Stone and others, 1989).

GLACIAL LAKE PASSAIC DEPOSITS--Beach and lake-bottom deposits laid down in glacial Lake Passaic. This lake filled the central Passaic River basin between Second Watchung Mountain and the Highlands. In the Bernardsville quadrangle, it includes 5 stages: an advance-phase stage, 2 recessional stages, and 2 postglacial stages. When the advancing late Wisconsinan glacier east of First Watchung Mountain blocked Millburn Gap, the Chatham stage of Lake Passaic flooded the central Passaic basin. This stage was controlled by a spillway at an elevation between 250 and 300 feet on a divide in the Blue Brook valley between First and Second Mountains south of Millburn Gap. With continued advance, the glacier blocked the Blue Brook spillway. At this time Lake Passaic rose to the Moggy Hollow stage. This stage was controlled by a spillway about 2 miles west of Liberty Corner at an elevation of 340 feet (symboled on map). Elevation of the lake level at this stage in the Bernardsville quadrangle was 340 to 350 feet. Deposition of the terminal moraine then filled the Short Hills Gap (fig. 1) to an elevation of 375 to 380 feet, holding the lake at the Moggy Hollow stage during deglaciation. A lower lake level, the Great Notch stage, was established when the retreating ice front uncovered Great Notch, a gap in First Watchung Mountain 23 miles northeast of Basking Ridge. The Great Notch spillway is at an elevation of about 305 feet, and the elevation of the lake level at this stage in the Bernardsville quadrangle ranges from 260 to about 275 feet. The Great Notch stage drained when the gap through First Watchung Mountain at Paterson was deglaciated. After the Great Notch stage drained, a moraine dam between Chatham and Summit held in a postglacial lake (the Stanley stage) in the Passaic and Dead River valleys upstream from the dam. The initial level of the spillway here was at an elevation of about 230 feet (Stanford, 2007). Elevation of the lake in the Bernardsville quadrangle ranged from 220 feet at Stirling to 215 feet at Liberty Corner. Downcutting of the Passaic River into the moraine gradually lowered the spillway and drained the lake, although postglacial rebound may have created shallow pondings in the valley upstream of the moraine afterwards. At the same time as the Stanley stage formed, the Millington stage occupied the Great Swamp basin, which held a lake because the former gap at Chatham through Long Hill was filled with moraine deposits. This lake was controlled by a spillway in a gap in Long Hill at Millington. The initial spillway here, marked by a topographic bench along the top of the Millington gorge, was at an elevation of about 260 feet. Elevation of this lake level ranged from 260 feet at Millington to about 265 feet at Basking Ridge. Downcutting of the Passaic River into the fractured basalt at the gap gradually lowered the spillway and, along with postglacial rebound, drained the lake.

Qpl Lake-bottom deposits--Silt, clay, minor very-fine-to-fine sand; gray, light gray, light reddish-brown; laminated. As much as 70 feet thick. Deposited chiefly during the Moggy Hollow stage. Uppermost parts may have been laid down in the Great Notch, Stanley, and Millington stages, lowermost parts in the Chatham stage.

Qpgb Beach deposits, lower stages--Medium-to-coarse sand and pebbly sand; brown, reddish-brown, gray; unstratified to weakly stratified. Sand and pebbles consist chiefly of red and gray shale; a few are basalt, quartzite, sandstone, and gneiss. As much as 10 feet thick (estimated). Formed by wave erosion of shale bedrock along the shoreline of the Great Notch and Millington stages.

Qpmb Beach deposits, Moggy Hollow stage--Pebble gravel, pebbly sand, silt; light reddish-brown; unstratified to weakly stratified. Pebbles consist chiefly of red and gray shale; a few are basalt, quartzite, sandstone, and gneiss. As much as 10 feet thick (estimated). Formed by wave erosion of shale bedrock, and some ice-rafted erratic gravel, along the shoreline of the Moggy Hollow stage.

ILLINOIAN LACUSTRINE DEPOSITS--Lake-bottom deposits laid down in an Illinoian glacial lake occupying the central Passaic basin. This lake was controlled at first by the spillway at Moggy Hollow, probably at an elevation slightly higher than 340-foot altitude of the late Wisconsinan spillway. During Illinoian retreat, the lake was controlled by a much lower spillway across Illinoian till in the Short Hills Gap at an elevation between 150 and 200 feet. This spillway is now buried beneath the late Wisconsinan deposits. Depending on the elevation of the spillway, this lake drained either when the gaps through the Watchungs at Little Falls and Paterson were deglaciated or when the spillway was eroded low enough to expose the lake bottom.

Qil Lake-bottom deposits--Silt, clay, minor very-fine-to-fine sand; reddish-brown to gray; laminated. As much as 30 feet thick. In subsurface only. Contact with Qpl in subsurface is picked at change to coarser grain size marking thin interglacial alluvial or eolian deposits atop Qil (for example, in boring 215).

PRE-ILLINOIAN LACUSTRINE DEPOSITS--Deltaic, lacustrine-fan, and lake-bottom deposits laid down in glacial Lake Watchung. This lake occupied the Dead River and Great Swamp lowlands and was controlled by a spillway across Second Watchung Mountain at an elevation between 400 and 430 feet. The lake lowered as the pre-Illinoian glacier retreated and it drained when the gaps at Short Hills and Millburn were uncovered.

Qps Deltaic and lacustrine-fan deposits--Fine-to-coarse sand, pebble-to-cobble gravel, very-fine-to-fine sand and silt; reddish-yellow, very pale brown, yellow. Generally massive but locally stratified, rarely bedded in places. The gravel consists chiefly of gneiss and some quartzite, basalt, sandstone, and siltstone. Most gneiss, sandstone, and siltstone clasts are deeply weathered or decomposed; most feldspathic sand grains are partially or fully weathered to white clay. As much as 80 feet thick.

Qpsl Lake-bottom deposits--Clay, silt, very fine-to-fine sand, minor fine-to-medium sand; reddish-yellow, yellowish-brown, light gray. Chiefly unstratified, thinly bedded to laminated in places. As much as 15 feet thick (estimated).

Qpt PRE-ILLINOIAN TILL--Reddish-brown to reddish-yellow silty clay to sandy clayey silt with some (5 to 10 percent by volume) to many (>10 percent by volume) subrounded to subangular pebbles and cobbles and very few subrounded boulders. Pebbles and cobbles consist of, in approximate order of abundance, gray and reddish-brown quartzite, gray and white gneiss, gray and red siltstone and sandstone, gray and brown basalt, purple quartzite-conglomerate, and dark gray chert. Boulders are chiefly gray gneiss and quartzite. The siltstone, sandstone, gneiss, and basalt gravel clasts have weathering rinds or are completely decomposed. As much as 40 feet thick. Equivalent to the Port Murray Formation, till facies, of Stone and others (2002).

Hillslope Deposits--Unstratified, poorly sorted sediment deposited at the foot of hillslopes by movement of material downslope. Deposited primarily under cold climate conditions during the middle and late Pleistocene.

Qcg GNEISS COLLUVIUM--Yellowish-brown, reddish-yellow, light reddish-brown sandy silt, silty sand, sandy-clayey silt with some to many subangular gneiss pebbles and cobbles. Where adjacent to unit Qws, includes some red shale and siltstone pebbles. Gneiss clasts vary from lightly weathered to deeply weathered. Long dimensions of clasts typically are aligned parallel to the hillslope. As much as 20 feet thick.

Qcb BASALT COLLUVIUM, BLOCKY PHASE--Reddish-brown, reddish-yellow, yellowish-brown, brown clayey silt, silty clay, minor fine-sandy silt with some to many subangular basalt pebbles and cobbles. Long dimensions of clasts typically are aligned parallel to the hillslope. As much as 20 feet thick. Includes chips and angular pebbles to fine cobbles of red shale and mudstone in deposits in the Chambers and Mine Brook valleys, and on Long Hill.

Qcbl BASALT COLLUVIUM, SILTY PHASE--Reddish-yellow, reddish-brown, light gray, very pale brown clayey silt to silty clay, minor fine sandy silt, with few subangular basalt pebbles. As much as 10 feet thick. At foot of long, gentle slopes or at distal edge of aprons of blocky colluvium. Deposited in part by ground-water seepage. Mapped only where continuous and generally more than 3 feet thick. Occurs discontinuously along lower parts of most slopes on basalt bedrock.

Qcsi SHALE COLLUVIUM, SILTY PHASE--Reddish-brown, yellowish-brown, light gray silty clay with few to some shale chips and a few to very few basalt pebbles. As much as 10 feet thick (estimated).

Weathered Bedrock Material--Unstratified, poorly sorted sediment formed by mechanical and chemical weathering of basalt, shale, and gneiss.

Qwb WEATHERED BASALT--Reddish-yellow, reddish-brown, light gray, to yellowish-brown clayey silt, silty clay, to clayey coarse sand with some to many subangular pebbles and cobbles of basalt and, in places, gabbro. Most clasts have clayey-silty reddish-yellow weathering rinds. Includes mixed clast-and-matrix sediment, granular decomposed rock, fractured-rock rubble, and saprolite that preserves original rock structure. As much as 50, but generally less than 20, feet thick. Qwbt indicates areas where weathered material is thin or absent and fractured-rock rubble abundant.

Qws WEATHERED SHALE--Reddish-brown, brown, yellowish-brown clayey silt to silty clay with many shale chips or subangular pebbles and cobbles of siltstone. As much as 20, but generally less than 5, feet thick.

Qwg WEATHERED GNEISS--Yellowish-brown, yellow, very pale brown, reddish-yellow, silty sand, silty clayey sand to sandy clayey silt, locally micaceous, with few to many subangular pebbles and cobbles of gneiss. Includes mixed clast-and-matrix sediment, granular decomposed rock, fractured-rock rubble, and saprolite that preserves original rock structure. Clasts range from unweathered to fully decomposed. Generally less than 30, but may be as much as 60, feet thick. Qwgt indicates areas where weathered material is thin or absent and fractured outcrop abundant.

MAP SYMBOLS

- **Contact**--Solid where well-defined by landforms, long-dashed where approximately located, short-dashed where gradational or feather-edged, dotted where removed by excavation or concealed by water.
- **Material observed in hand-auger hole, exposure, or excavation**
- **Excavation perimeter**--Line at limit of excavation. Outlines quarries. Topography within these areas may differ from that on the base map.
- **Bedrock ridge or scarp**--Line on crest. Low ridges or scarps formed on resistant basalt flows or siltstone beds.
- **Quarry**--Active in 2005.
- **Quarry**--Inactive in 2005.
- **Well with log in table 1**--Location accurate within 100 feet.
- **Well with log in table 1**--Location accurate within 500 feet.
- **Elevation of bedrock surface from seismic survey**--From Hoffman and others (in review).
- **Multiple surficial units in exposure or hand-auger hole**--Observed in 2006-2007. Number following unit is thickness of unit, in feet.
- **Multiple surficial units in trench excavation**--From Ratcliffe and others (1990).
- **Elevation of bedrock surface**--Contour interval 50 feet. Includes top surface of weathered bedrock.
- **Large bedrock outcrop**--Small outcrops within units Qal, Qcal, Qwb, Qwbt, Qwg, Qwgt, and Qws are not shown.
- **Well on sections**--Projected to line of section. Owing to projection, depths of contacts on section may not be identical to those in well.
- **Unit to left of slash overlies unit to right**--Shows extent of underlying deposits beneath thin eolian sediments.
- **Beach deposits**--Small sand or gravel deposits at shoreline of the Moggy Hollow stage of Lake Passaic. Shown only where observed in 2006-2007. Additional occurrences noted by Salisbury and Kummel (1895) are now obscured by urbanization.
- **Spillway of glacial lake**--Symbol in spillway of Moggy Hollow stage of Lake Passaic, arrow shows drainage direction.
- **Alluvial lag**--Surface concentration of basalt cobbles, with interstitial alluvial clay and silt, on floor of Moggy Hollow, formed by washing of weathered basalt by spillway drainage from the Moggy Hollow stage of Lake Passaic.
- **Thermokarst basin**--Line on rim, pattern in basin. Small, shallow basins (maximum depth 8 feet) formed chiefly from melting of ground ice. A few basins may have been formed by wind erosion or, possibly, ground-water seepage. May contain thin peat deposits. Larger basins with thicker peat are mapped as unit Qs.

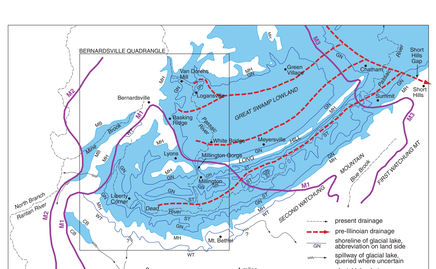
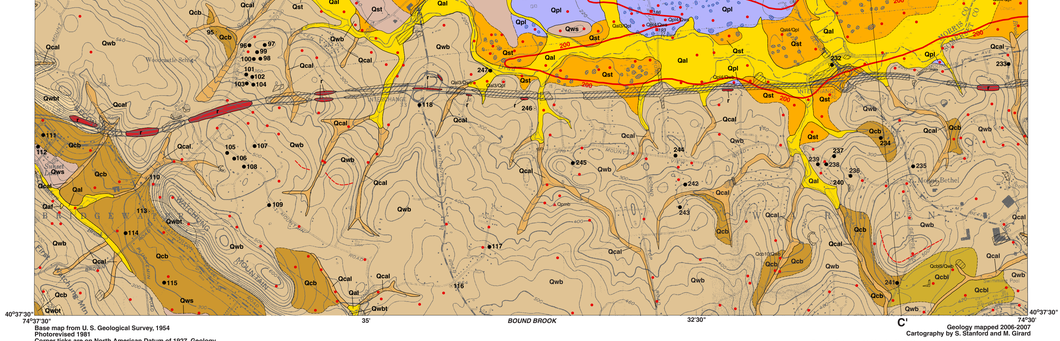


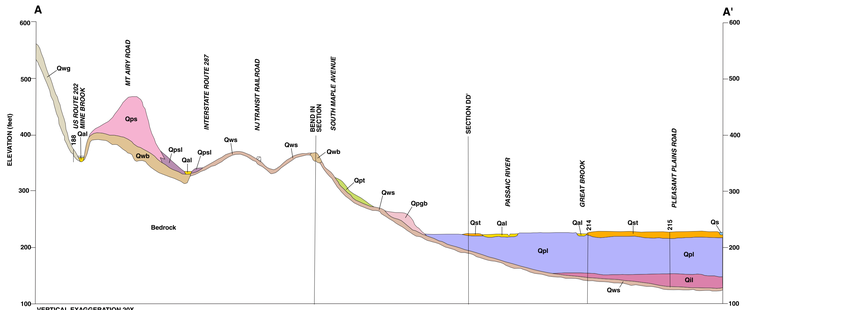
Figure 1.-- Glacial lakes, ice margins, and pre-Illinoian drainage in the Bernardsville quadrangle and vicinity. Abbreviations on lake shorelines are MH=Moggy Hollow stage of Lake Passaic, GN=Great Notch stage (in the Great Swamp lowland, the Great Notch stage is close to the initial level of the Millington stage of Lake Passaic, before cutting of the Millington gorge), ST=Stanley stage of Lake Passaic, WT=glacial Lake Watchung, CB=glacial lake in Chambers Brook valley, MB=glacial lake in Mine Brook valley. The Lake Passaic stages are all of late Wisconsinan age, the other lakes are of pre-Illinoian age. Abbreviations on glacier margins are: M1=maximum extent of pre-Illinoian glacier, delta deposited in Lake Watchung at Bernardsville, M2=approximate position of pre-Illinoian glacier at maximum extent of lake in Mine Brook valley, M3=maximum extent of late Wisconsinan and Illinoian glaciers, marked by the late Wisconsinan terminal moraine

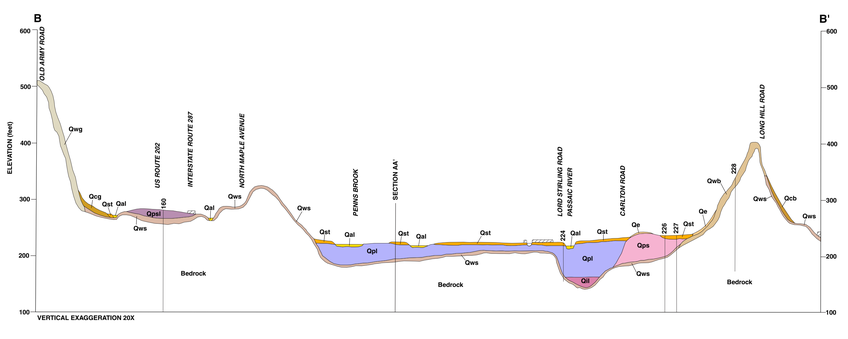


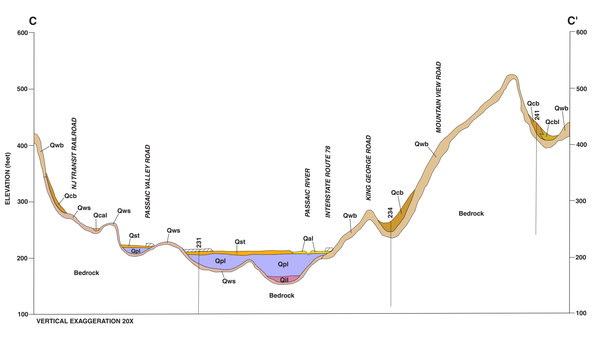
Base map from U. S. Geological Survey, 1954
Photorevised 1981
Corner ticks are on North American Datum of 1927. Geology and base map do not edge-match adjoining quadrangles with corner ticks on North American Datum of 1983. Overlap of information occurs at the east edge of the quadrangle, and a gap of information occurs at the west edge.

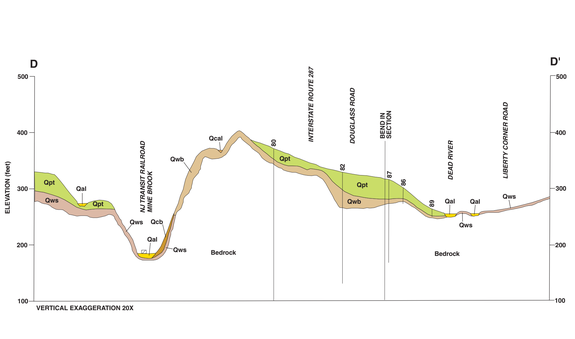
Geology mapped 2006-2007
Cartography by S. Stanford and M. Girard

Research supported by the U. S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number 08HQAG0047. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.

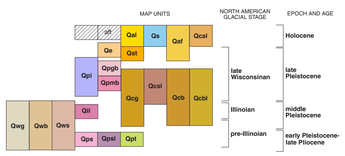








CORRELATION OF MAP UNITS



NEW JERSEY GEOLOGICAL SURVEY
1835

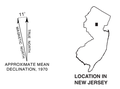
SURFICIAL GEOLOGY OF THE BERNARDSVILLE QUADRANGLE MORRIS AND SOMERSET COUNTIES, NEW JERSEY

by
Scott D. Stanford
2008

SCALE 1:24 000

1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
.5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



Surficial Geology of the Bernardsville Quadrangle
Morris and Somerset Counties, New Jersey

New Jersey Geological Survey
Open-File Map OFM 74
2008

pamphlet to accompany map

Table 1.--Selected well and boring records.

Well No.	Identifier[1]	Depth to bedrock or driller's log with depth and description[2]	
1	25-14628	0-24	overburden (Qwg)
		24-40	soft rock (Qwg)
		40-144	hard granite
2	25-17770	10	
3	25-28004	20	
4	25-43649	0-18	clay (Qwg)
		18-28	sandstone (Qwg)
		28-555	granite
5	25-42962	0-12	sandy brown soil (Qwg)
		12-110	mixed hard granite
6	25-23231	0-45	broken rock (Qwg)
		45-200	granite
7	25-23781	0-18	sandy hardpan (Qcg)
		18-85	sandstone (Qwg)
		85-123	medium brown granite
8	25-24178	0-30	sandy soil (Qwg)
		30-130	granite
9	25-21099	0-13	hardpan (Qwg)
		13-36	brown granite
		36-98	gray granite
10	25-28512	0-33	sandy hardpan (Qwg)
		33-147	medium granite
11	25-44174	0-13	orange silty fine-to-medium sand (Qwg)
		13-53	rock
12	25-29567	15	
13	25-20926	20	
14	25-39128	0-17	clay (Qwg)
		17-25	weathered rock (Qwg)
		25-405	granite
15	25-33377	0-10	brown sandy soil (Qwg)
		10-30	decomposed granite (Qwg)
		30-230	granite

16	25-39031	0-8	clay (Qwg)
		8-28	weathered rock (Qwg)
		28-155	granite
17	25-24337	0-17	hardpan (Qwg)
		17-197	granite
18	25-19213	0-30	sandy soil (Qwg)
		30-150	sandstone (gneiss)
19	25-18515	20	
20	25-19206	0-25	sandy soil (Qwg)
		25-175	granite
21	25-18044	15	
22	25-18121	20	
23	25-25216	0-30	yellow clay (Qwg)
		30-40	decomposed granite (Qwg)
		40-310	gray granite
24	25-25750	32	
25	25-31181	0-28	sandy hardpan and rock (Qwg)
		28-980	granite
26	25-29736	0-13	hardpan (Qwg)
		13-48	sandstone (Qwg)
		48-498	granite
27	25-33752	12	
28	25-31584	0-80	clay (Qwg)
		80-825	granite
29	25-34761	0-28	sandy loam (Qwg)
		28-805	granite
30	25-30093	0-50	sandy (Qwg)
		50-500	granite
31	25-22649	0-15	rotten rock (Qwg)
		15-360	granite
32	25-22358	0-40	sandy, loose rock (Qwg)
		40-400	gray shale
33	25-25857	40	
34	25-25659	15	
35	25-25527	25	
36	25-19288	0-27	overburden, clay hardpan (Qwg)
		27-49	very soft granite (Qwg)
		49-373	gray granite
37	25-19324	0-24	sand and hardpan (Qwg)
		24-98	granite
38	25-19320	0-28	hardpan (Qwg)
		28-73	brown granite
39	25-28297	0-12	brown sandy soil (Qws)
		12-110	medium hard shale and sandstone

40	25-42159	0-8	clay (Qwg)
		8-27	weathered rock (Qwg)
		27-1130	granite
41	25-6355	0-6	earth and fill
		6-10	broken rock (Qwg)
		10-177	granite
42	25-22959	0-12	sandy soil (Qwg)
		12-150	granite
43	25-22289	0-6	mixed stones and sandy soil (Qwg)
		6-20	sandy yellow soil (Qwg)
		20-260	granite
44	25-30357	0-21	boulders, sand, and overburden (Qwg)
		21-230	granite and traprock
45	25-20772	0-20	loose dirt and stones (Qwg)
		20-210	granite
46	25-18038	0-40	sandy soil (Qwg)
		40-225	sandstone
47	25-40027	0-9	clay (Qwg)
		9-33	weathered rock (Qwg)
		33-1000	granite
48	25-29773	0-17	sand, gravel, clay overburden (Qwg)
		17-100	slate
49	25-17495	0-30	sandy soil (Qwg)
		30-300	sandstone
50	25-10597	0-11	clay and stones (Qwg)
		11-180	hard granite rock
51	25-24365	0-64	hardpan and sandstone (Qwg)
		64-298	granite
52	25-25191	0-20	sandy mixed soil (Qwg)
		20-365	granite
53	25-28861	0-12	sandy soil and boulders (Qwg)
		12-200	mixed granite
54	25-29774	0-27	sand, clay, and gravel overburden (Qwg)
		27-250	slate
55	25-39910	0-9	clay (Qwg)
		9-30	sandstone (Qwg)
		30-220	granite
56	25-27964	30	
57	25-20880	0-60	sand, loose rock (Qwg)
		60-100	granite
58	25-22443	0-10	loose rock formation (Qwg)
		10-24	yellow sandstone (Qwg)
		24-300	granite with layers of yellow sandstone (weathered zones)
59	25-14256	0-11	clay and dirt (Qwg)
		11-40	rotten, broken granite (Qwg)
		40-500	solid granite
60	25-24122	0-29	sandy hardpan (Qwg)
		29-248	granite

61	25-22568	0-21	brown sandy soil, some stones (Qcg)
		21-200	red shale and sandstone
62	24-15507	0-30	rotten rock (Qws)
		30-54	soft shale
		54-400	shale
63	25-24905	0-40	clay, broken rock (Qcg)
		40-400	shale
		400-500	rock
64	25-16267	0-130	clay and boulders (Qpt over Qws, anomalous thickness)
		130-294	red sandstone
65	25-6135	0-14	clay (Qpt)
		14-20	clay and stones (Qpt)
		20-170	red sandstone
66	25-20981	0-85	hardpan and red clay (Qws, anomalous thickness)
		85-173	red shale
67	25-41970	35	
68	25-39319	0-8	clay (Qwb)
		8-655	granite
69	25-42975	0-22	stony hardpan (Qwb)
		22-83	red traprock
		83-698	gray traprock
70	25-32272	0-12	rocky overburden (Qwb)
		12-600	blue rock
71	25-40689	0-15	fractured trap (Qwb)
		15-620	trap rock
		620-660	red rock
		660-675	fractured trap
72	25-31799	15	
73	25-36326	10	
74	25-43021	0-15	clay (Qwb)
		15-580	trap rock
		580-605	broke into shale
75	24-21447	0-9	soft red clay (Qws)
		9-123	red shale
76	25-32573	0-7	clay hardpan (Qpt over Qws)
		7-173	red and blue shale
77	25-21880	0-20	clay (Qwb)
		20-85	trap rock
78	25-39494	0-15	hardpan (Qwb)
		15-505	trap rock
79	25-41146	40	
80	25-21177	0-20	clay (Qpt over Qwb)
		20-300	basalt
81	25-30293	0-12	hardpan (Qwb)
		12-25	fractured rock
		25-600	unweathered granite

82	25-24530	0-64	sandy hardpan (Qpt over Qwb)
		64-197	trap rock
83	25-19713	0-76	sand and gravel (Qpt over Qwb)
		76-148	trap rock
84	25-16796	0-30	sand, gravel (Qpt over Qwb)
		30-248	trap rock
85	25-19612	0-58	sand and gravel (Qpt)
		58-320	trap rock
86	25-40392	0-17	silt, sand, and clays (Qpt)
		17-20	shale
87	25-33838	0-35	clay (Qpt)
		35-148	trap rock
88	25-21761	0-18	clay and gravel (Qwb)
		18-225	trap rock
89	25-40394	0-17	silt, sand, and clays (Qpt)
		17-20	shale
90	25-24668	0-30	clay (Qpt)
		30-150	blue rock
91	25-31816	0-12	red clay (Qws)
		12-173	red shale
92	25-34342	0-6	red clay (Qws)
		6-98	red shale
93	25-20268	11	
94	25-33821	0-27	subsoil and broken rock (Qwb)
		27-220	gray trap
95	25-25488	0-7	red clayey silt (Qcb)
		7-24	decomposed basalt (Qwb)
96	25-25304	0-25	loose rock (Qwb)
		25-300	granite
97	25-20867	0-16	clay and chunks of trap (Qwb)
		16-273	trap rock
98	25-26755	0-10	loose stones (Qwb)
		10-45	brown clay (Qwb)
		45-100	mixed red-trap rock
99	25-26621	0-25	loose stones and clay (Qwb)
		25-360	medium hard trap rock
100	25-27002	0-55	brown clay (Qwb)
		55-210	hard trap rock
101	25-34149	0-34	clay (Qwb)
		34-38	weathered rock (Qwb)
		38-298	trap rock
102	25-34148	0-23	clay (Qwb)
		23-198	trap rock
103	25-34144	0-19	clay (Qwb)
		19-31	weathered rock (Qwb)
		31-298	trap rock

104	25-34145	0-35	clay (Qwb)
		35-423	trap rock
105	25-25752	0-30	yellow clay (Qwb)
		30-150	trap rock
106	25-23407	0-10	sandy soil (Qwb)
		10-40	hardpan and trap rock (Qwb)
		40-150	solid trap rock
107	25-34192	0-10	clay (Qwb)
		10-14	clay and gravel (Qwb)
		14-87	trap rock
		87-95	red shale
		95-198	trap rock
108	25-24262	0-30	clay (Qwb)
		30-330	trap rock
109	25-22605	0-20	overburden (Qwb)
		20-540	gray trap
		540-670	red rock
110	25-15421	0-54	overburden (Qcal over Qcb, possibly over Qps and Qws)
		54-160	red sandstone
111	25-24078	15	
112	25-24097	20	
113	25-33203	0-18	rocky overburden (Qcb)
		18-200	shale
114	25-13435	0-52	red clay (Qcb over Qps? and Qws)
		52-225	red shale with streaks of gray shale
115	25-11512	0-3	top soil (Qws)
		3-212	red shale
		212-230	trap rock
116	25-25486	0-12	brown silt clay, silty clay (Qwb)
		12-20	brown clayey silt (Qwb)
		20-26	decomposed diabase (Qwb)
117	25-27304	40	
118	25-43801	0-14	till, coarse-to-fine sand, trace coarse-to-fine gravel, trace cobbles and boulders, little silt (Qwb)
		14-28	gray basalt
119	25-33530	0-12	brown clay with silt and sand lenses (Qal)
		12-16	red, brown clay with shale fragments (Qws)
120	25-33531	0-6	red brown clay (Qal or fill)
		6-8	green brown clay (Qal or fill)
		8-24	gray brown clay with occasional sand layers (Qal)
121	25-36703	0-6	weathered rock (Qws)
		6-23	shale
122	25-21550	0-33	clay, sand (Qwb)
		33-61	soft rotten shale
		61-110	red shale
123	25-21146	0-54	clay and stones (Qwb)
		54-108	trap rock
		108-148	red shale

124	25-21525	0-8	clay and sand (Qwb)
		8-90	trap rock
		90-348	red shale
125	25-44006	abbreviated log	
		0-18	brown fine sand, some silt and shot rock (fill)
		18-29	brown fine sand and silt, some gravel (Qal)
		29-45	stiff brown silt with layers of weathered shale (Qws)
126	25-38500	abbreviated log	
		0-12	brown, yellow, reddish-yellow clay (Qws)
		12-21	yellow shale with clay
127	25-11173	0-18	earth and hardpan (Qws)
		18-115	red shale
		115-215	trap rock
128	25-44003	0-5	red brown sand (fill or Qws)
		5-10	red sand and clay (fill or Qws)
		10-15	red sand and clay, trace decomposed shale (Qws)
		15-16	red shale
129	25-31140	0-6	red clay (Qws)
		6-56	red shale
		56-273	trap rock
130	25-44288	0-8	brown silty sand, gravel, and cobbles (Qwb)
		8-30	rock
131	25-43638	0-5	brown clay and gravel (Qwb)
		5-10	silty sand and clay (Qwb)
		10-13	gravel, clay (Qwb)
		13-18	gravel (Qwb)
		18-27	rock
132	25-20316	0-22	brown clay and stones (Qwb)
		22-198	trap rock
133	25-30365	0-29	sandy hardpan (Qcg over Qwg)
		29-48	sandstone (Qwg)
		48-73	granite
		73-100	sandstone (weathered gneiss)
134	25-31813	0-9	hardpan (Qwg)
		9-35	sandstone (Qwg)
		35-447	granite
135	25-34036	0-30	deteriorated rock (Qwg)
		30-40	fractured rock (Qwg)
		40-755	granite
136	25-34002	0-5	dirt topsoil (Qwg)
		5-30	deteriorated rock (Qwg)
		30-40	fractured rock (Qwg)
		40-630	granite
137	25-28265	0-15	gravelly and sandy (Qwg)
		15-630	granite, no soft spots
138	25-42175	0-5	soil-weathered granite (Qwg)
		5-15	granite
		15-20	trap rock
139	25-41384	0-12	tan and orange clay, silt, trace medium-to-fine sand (Qwg)
		12-44	very weathered rock (Qwg)
140	25-25137	0-28	sandy hardpan (Qwg)
		28-272	granite

141	25-25138	0-19	sandstone (Qwg)
		19-98	granite
142	25-20646	0-70	brown clay and mica (Qwg)
		70-76	rotten gray gneiss (Qwg)
		76-495	gray hard gneiss
143	25-31252	0-55	sand (Qwg)
		55-900	granite
144	25-17857	0-30	sandy soil (Qwg)
		30-300	sandstone (gneiss)
145	25-26269	50	
146	25-28578	0-20	sandy soil (Qwg)
		20-45	brown decomposed granite (Qwg)
		45-230	granite
147	25-22732	50	
148	25-20381	0-18	water, clay, stones (Qwg)
		18-198	trap rock
149	25-10622	0-25	sand and clay (Qwg)
		25-35	rotten rock (Qwg)
		35-125	sandstone
150	25-41765	abbreviated log	
		0-36	brown, red, white coarse-to-fine sand, some silt, clayey silt, and medium-to-fine gravel (Qps)
151	25-42670	0-3	fill
		3-14	silt and sand (Qps)
		14-34	soft broken rock (Qwg)
		34-44	rock
152	25-32859	0-12	yellow-brown silty clay, large gravel (Qps)
		12-20	brown till, silt, fine sand, clay, fine gravel (Qps)
		20-30	gray-green soft shale rock
153	25-38377	0-30	gray clay and silt (Qps)
154	25-41482	0-35	brown clay with some silt, micaceous (Qps)
155	25-41378	0-5	reddish-brown medium-to-fine sand and clay (Qps)
		5-10	reddish-brown clay, some medium-to-fine sand (Qps)
		10-25	reddish-brown silty clay (Qps)
		25-30	orange-brown silty clay, trace gravel, some fine-to-coarse sand (Qps)
		30-35	olive-green silty clay, little gravel (Qps)
156	25-34861	0-8	brown fine sand, some gravel, little silt (Qps)
		8-10	coarse gravel, some brown silty sand (Qps)
		10-15	gray-brown fine sand, some medium-to-fine gravel (Qps)
		15-23	gray-brown fine sand, some medium-to-fine gravel, little silt (Qps)
157	25-2059	0-22	earth and clay (Qcg)
		22-110	red shale
		110-190	red rock
158	25-40530	0-27	orange-brown silts and clays with some pieces of fractured rock grading down to a fine sandstone at 26 (Qwb)
159	25-24203	0-10	clay (Qws)
		10-160	shale, bluestone
160	25-10173	0-40	yellow clay (Qpsl over Qws)

		40-1435	blue and red shale and sandstone
161	25-25293	0-30	hardpan, boulders (fill over Qal)
		30-151	gray rock
		151-NR	red rock
162	25-29368	abbreviated log	
		0-4	red clayey sand and gravel (fill)
		4-6	greenish-gray clay, trace sand, organic fibers (Qal)
		6-14	brown clayey gravel and sand (Qal)
163	25-33159	0-7	medium-to-fine clayey sand, some silt (fill?)
		7-22	brown clay, some gravel (Qws)
164	25-30024	18	
165	25-23603	0-10	sandy soil (Qcg)
		10-150	red and gray shale
		150-190	volcanic rock
166	25-20499	0-20	brown sandy soil (Qcg)
		20-520	brown, red, gray shale and argillite
167	25-2177	0-10	dirt and stones (Qwb)
		10-223	brown and red rock
168	25-22148	0-18	clay and sand (Qwb)
		18-75	trap
		75-198	red shale
169	25-22290	0-20	red clay (Qwb)
		20-150	trap rock
		150-230	red shale
170	25-43019	0-40	overburden (Qwb)
		40-115	trap rock
		115-150	red shale
171	25-37650	0-80	overburden (Qwb over basalt)
		80-300	shale
172	25-34281	0-80	overburden (Qwb and basalt)
		80-300	shale and argillite
173	25-30353	8	
174	25-31767	0-18	sandy overburden (Qwb)
		18-400	red shale and layers of blue stone
175	25-43077	0-4	clay (Qws)
		4-42	shale
		42-280	trap
176	25-14418	0-20	overburden, clay and rock (thin Qcb over Qws)
		20-50	gray rock, trap
		50-60	gray rock changed to red
		60-150	red rock and sandstone
177	25-20041	0-12	red clay (Qws)
		12-249	red shale and limestone
178	25-19986	0-18	red clay (Qwb)
		18-75	trap rock
		75-147	red shale
179	25-32514	20	
180	25-32023	10	

181	25-30354	0-21	sand, clay, gravel overburden (Qwb)
		21-300	red slate rock
182	25-32297	0-30	sand, clay (Qwb)
		30-300	basalt
183	25-31139	15	
184	25-33094	0-27	overburden (Qwb)
		27-110	black trap
		110-600	brown and gray sandstone
185	25-22196	0-30	soil mixed with clay (Qwb)
		30-140	trap rock
		140-210	red shale
186	25-20982	0-55	brown clay and stones (Qwb)
		55-198	trap rock
187	25-18889	5	
188	25-21751	0-14	hardpan (Qwb)
		14-65	trap rock
		65-648	red shale
189	25-20627	0-20	brown hardpan, loose stones (Qwb)
		20-125	blue basalt
190	25-20755	0-20	loose rock (Qwb)
		20-200	argillite (basalt)
		200-330	shale
191	25-36084	0-3	soil (Qwb)
		3-15	hardpan (Qwb)
		15-28	fractured rock (Qwb)
		28-180	granite, occasional fractures (basalt)
192	25-26760	0-21	trap rock and brown clay (Qwb)
		21-221	trap rock
		221-498	red rock
193	25-28171	0-8	loose brown rock (Qwb)
		8-20	brown rock with some sand (Qwb)
		20-140	blue rock with granite (basalt)
		140-180	blue rock with some fractures (basalt)
194	25-37608	0-7	soil (Qwb)
		7-17	broken granite (Qwb)
		17-170	gray granite
195	25-22361	0-10	yellow clay and stones (Qwb)
		10-165	basalt
196	25-27762	12	
197	25-27861	0-10	decomposed rock (Qwb)
		10-210	trap rock
198	25-33218	0-10	clay (Qws)
		10-450	shale
199	25-41959	0-7	clay (Qwb)
		7-244	trap
		244-700	shale
200	25-53356	0-2	soil (Qwb)
		2-32	clay (Qwb)

		32-550	shale
201	25-33162	0-7	clay (Qws)
		7-21	red shale
		21-223	trap rock
202	25-19031	0-20	dirt (Qwb)
		20-210	gray rock
		210-250	red rock
203	25-18389	9	
204	25-27381	0-20	clay (Qwb)
		20-340	blue rock (basalt)
205	25-29656	0-17	red clay and shale (Qws)
		17-22	yellow shale
		22-51	red rock
		51-273	gray trap
206	25-29091	0-15	red clay and shale (Qws)
		15-98	red shale
		98-298	gray trap
207	25-34456	0-23	red and brown clay (Qws)
		23-25	blue traprock and red clay
		25-198	blue, red, green traprock
208	25-32417	0-11	red clay and weathered rock (Qws)
		11-25	clay and sand (Qwb)
		25-272	trap rock
		272-598	red and blue shale
209	25-12714	0-5	clay (Qws)
		5-38	red shale
		38-300	trap rock
210	25-46762	0-3	organic loam
		3-15	red fine clay with gravel (Qws)
211	25-22063	0-20	yellow clay (Qst over Qpl)
		20-50	soft red shale
		50-150	hard red shale
212	25-42553	0-9	red-brown sandy silt over fine-to-medium sand with clayey silt, trace gravel (fill)
		9-13	brown fine-to-coarse sand and gray fine sand (fill)
		13-18	gray fine-to-coarse sand, some silt, trace gravel (fill)
		18-19	brown organic silt, trace roots, gravel (Qal)
		19-21	red-brown fine-to-medium sand and clayey silt (Qal)
		21-32	soft weathered red-brown shale
213	25-36606	0-4	dark red-brown silty loam (fill)
		4-9	dark red-brown silty clay (Qws)
		9-30	dark red-brown weathered shale
214	25-31770	0-3	clay, top soil (Qpl)
		3-71	red-brown clay (Qpl over Qil)
		71-89	clay and shale
		89-110	gray shale
		110-198	red shale
215	GS1 of Reimer (1984)	abbreviated log	
		0-11	brown, reddish-brown laminated silt and clay, some very fine sand in the silt beds, sand content increases towards top (Qst over Qpl)
		11-77	brown, dark brown, dark grayish-brown laminated silt and clay, microvarved from 11 to 16 feet (Qpl)
		77-88	grayish-brown massive to laminated sand and silt, some cross bedding in

			sand beds (interglacial alluvial and shallow-lake deposits)
		88-96	brown, reddish brown laminated silt and clay (Qil)
		at 96	red siltstone
216	25-11553	no log, cased to 76 (approximate depth to bedrock)	
217	25-27175	0-6	dark gray silty clay, little coarse-to-fine sand (Qws)
		6-10	red shale
218	25-21780	0-40	loose rock, sand and gravel (Qps)
		40-200	trap rock
219	25-52745	0-5	soil and fill (Qws)
		5-22	red rock
220	25-7283	20	
221	25-23764	15	
222	25-24124	25	
223	25-42490	0-6	red-brown to brown clayey silt, some coarse-to-fine sand, little fine-to-coarse gravel (Qws)
		6-8	red-brown silty fine-to-medium sand, little fine-to-coarse gravel, trace clay (Qws)
		8-18	gray brown to gray fine-to-coarse gravel some fine-to-coarse sand with silt--shale
		18-21	gray and red-brown fine-to-coarse sand, some fine-to-coarse gravel with silt (shale)
224	GS6 of Reimer (1984)	abbreviated log	
		0-12	brown to yellowish-brown laminated silt and clay, at 4.5 feet there is a compact, weathered-pebble layer similar to that at 64-69 feet about a foot thick (Qst over Qpl)
		12-64	brown, dark brown laminated silt and clay (Qpl)
		64-69	compact, massive silty clay with decomposed pebbles, granules, and sand, reddish-brown to dark grayish-brown, pebbles are cream to dark reddish-brown in color and are probably shale, one cobble is decomposed gneiss (Qpt or interglacial alluvial gravel mixed with weathered shale)
		at 69	shale
225	25-39983	0-32	gray clay (Qst over Qpl)
		32-120	red shale
		120-170	mixed gray shale and blue shale
226	25-21784	0-40	sand (Qst over Qpl)
		40-150	red shale
227	25-26084	10	
228	25-31242	0-7	yellow-brown soil (Qwb)
		7-12	weathered rock (Qwb)
		12-165	hard trap rock
229	25-21637	0-10	clay (Qwb)
		10-195	granite (basalt)
		195-300	shale
230	25-30177	0-10	red clay and stones (Qws)
		10-185	medium hard red shale
231	25-10320	0-21	clay (Qst over Qpl)
		21-30	soft red shale (Qws)
		30-297	red shale
232	25-16029	0-60	clay (Qal over Qpl)
		60-130	shale
		130-150	trap

233	25-39027	5	
234	25-34676	0-20	yellow-brown clay (Qcb)
		20-28	brown decomposed trap (Qwb)
		28-150	hard trap rock
235	25-41899	0-20	dry brown soil with some loose stones (Qwb)
		20-30	brown trap rock
		30-200	hard blue-gray trap rock
		200-228	soft red trap rock
236	25-24349	0-35	brown clay (Qwb)
		35-80	trap rock
237	25-26519	0-20	clay and loose stones (Qwb)
		20-240	medium hard trap rock
238	25-24167	0-25	broken rock (Qwb)
		25-210	solid trap
239	25-30178	0-12	brown clay soil and stones (Qwb)
		12-105	mixed hard trap rock
240	25-19332	40	
241	25-26330	0-30	clay (Qcb)
		30-200	granite (basalt)
242	25-40138	20	
243	25-9288	0-35	dirt and clay (Qwb)
		35-55	sand rock (Qwb)
		55-80	blue rock (basalt)
244	25-1066	35	
245	25-20024	0-50	clay (Qwb)
		50-115	trap
246	25-25061	0-15	stony sandy hardpan (Qwb)
		15-19	trap rock
247	25-24071	0-5	brown hard-packed clay, dry (Qal)
		5-8	wet clay (Qal)
		8-14	decomposed brown trap rock (Qwb)
		14-32	trap rock
248	25-37709	0-5	gray-brown clay, small cobbles (Qws)
		5-10	gray-brown sandy clay, red gravel (Qws)
		10-21	red shale

[1]Identifiers of the form 25-xxxx are well permit numbers issued by the N. J. Department of Environmental Protection, Bureau of Water Allocation. Identifiers accompanied by a reference, for example, “GS6 of Reimer (1984)” are from the cited publication.

[2]A number without a log is the depth, in feet below land surface, to bedrock reported for wells where the surficial material is either not identified or identified only as “overburden” or other non-informative nomenclature. For wells and borings with logs of the surficial materials, the depth (in feet below land surface) and driller’s or logger’s description, or the description contained in the cited publication, is provided. Inferred map units and comments are indicated in parentheses. All descriptions are reproduced as they appear in the original source, except for minor format, punctuation, and spelling changes. Logs identified as “abbreviated” have been condensed for brevity, or have

minor details omitted. Many bedrock descriptions have been condensed; these are not identified as abbreviated. Map units are inferred from the known extent of materials at the surface and from known depositional settings, in addition to the drillers' descriptions.