Surficial Map Unit Properties Table: Morristown National Historical Park

Colored map units are mapped within Morristown National Historical Park. Bold text refers to sections in report.

Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Holocene)	Artificial fill (Qf) Trash fill (Qaft)	These units are anthropogenic. **Qf** consists of sand, gravel, silt, clay, and rock fragments, as well as anthropogenic materials, such as cinders, ash, brick, concrete, wood, slag, asphalt, metal, glass, and trash (**Qaft**). **Qaft** occurs as solid-waste landfills. Trash is mixed and covered with sand, silt, clay, and gravel. Units are 6–9 m (20–30 ft) thick. **Qf** and **Qaft** reflect the long anthropogenic influence on the landscape surrounding the park.	None reported.	**Disturbed Lands**—Landfills occur in the park area, but are too small to appear in the map data.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—Units record episodes in the human history of landscape change.
QUATERNARY (Holocene)	Alluvium (Qal)	**Qal** is sorted sand, silt, clay, pebble gravel, and some cobbles deposited by rivers and streams. Some deposits of **Qal** are massive, whereas others are layered. The coarser components (sand and gravel) are deposited in stream channels. Finer silt and clay are deposited on levees and overbank areas as part of the floodplain adjacent to streams. Unit may contain organic matter or demolition debris and trash downstream of urban areas. **Qal** is up to 9 m (30 ft) thick. **Qal** is mapped within park boundaries at the New Jersey Brigade and Jockey Hollow encampment area units.	**Postglacial Deposits**—**Qal** covers some glacial deposits. **Paleontological Resources**—This unit may contain Pleistocene fossils.	**Slope Movement Hazards and Risks**—Local streams simultaneously deposit and erode local alluvium during channel meandering. **Flooding**— Flooding undercuts and erodes trails, alters river-channel morphology and sedimentation patterns, and can damage infrastructure.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—Following the last glaciation, local streams and rivers began to incise thick glacial deposits, establishing modern drainages.
QUATERNARY (Holocene)	Swamp and marsh deposits (Qs)	**Qs** collects in stagnant-water swamps and marshes, where fine-grained material slowly settles and abundant organic material is interlayered. **Qs** consists of peat, organic silt, clay, and minor sand. Unit is black, brown, and gray. Unit is up to 6 m (20 ft) thick.	**Paleontological Resources**—**Qs** contains a pollen record including pollen from pine, spruce, and birch documenting accumulation dating to at least 9,000 years before present.	None reported.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—**Qs** deposits collect in areas underlain by glaciolacustrine deposits of Lake Passaic. Such deposits contain paleoclimatic markers.
QUATERNARY (Holocene)	Alluvium and colluvium, undivided (Qcal)	Interbedded and poorly sorted colluvium (**Qcg**, **Qcb**, **Qcbl**, **Qcs**, and **Qcsl**) and alluvium (**Qal**). Colluvium is a slope deposit, forming as blocks are weathered from an exposure and tumble downslope under the force of gravity. **Qcal** consists of up to 5 m (15 ft) silty sand, sandy to clayey silt, and some pebbles and cobbles, with scant organic matter. It appears yellowish or reddish brown. **Qcal** locally includes lag accumulations (areas where wind has blown away finer material) on eroded surfaces or local bedrock. **Qcal** is mapped within park boundaries at the New Jersey Brigade and Jockey Hollow encampment area units	**Postglacial Deposits**—**Qcal** covers some glacial deposits. **Paleontological Resources**—This unit may (but is not likely to) contain Pleistocene fossils.	**Slope Movement Hazards and Risks**—Talus and colluvium are associated with slope processes. **Flooding**— Flooding undercuts and erodes trails, alters river-channel morphology and sedimentation patterns, and can damage infrastructure.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—Following the last glaciation, local streams and rivers began to incise thick glacial deposits, establishing modern drainages. Colluvium collected as a result of slope processes.
QUATERNARY (Holocene and late Pleistocene)	Alluvial fan deposits (Qaf)	**Qaf** consists of sorted and stratified (layered) sand, silt, pebbles, and cobbles. It is up to 12 m (40 ft) thick. Organic material may be present locally. Unit may be reddish or yellowish brown. **Qaf** may be dissected by modern streams depositing **Qal**.	None reported.	**Flooding**— Flooding undercuts and erodes trails, alters river-channel morphology and sedimentation patterns, and can damage infrastructure.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—**Qaf** collects at the bases of scarps, such as the Highland scarp, where drainages suddenly deposit sediment loads in fan-shaped deposits.

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QUATERNARY (Holocene and Late Pleistocene)	Talus (Qta)	**Qta** is angular to subangular (i.e., not rounded by flowing water) cobbles and small boulders of basalt. Deposits of **Qta** are up to 5 m (15 ft) thick. **Qta** collects as an apron at the bases of cliffs along Green Brook south of Seelys Pond.	None reported.	**Slope Movement Hazards and Risks**—Talus and colluvium are associated with slope processes.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—**Qta** formation accelerated during colder climates of the ice ages, and deposits collected at the bases of local slopes.
	Eolian deposits (Qe)	**Qe** consists of very fine to fine sand, silty fine sand, and minor fine to medium sand. Some deposits of **Qe** are massive, whereas others are layered. **Qe** is up 5 m (15 ft) thick and appears pale brown to yellowish brown.	**Postglacial Deposits**—**Qe** formed as glacial Lake Passaic drained away from the area, leaving broad expanses of lake deposits available for aeolian transport as sheets and small dunes.	None reported.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—Wind-transported **Qe** sediments were deposited on adjacent uplands and slopes shortly after draining of the Moggy Hollow stage of Lake Passaic.
QUATERNARY (Late Pleistocene)	Stream terrace deposits (Qst) High stream terrace deposits (Qstu)	**Qst** consists of silt, fine to coarse sand, and pebbles in well-sorted, stratified to massive exposures. Some coarser deposits, including cobbles to boulders (**Qstu**), occur along larger rivers, such as the Passaic River. Most outcrops are pale brown, yellowish to reddish brown, or light gray. **Qst** is up to 5 m (15 ft) thick and is perched 2–5 m (5–15 ft) above modern floodplains. **Qst** is mapped within park boundaries at the Washington's Headquarters unit. **Qstu** is weakly stratified, moderately sorted, pebble to cobble gravel and fine to medium sand perched 6–8 m (20–25 ft) above the modern Passaic River floodplain in Summit. **Qstu** is up to 2 m (6 ft) thick and appears brown to reddish brown in outcrop.	**Postglacial Deposits**—**Qst** was, in part, deposited in shallow postglacial lakes (including the Stanley and Millington stages of Lake Passaic), forming a sequence of abandoned and incised meanders as the lakes lowered and drained away following the end of the Pleistocene ice ages. **Qstu** may mark the initial spillway level for the Stanley stage of Lake Passaic. **Paleontological Resources**—This unit may (but is not likely to) contain Pleistocene fossils.	None reported.	**Postglacial Modification of the Landscape and Modern Geomorphological Development**—Portions of **Qst** were incised between about 14,000 and 10,000 years before present. Organic layers in **Qst** date to 13,975 ± 340 years before present. The Passaic River deposited **Qtsu** during early downcutting through the glacial moraine at Stanley.
	Great Notch stage deposits (Qpg)	**Qpg** is fine to medium sand, pebbly sand, and pebble to cobble gravel that appears yellowish brown, brown, and reddish brown in outcrop. Deposits are up to 5 m (15 ft) thick.	**Glacial Features**—**Qpg** was deposited as alluvial fans in the Great Notch stage of Lake Passaic. Some areas of **Qpg** were deposited at the mouths of streams eroding material from adjacent Moggy Hollow–stage deltas.		**Pleistocene Ice Ages**—Portions of **Qst** were deposited as alluvial fans during several stages of Lake Passaic.
	Conglomerate colluvium (Qcc)	**Qcc** contains subrounded, fractured pebbles and cobbles derived from weathered conglomeratic bedrock and some weathered-rock surface rubble. Some minor sand and silt layers occur within **Qcc**. Thickness of **Qcc** ranges from 3 to 9 m (10–30 ft).	None reported.	**Slope Movement Hazards and Risks**—Layers of **Qcc** have been subjected to creep or possibly solifluction. Colluvium is associated with slope processes.	**Pleistocene Ice Ages**—**Qcc** formation accelerated during glaciations.
	Lake bottom deposits (Qpml)	**Qpml** consists of silt, clay, and minor fine sand in laminated outcrops that appear gray to light-reddish brown. **Qpml** is up to 36 m (120 ft) thick.		None reported.	**Pleistocene Ice Ages**—Portions of **Qpml** were deposited in the Chatham, Moggy Hollow (majority), Great Notch, Stanley, Millington, and Totowa stages of Lake Passaic.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Late Pleistocene)	Beach deposits, lower stages (Qpgb)	**Qpgb** contains medium to coarse sand and pebbly sand that appears in reddish-brown to gray, unstratified (layered) to weakly stratified outcrops. Individual clasts are primarily weathered shales with some quartz and quartzite pieces. Estimated thickness of **Qpgb** is 5 m (15 ft).	**Glacial Features**—**Qpgb** formed by wave-action erosion of shale bedrock along the shores of Lake Passaic.	None reported.	**Pleistocene Ice Ages**—**Qpgb** formed along the shoreline of Lake Passaic during the Great Notch and Millington stages.
	Shale colluvium, silty phase (Qcsl)	**Qcsl** consists of reddish- to yellowish-brown to gray, silty clay with shale chips and sparse basalt pebbles. It is up to 3 m (10 ft) thick.	None reported.	**Slope Movement Hazards and Risks**—Colluvium is associated with slope processes.	**Pleistocene Ice Ages**—**Qcsl** formation accelerated during glaciations.
	Rahway Till (Qr) Rahway Till, yellow phase (Qry) Rahway Till, terminal moraine (Qtmr) Rahway Till, less than 10 feet thick over bedrock (Qrt)	Glacial till generally consists of unsorted mixtures of directly deposited glacial sediments. **Qr** consists of reddish- to yellowish-brown silty sand to clayey sandy silt and locally clayey silt with pebbles, cobbles, and (rarely) boulders. All larger clasts are somewhat rounded, with compositions ranging from red and gray sandstone and siltstone, gray gneiss, and white quartz to purple conglomerate, quartzite, and basalt. Matrix between clasts is generally compact with sticky (clay-rich) areas. Lenses and blocks of deformed laminated silt, clay, and sand also occur locally. **Qr** is up to 33 m (110 ft) thick, but **Qrt** denotes areas where **Qr** is present in thin (less than 3-m- [10-ft-] thick) deposits over bedrock. **Qry** is glacial till as in **Qr**, but the dominant color is yellowish brown and the matrix is mostly sandy clayey silt. **Qry** is about 12 m (40 ft) thick. **Qtmr** has the same composition as **Qr** and marks the greatest extent of that particular glacial advance.	**Glacial Features**—**Qtmr** formed as the glacier dumped till at its terminus before retreating up the valley. Deformed lenses and blocks of layered deposits represent glacial erosion of glaciolacustrine deposits.	None reported.	**Pleistocene Ice Ages**—**Qtmr** formed during the maximum extent of an ice lobe, followed by glacial retreat. **Qr** formed atop previous glaciolacustrine deposits in repeated glaciations.
	Netcong Till (Qn) Netcong Till, terminal moraine (Qtmn)	Glacial till generally consists of unsorted mixtures of directly deposited glacial sediments. **Qn** is yellowish-brown to brown to grayish-brown silty sand to sandy silt, with many pebbles and cobbles and sparse boulders. Fine-grained matrix around larger clasts is generally compact, with some subhorizontal fissility (tendency to break into shards). Deposits of **Qn** may reach 24 m (80 ft) thick. **Qtmn** has the same composition as **Qn** and marks the greatest extent of that particular glacial advance.	**Glacial Features**—**Qn** and **Qtmn** formed as local glaciers melted, leaving their assorted sediments in an unsorted deposit.		**Pleistocene Ice Ages**—**Qtmn** formed during the maximum extent of an ice lobe, followed by glacial retreat.
	Beach deposits, Moggy Hollow stage (Qpmb)	**Qpmb** consists of pebble gravel, pebbly sand, and silt in reddish-brown, weakly layered deposits. Most pebbles are red and gray shale, basalt, quartzite, sandstone, and gneiss. **Qpmb** is up to 3 m (10 ft) thick.	**Glacial Features**—**Qpmb** includes scant ice-rafted glacial erratics.		**Pleistocene Ice Ages**—**Qpmb** formed as wave action eroded shale bedrock adjacent to the Lake Passaic shoreline during the Moggy Hollow stage.
	Deltaic deposits (Qpmd)	**Qpmd** contains fine to coarse sand and pebble to cobble gravel with some minor silt and very fine sand. Deposits are up to 21 m (70 ft) thick. **Qpmd** is mapped within park boundaries at the Washington's Headquarters unit.	**Glacial Features**—**Qpmd** formed as fluvial deltas deposited in Lake Passaic. Many areas of **Qpmd** formed along the front of the terminal moraine during glacial retreat. **Paleontological Resources**—This unit may contain Pleistocene fossils.		**Pleistocene Ice Ages**—**Qpmd** formed in Lake Passaic during the Moggy Hollow stage.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Late Pleistocene)	Lacustrine fan deposits (Qpmf)	**Qpmf** consists of fine to coarse sand and pebble to cobble gravel with minor silt and very fine sand. **Qpmf** is up to 24 m (80 ft) thick.	None reported.	None reported.	**Pleistocene Ice Ages**—**Qpmf** formed in Lake Passaic during the Moggy Hollow stage.
	Plainfield glaciofluvial deposit (Qpf)	**Qpf** contains pebble to cobble gravel and fine to coarse sand in deposits up to 24 m (80 ft) thick.			**Pleistocene Ice Ages**—**Qcs** formation accelerated during glaciations.
	Deltaic and lacustrine fan deposits (Qpc)	**Qpc** consists of fine to coarse sand, pebble gravel, minor cobble gravel, silt, and clay deposits. **Qpc** is up to 36 m (120 ft) thick. Unit also contains some beach or spit gravel and a few ice-rafted glacial erratics.	**Glacial Features**—**Qpc** formed as deltas and lacustrine fans in Lake Passaic. Unit includes some ice-rafted erratics.		**Pleistocene Ice Ages**—**Qpc** was deposited in Lake Passaic during the Chatham stage; some lower reaches of the unit may have been deposited during the Great Notch stage.
	Late Wisconsinan glacial lake-bottom deposits (Qwlb) Late Wisconsinan glacial delta deposits (Qwde) Late Wisconsinan glaciofluvial terrace deposits (Qwft)	**Qwlb** includes a fluviodelta, lake bottom silt, sand, clay, and some alluvium. Deltaic deposits are at an altitude of 116 m (380 ft) and are about 46 m (150 ft) thick. **Qwde** consists of two ice-marginal deltas and one fluviodelta with glaciolacustrine fans and lake-bottom fine sand, silt, and minor clay. Unit is approximately 46 m (150 ft) thick. **Qwft** contains coarse gravel, sand and gravel, and pebbly sand in terraces perched above the Rockaway River Valley and local tributary valleys. Deposits are up to 15 m (50 ft) thick.	**Glacial Features**—**Qwlb** contains glaciofluvial deposits and glaciolacustrine deposits from Lake Whippany. The spillway from Lake Whippany (over deposits of **Qrpm**) into Lake Passaic was at 113 m (372 ft) elevation. **Qwde** contains glaciofluvial and glaciodeltaic deposits. The spillway from Lake Succasumma is over bedrock near Milltown.		**Pleistocene Ice Ages**—Lake Whippany was dammed by **Qrpm** of Lake Passaic (Moggy Hollow–stage deposits). When the ice margin had retreated to the Cedar Knolls area, Lake Whippany lowered to the level of the Moggy Hollow stage of Lake Passaic. **Qwde** formed in Lake Succasumma in preglacial, north-draining tributary valleys of the Rockaway River. **Qn** deposits overlay **Qwde** locally, indicating a temporal relationship. **Qwft** formed as fluvial terraces after the draining of lakes Dover and Denville. **Postglacial Modification of the Landscape and Modern Geomorphological Development**—Many local, north-flowing drainage basins filled with sediment and the drainages reversed to flow southward.
	Uncorrelated lacustrine deposits (Qsu)	**Qsu** deposits were not correlated with any specific glaciolacustrine event. Unit consists of fine to coarse sand and pebble to cobble gravel in deposits up to 6 m (20 ft) thick.	None reported.		**Pleistocene Ice Ages**—**Qsu** was deposited in Lake Passaic in uncorrelated stages.
	Meltwater terrace deposits (Qmt)	**Qmt** contains gravel, pebbles, and cobbles, with some fine to coarse sand in deposits up to 6 m (20 ft) thick.			**Pleistocene Ice Ages**—**Qmt** was deposited along meltwater streams during the last major glaciation.

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QUATERNARY (Middle to Late Pleistocene)	Shale colluvium (Qcs)	**Qcs** consists of reddish- to yellowish-brown, clayey to sandy silt with shale chips and scant sandstone cobbles. The unit is poorly sorted, compact, and has a firm consistency. It is up to 9 m (30 ft) thick. Some surfaces of **Qcs** include rock rubble.	None reported.	**Slope Movement Hazards and Risks**—Layers of **Qcs** have been subjected to creep or possibly solifluction. Colluvium is associated with slope processes.	**Pleistocene Ice Ages**—**Qcs** formation accelerated during glaciations.
	Gneiss colluvium (Qcg)	**Qcg** contains sandy silt, silty sand, sandy-clayey silt, and pebbles and cobbles of variably weathered gneiss. Pebbles of red shale and siltstone occur where the unit is adjacent to **Qws**. **Qcg** is up to 21 m (70 ft) thick. Outcrops are yellowish or reddish brown to brown and typically poorly sorted, with some layering. **Qcg** is mapped within park boundaries at the New Jersey Brigade and Jockey Hollow encampment area units.	**Periglacial Bedrock Weathering and Thermokarst Topography**—**Qcg** formation was likely accelerated during the periglacial climates of the Pleistocene Epoch. **Paleontological Resources**—This unit may (but is not likely to) contain Pleistocene fossils.	**Slope Movement Hazards and Risks**—Layers of **Qcg** have been subjected to creep or possibly solifluction. Colluvium is associated with slope processes.	**Pleistocene Ice Ages**—**Qcg** formed atop deposits left by the Illinoian glaciation.
	Basalt colluvium, blocky phase (Qcb) Basalt colluvium, silty phase (Qcbl)	**Qcb** contains reddish- to yellowish-brown to brown clayey silt, silty clay, and some minor sandy silt with subangular (not entirely rounded edges) pebbles to cobbles of basalt. Red shale and mudstone chips occur locally. Deposits of **Qcb** are up to 18 m (60 ft) thick. **Qcbl** contains reddish-yellow to brown to gray clayey silt to silty clay with minor sandy silt and scant basalt pebbles. **Qcbl** tends to occur as less than 3-m- (10-ft-) thick distal edges of **Qcb** deposits and is mapped only where more than 1 m (3 ft) thick.	**Periglacial Bedrock Weathering and Thermokarst Topography**—Weathered basalt clasts are common in some thicker deposits of **Qcb**, whereas unweathered basalt clasts dominate more surficial colluvium. These characteristics indicate periods of repeated deposition of colluvium during the extreme climates of glacial periods (as frost weathering was accelerated), and slope stability (outcrop weathering) during interglacial periods.	**Slope Movement Hazards and Risks**—Groundwater seepage may be responsible for some **Qcbl** deposition.	**Pleistocene Ice Ages**—**Qcb** contains deposits that were (1) originally glacial erratics from pre-Illinoian glacial till, (2) late Wisconsinan till, and (3) erratics deposited by icebergs on Lake Passaic.
	Weathered conglomerate (Qwc) Weathered gneiss (Qwg) Weathered gneiss, thin or absent (Qwgt) Weathered basalt (Qwb) Weathered basalt, thin or absent (Qwbt) Weathered shale (Qws) Weathered shale and sandstone, thin or absent and outcrop or shale-chip rubble abundant (Qwst)	**Qwc** contains unsorted, reddish-brown, fine to coarse sand and silty sand with abundant white to purple quartz and conglomerate pebbles and subangular (less rounded) red sandstone pebbles and cobbles. Layers of **Qwc** are up to 61 m (200 ft) thick. **Qwg** consists of yellowish-brown to reddish-yellow silty sand and mixtures of sand, clay and silt, with some subangular (not completely rounded) pebbles and cobbles of gneiss. Most clasts are highly weathered. Exposures of **Qwg** are up to 30 m (100 ft) thick; however, **Qwgt** is mapped where fractured, less-weathered outcrop appears in lieu of weathered material. **Qwb** appears reddish yellow to brownish to gray in outcrop exposures and contains mixtures of clay, silt, and sand, with some to many angular pebbles and cobbles of basalt. Locally, gabbro (very-low-silica basalt) clasts occur. Most clasts have distinct weathering rinds. Exposures of **Qwb** are up to 15 m (50 ft) thick; however, **Qwbt** is mapped where fractured, less-weathered outcrop appears in lieu of weathered material. **Qws** consists of reddish- to yellowish-brown mixtures of clay and silt with many shale chips or angular pebbles and cobbles of mudstone. **Qws** is up to 5 m (15 ft) thick; however, **Qwst** is mapped where fractured, less-weathered outcrop appears in lieu of weathered material. In areas where **Qws** is combined with quartzite and conglomerate saprolite and rock rubble, the thickness can reach 46 m (150 ft). **Qwg** is mapped within the park boundaries at the Fort Nonsense, New Jersey Brigade Encampment Area, and Jockey Hollow Encampment Area units. **Qwgt** is mapped in the New Jersey Brigade Encampment Area unit.	**Periglacial Bedrock Weathering and Thermokarst Topography**—**Qwc**, **Qwg**, **Qwgt**, **Qwb**, **Qwbt**, **Qws**, and **Qwst** weather unevenly to produce thick layers of saprolite or unconsolidated, but compact, material as a mixture of clays and weathered clasts of different grain sizes. Some units contain up to 60% weathered, but distinct, pebbles and/or cobbles. These units vary based on the source or parent material's composition (fractured bedrock in most cases). As the rocks weather in situ, the original bedrock fabrics or structures are preserved in the saprolite. **Paleontological Resources**—This unit may (but is not likely to) contain Pleistocene fossils.	**Slope Movement Hazards and Risks**—Thick, weathered deposits (saprolite) may be prone to fail on slopes, particularly when water saturated. **Qbw** may be present as weathered rock rubble with boulders.	**Pleistocene Ice Ages**—These units formed during the long-standing, accelerated weathering climates of the Pleistocene.

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QUATERNARY (Middle Pleistocene)	Flanders Till (Qitf)	Glacial till generally consists of unsorted mixtures of directly deposited glacial sediments. **Qitf** is brown to yellowish-brown silty sand to sandy clayey silt, with many pebbles and cobbles and sparse boulders. Larger clasts are typically weathered gneiss, mudstone, sandstone, conglomerate, and quartzite. Fine-grained matrix around larger clasts is generally compact, with some subhorizontal fissility (tendency to break into shards). Deposits of **Qitf** are generally up to 12 m (40 ft) thick (up to 66 m [215 ft] thick in thickest till).	**Glacial Features**—**Qitf** formed as local glaciers melted, leaving their assorted sediments in an unsorted deposit. **Qitf** forms drumlins in the thickest deposits.	None reported.	**Pleistocene Ice Ages**—**Qitf** is locally truncated by **Qn** deposits and is part of the Jerseyan drift.
	Illinoian glaciolacustrine sand and gravel deposits (Qide)	**Qide** contains six ice-margin deltas (up to 46 m [150 ft] thick) and lake-bottom silt and fine sand (up to 24 m [80 ft] thick) from different glacial lake stages.	**Glacial Features**—**Qide** contains glaciofluvial deposits and glaciolacustrine deposits from Lake Shongum. The highest spillway from Lake Shongum was at 259 m (850 ft) elevation at the Rockaway River–Whippany River drainage divide.		**Pleistocene Ice Ages**—Lake Shongum was dammed by glacial ice, occupying the Mill Brook Valley and an adjacent valley to the east. **Qide** collected in the impounded basin. When the Illinoian ice margin retreated north of Rockaway, the lake drained.
	Illinoian terminal moraine deposits (Qimt)	**Qimt** likely resembles **Qide** or **Qitf** in composition, but no description is available.	None reported.		**Pleistocene Ice Ages**—**Qimt** formed during the maximum extent of an Illinoian ice lobe, followed by glacial retreat.
	Bergen Till (Qb)	Glacial till generally consists of unsorted mixtures of directly deposited glacial sediments. **Qb** is reddish-brown or yellow mixtures of sand and clay. Composition of **Qb** is similar to that of **Qr,** with a compact matrix and slightly sticky behavior when saturated with water. Larger clasts include weathered gneiss, sandstone, and mudstone. **Qb** is up to 15 m (50 ft) thick.	**Glacial Features**—**Qb** formed as local glaciers melted, leaving their assorted sediments in an unsorted deposit. **Qb** tends to be deposited immediately atop bedrock and not on other glacial deposits.		**Pleistocene Ice Ages**—**Qb** predates late Wisconsinan till.
NEOGENE–QUATERNARY (Late Pliocene to Early Pleistocene)	Deltaic and lacustrine fan deposits (Qps)	**Qps** consists of reddish-yellow to pale-brown, fine to coarse sand, pebbles, cobbles, and some fine sand, clay, and silt layers. Larger clasts are weathered gneiss, quartzite, basalt, sandstone, and siltstone. Many clasts are almost entirely altered to clay. Deposits of **Qps** are up to 30 m (100 ft) thick.	**Glacial Features**—**Qps** contains some ice-rafted erratics.		**Pleistocene Ice Ages**—**Qps** was deposited in the Chatham stage; lower reaches of the unit may have been deposited in the Great Notch stage.
	Lake bottom deposits (Qpsl)	**Qpsl** contains reddish-yellow to brown clay, silt, very fine to fine sand, and scant coarser sand in unsorted, but thinly bedded, exposures. **Qpsl** is up to 5 m (15 ft) thick.	**Glacial Features**—**Qpsl** collected in glaciolacustrine settings.		**Pleistocene Ice Ages**—**Qpsl** was deposited in an early glacial lake, perhaps prior to the Illinoian glaciation.

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NEOGENE–QUATERNARY (Late Pliocene to Early Pleistocene)	Pre-Illinoian till (Qpt)	Glacial till generally consists of unsorted mixtures of directly deposited glacial sediments. **Qpt** consists of reddish-brown to yellow clay, sand, and silt mixtures with some slightly rounded pebbles, cobbles, and scant boulders. Larger clasts include weathered red and gray mudstone, sandstone, basalt, purple quartzite conglomerate, gray quartzite, chert, quartz from **Tp**, and gneiss. **Qpt** is up to 15 m (50 ft) thick.	**Glacial Features**—**Qpt** formed as local glaciers melted, leaving their assorted sediments in an unsorted deposit.	None reported.	**Pleistocene Ice Ages**—**Qpt** predates the Illinoian glaciation.
NEOGENE (Late Pliocene)	Pensauken Formation (Tp)	**Tp** is reddish-yellow to brown, clay-rich, medium to coarse sand with some finer sand and pebbles. The sand is weathered feldspar; its weathered composition is almost entirely clay. Pebbles and gravel are primarily quartzite and dark-gray chert, with some weathered shale, sandstone, and gneiss. **Tp** is up to 3 m (10 ft) thick.	None reported.		**Continual Weathering and Erosion**—**Tp** formed as a weathering product of quartzofeldspathic bedrock.
	Large bedrock outcrop (r)	Bedrock outcrops occur throughout the area where glacial deposits have eroded away or were never deposited.	See Bedrock Geologic Map Unit Properties Table.		