Prepared in cooperation with the
U. S. GEOLOGICAL SURVEY
NATIONAL GEOLOGIC MAPPING PROGRAM

INTRODUCTION

The Brookville quadrangle is in the Pine Barrens region of the New Jersey Coastal Plain, in the southeastern part of the state. Geologic materials in the Brookville quadrangle include surficial deposits of late Miocene to Holocene age that overlie the Cohansey Formation, a marginal marine deposit of middle Miocene age. The surficial deposits include river, wetland, hillslope, and windblown sediments. The Cohansey Formation was deposited in coastal settings between about 13 and 10 million years ago (Ma), when sea level was more than 200 feet higher than at present in this region. As sea level lowered after 10 Ma, rivers flowing on the emerging Coastal Plain deposited the Beacon Hill Gravel, forming a broad regional river plain. As sea level continued to lower, the regional river system shifted to the west of the Pine Barrens region, and local streams began to erode into the Beacon Hill plain. During the latest Miocene, Pliocene, and Pleistocene Epochs (about 8 Ma to 20,000 years ago), stream and hillslope sediments were deposited in several stages as valleys were progressively deepened by stream incision, and widened by seepage erosion, in step with lowering sea level.

A brief summary of depositional settings of the Cohansey Formation, and of the geomorphic history of the quadrangle, as recorded by surficial deposits and landforms, is provided in the two following sections. The age of the deposits and episodes of valley erosion are shown on the correlation chart. Lithologic logs for three test borings drilled for this study (numbers E200905910, E200905911, and E200905912) are provided in table 1.

This map shows materials to a depth of 250-300 feet, which includes the Cohansey Formation and, in the western part of the quadrangle, the uppermost part of the Kirkwood Formation. Three test holes in the quadrangle (wells 32-49, 32-8457, and 33-43) penetrated below the Kirkwood, to total depths of 1741, 3340, and 1759 feet, respectively. A lithologic log for test hole 32-49 (Transcontinental Gas Pipeline Corporation well 17) is in Johnson (1961), formation assignments for test hole 33-43 (Transcontinental Gas Pipeline Corporation well 18) are in Kasabach and Scudder (1961), and an electric log for well 33-43 (U. S. Geological Survey well number 29-372) is in Zapecza (1989). Formations below the Kirkwood are shown on sections and described in Owens and others (1998). They are not shown or discussed on this map.

COHANSEY FORMATION

The Cohansey Formation has been interpreted as either 1) a deltaic deposit with inner-shelf sand at its base, passing upward into interbedded delta-front sand and clay, in turn overlain by fluvial sand and gravel and alluvial clay (Markiewicz, 1969; Rhodehamel, 1973; Newell and others, 2000), or 2) two or three stacked sequences composed of beach and shoreface sand overlain by tidal-flat sand and clay (Carter, 1972, 1978). Newell and others (2000) mapped inner-shelf and overlying delta-front facies in the Brookville quadrangle, implying a single transgression of sea level. Carter (1972) indicated two or three stacked transgressive sequences in the map area. Pollen and dinoflagellates recovered from peat beds in the Cohansey at Legler, about 20 miles north of Brookville, indicate a coastal swamp-tidal marsh environment (Rachele, 1976). The Legler pollen (Greller and Rachele, 1983), pollen recovered from a corehole near Mays Landing, New Jersey (Owens and others, 1988), and dinocysts recovered from coreholes in Cape May County, New Jersey (de Verteuil, 1997; Miller and others, 2001) indicate a late middle to early late Miocene age for the Cohansey.

In the Brookville quadrangle, clays in the Cohansey are in thin beds or laminas generally less than six inches thick, and are always interbedded with sand. Most are oxidized and multicolored but brown organic clay and peat was penetrated in several hand-auger holes in the Oyster Creek headwaters and in boring E200905911 at depths of 57-59 feet and 80-83 feet (table 1). Clayey strata are generally less than 25 feet thick, and some are continuous for more than 8 to 10 miles both downdip (northwest to southeast) and along strike (northeast to southwest). The laminated bedding and thin but areally extensive geometry indicate bay or estuarine intertidal settings. Alluvial clays generally are thicker and more restricted areally because they are deposited in flood plains and abandoned river channels. Clayey strata occur throughout the entire thickness of the Cohansey in the Brookville quadrangle, and there is no upsection transition to coarser fluvial sediments. The contact of the Cohansey and the Beacon Hill Gravel is not exposed but clayey strata in the Cohansey are within 25 stratigraphic feet of the base of the Beacon Hill (section AA'), so the transition from intertidal deposition in the Cohansey to fluvial deposition in the Beacon Hill is abrupt and possibly unconformable. Similar relationships are observed in the adjacent Woodmansie quadrangle (Stanford, 2010). These observations favor the stacked beach-tidal flat model of Carter (1972) for the Cohansey in this area, and imply that the Cohansey was deposited during several rises and falls of sea level.

SURFICIAL DEPOSITS AND GEOMORPHIC HISTORY

Sea level in the New Jersey region began a long-term decline following deposition of the Cohansey Formation. As sea level lowered, the inner continental shelf emerged as a coastal plain. River drainage was established on this plain. The Beacon Hill Gravel, which caps the highest elevations in the quadrangle, on the Cedar Creek-Oswego River divide (fig. 1), is the earliest record of this drainage. It is a deeply weathered quartz-chert gravel preserved in

were likely also laid down at this time. Modern floodplain (unit Qal) and wetland (unit Qals) deposits were laid down within the past 10 ka, based on basal radiocarbon dates on peat in other alluvial wetlands in the Pine Barrens (Buell, 1970; Florer, 1972; Stanford, 2000).

Landforms and hydrologic observations indicate that groundwater seepage is an important geomorphic agent in the Brookville quadrangle, and in the Pine Barrens in general. Seepage occurs along the base of escarpments in the Cedar Creek, Forked River, and Oyster Creek basins (fig. 1). This seepage is from groundwater moving laterally atop a clay bed in the Cohansey Formation, which is continuous in the Cedar Creek and Forked River basins. In the Oyster Creek basin this clay thins and pinches out in places, and seepage is not as strongly developed as it is to the north, but a lower clay crops out near the valley floor (section CC'), creating a second seepage scarp (fig. 1). Groundwater intercepted by and moved eastward atop these clays, combined with the deeper incision of east-flowing streams owing to the much shorter distance they travel to the ocean, has led to groundwater diversion from the Oswego River basin into the east-draining basins, and westward migration of the surface divide (fig. 1). Oyster Creek and the South Branch of the Forked River are the most deeply incised, and collect seepage from two clay beds, and so divert groundwater southward from the North Branch Forked River basin and northward from the Fourmile Branch of Mill Creek basin, causing the surface divide to migrate northward and southward, respectively.

These geomorphic observations are supported by base-flow measurements. Base flow, calculated from continuous and low-flow partial streamflow records collected for periods of 20 to 60 years and expressed as basin-wide recharge (in inches over the drainage area, fig. 2) is 48 inches in the Oyster Creek basin, 40 inches in the South Branch Forked River basin, 25 inches in the Mill Creek basin, 22 inches in the Cedar Creek basin, 17 inches in the Fourmile Branch basin, and 14 inches in the Oswego River basin (Gordon, 2004). These volumes indicate significant groundwater diversion from the Fourmile Branch and North Branch Forked River basins into the Oyster Creek and South Branch Forked River basins, and some diversion from the Oswego River basin into the Mill Creek and Cedar Creek basins, in agreement with observed seepage features and divide asymmetry. Further geomorphic evidence of divide migration is an abandoned valley on the Mill Creek-Dry Branch divide (shown by green arrow on fig. 1) marking the capture by Mill Creek of a former Oswego River tributary during the middle or late Pleistocene.

Cold climate at glacial maximums in the middle and late Pleistocene produced permafrost in the Pine Barrens region (Wolfe, 1953; French and others, 2003). During thaws, permafrost at depth acted as an impermeable layer and supported the water table at a higher elevation than in temperate climate. Seepage features, including inactive scarps and amphitheater-shaped hollows, were developed at sites that are dry today. These are indicated by special symbols on the map. Other permafrost-related features include thermokarst basins and cryoturbation structures. Thermokarst basins are shallow depressions that form when subsurface ice lenses melt (Wolfe, 1953). These basins (shown by a pattern on the map) typically form in sandy deposits in lowlands where the water table is shallow, or, more rarely, in upland settings where a perched water table forms atop shallow clay layers. A very few basins, for example, those bordering eolian deposits in the Chamberlain Branch valley, were probably formed or enlarged by wind erosion (French and Demitroff, 2001). Cryoturbation structures are folds and involutions in the upper several feet of surface materials. These structures formed by density flow of waterlogged sediment during melting of permafrost (French and others, 2005).

DESCRIPTION OF MAP UNITS

ARTIFICIAL FILL—Sand, pebble gravel, minor clay and peat; gray, brown, very pale brown, white. In places includes minor amounts of man-made materials such as concrete, asphalt, brick, cinders, and glass. Unstratified to poorly stratified. As much as 15 feet thick. In road and railroad embankments, dams, dikes around cranberry bogs, and filled low ground.

aft TRASH FILL—Trash mixed and covered with silt, clay, sand, and minor gravel. As much as 50 feet thick.

Qal ALLUVIUM—Fine-to-medium sand and pebble gravel, minor coarse sand; light gray, yellowish-brown, brown, dark brown. As much as 5 feet thick. Overlain and interbedded in places with peat and gyttja (colloidal organic material) less than 2 feet thick. Sand and gravel consist chiefly of quartz. In seasonally wet channels and floodplains.

Qals WETLAND AND ALLUVIAL DEPOSITS—Fine-to-medium sand and pebble gravel, minor coarse sand; light gray, yellowish-brown, brown, dark brown; overlain by brown to black peat and gyttja. Peat is as much as 8 feet thick. Sand and gravel consist chiefly of quartz and are generally less than 3 feet thick. Sand and gravel are stream-channel deposits; peat and gyttja form from the vertical accumulation and decomposition of plant debris in swamps and marshes. In alluvial wetlands on modern valley bottoms.

Qald DRY-VALLEY ALLUVIUM—Fine-to-medium sand and pebble gravel, minor coarse sand; very pale brown, white, brown, dark brown, light gray. As much as 5 feet thick. Sand and gravel consist chiefly of quartz. In dry valley bottoms forming headwater reaches of streams. These valleys lack channels or other signs of surface-water flow. They may have formed under cold-climate conditions when permafrost impeded infiltration, increasing surface runoff. The deposits are therefore largely relict.

Qe EOLIAN DEPOSITS—Fine-to-medium quartz sand; very pale brown, white. As much as 15 feet thick. Form small dunefields in the Chamberlain Branch and Oyster Creek valleys where sand of the Cohansey Formation or upper terrace deposits was exposed to wind erosion.

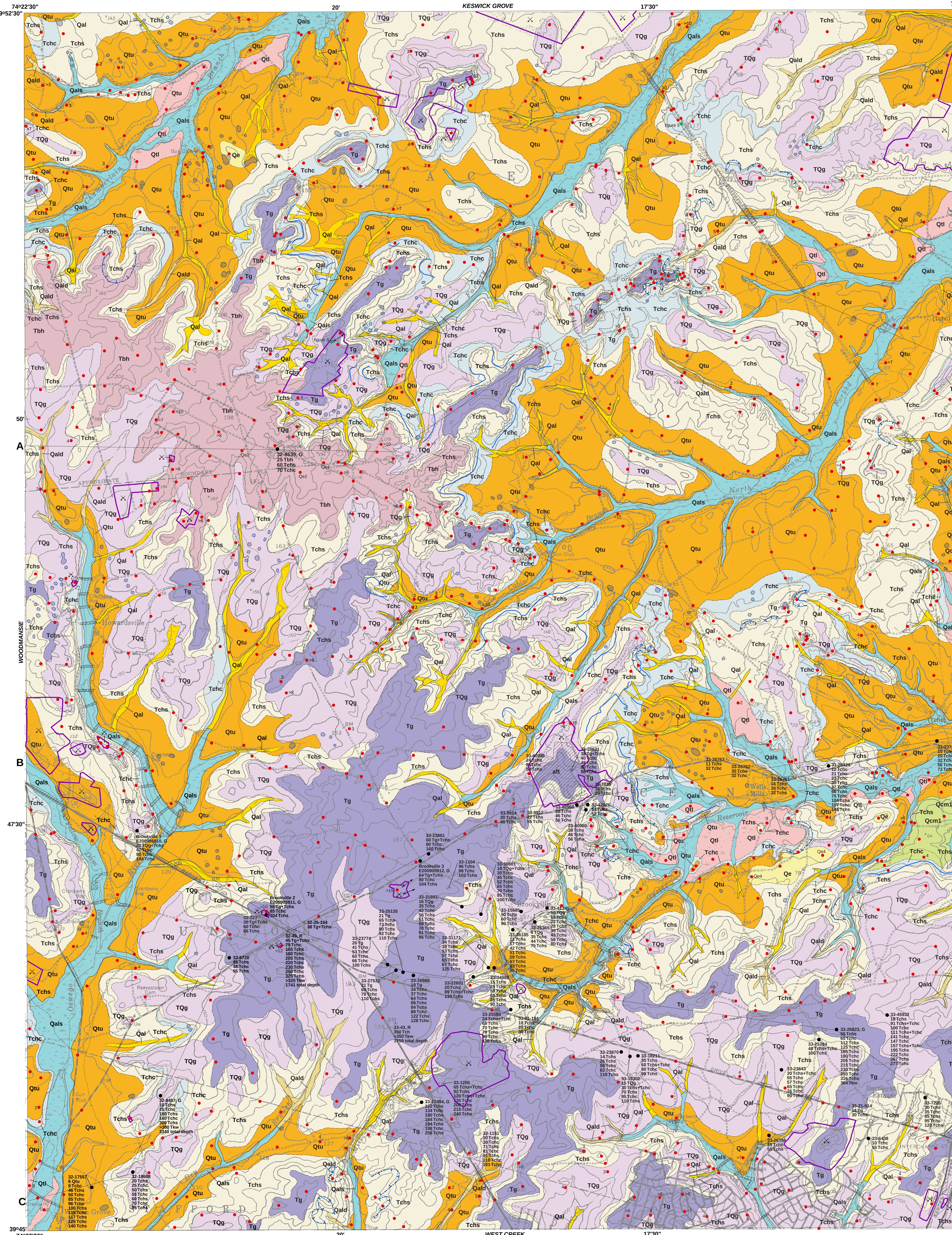
Qtl LOWER TERRACE DEPOSITS—Fine-to-medium sand, pebble gravel, minor coarse sand; light gray, brown, dark brown. As much as 10 feet thick. Sand and gravel consist chiefly of quartz. Form terraces and pediments in valley bottoms with surfaces 2 to 5 feet above modern wetlands. Include both stratified stream-channel deposits and unstratified pebble concentrates formed by seepage erosion of older surficial deposits. Sand includes gyttja in places, and peat less than 2 feet thick overlies the sand and gravel in places. The gyttja and peat are younger than the sand and gravel and accumulate because of poor drainage. Gravel is more abundant in Lower Terrace Deposits than in Upper Terrace Deposits due to winnowing of sand from the upper terraces by seepage erosion.

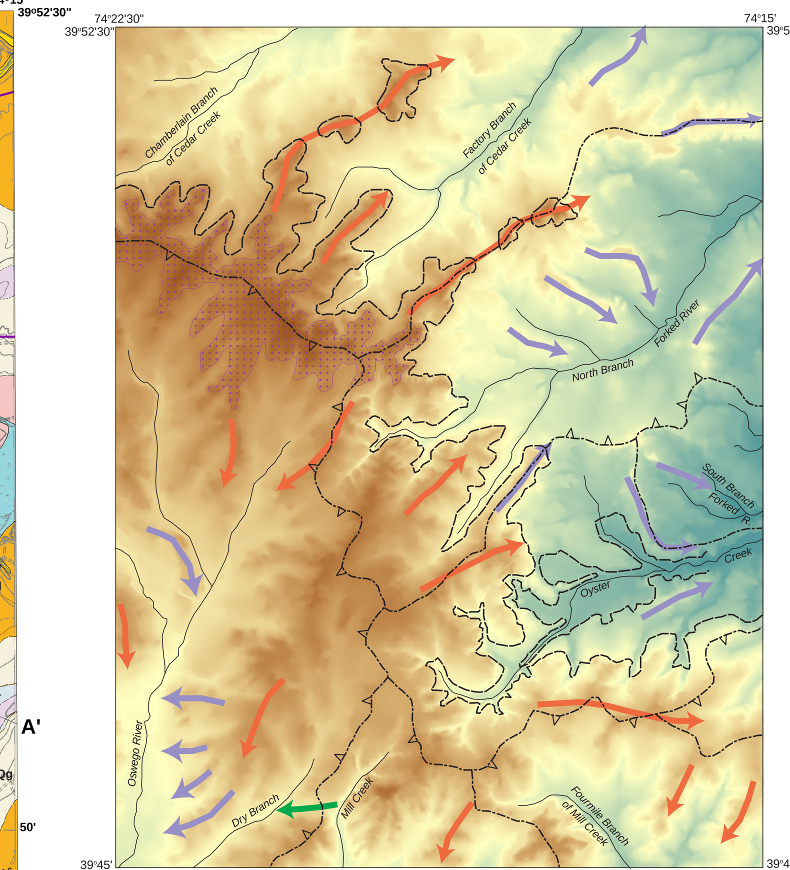
Qtu UPPER TERRACE DEPOSITS—Fine-to-medium sand, pebble gravel, minor coarse sand; very pale brown, brownish-yellow, yellow. As much as 20 feet thick, generally less than 10 feet thick. Sand and gravel consist chiefly of quartz. Form terraces and pediments with surfaces 5 to 25 feet above modern wetlands. Include stratified stream-channel deposits and poorly stratified to unstratified deposits laid down by groundwater seepage on pediments.

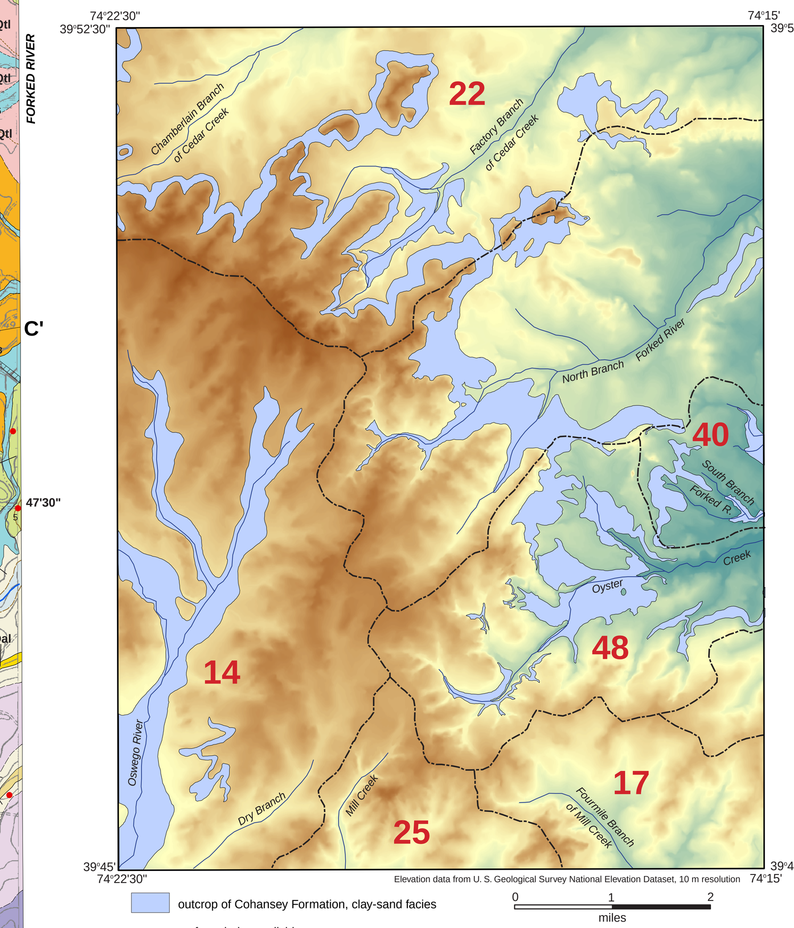
Qcm1 CAPE MAY FORMATION, UNIT 1—Fine-to-medium sand, pebble gravel; yellowish-brown, yellow, very pale brown. As much as 20 feet thick. Forms terraces with surfaces up to 65 feet in elevation in the Forked River and Oyster Creek valleys. These are the inland edge of a marine terrace formed during a middle Pleistocene sea-level highstand.

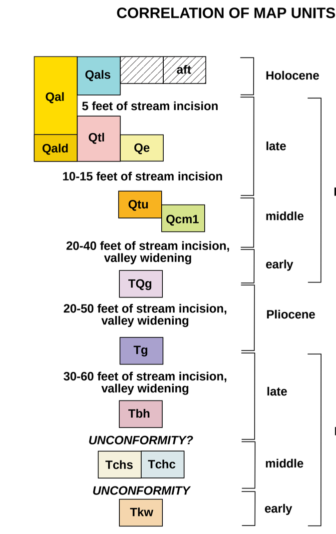
TQg UPLAND GRAVEL, LOWER PHASE—Fine-to-medium sand, slightly clayey in places, and pebble gravel; minor coarse sand; yellow, very pale brown, reddish-yellow. Sand and gravel consist chiefly of quartz with a trace (<1%) of white weathered chert in the coarse sand-to-fine pebble gravel fraction. Clay-size material is chiefly from weathering of chert. As much as 10 feet thick, generally less than 5 feet thick. Occurs as erosional remnants on lower interfluves and hilltops, and as more continuous deposits in headwater valleys, between 70 and 170 feet in elevation. Includes stratified stream-channel deposits, poorly stratified deposits laid down by groundwater seepage on pediments, and pebble concentrates formed by winnowing of sand from older surficial deposits and the Cohansey Formation by groundwater sapping or surface runoff.

Tg UPLAND GRAVEL, HIGH PHASE—Fine-to-medium sand, some coarse sand, clayey in places, and pebble gravel; yellow, brownish-yellow, reddish-yellow, very pale brown. Sand and gravel consist chiefly of quartz, and as much as 5 percent chert, and traces of weathered feldspar, in the coarse sand-to-fine pebble gravel fraction. Most chert is weathered to white and yellow clay-size material, some chert pebbles are gray to dark gray and unweathered to partially weathered. Rarely, chert pebbles contain fossil molds of brachiopods, pelecypods, and corals of Paleozoic age. Clay-size material chiefly is from weathering of chert and feldspar. As much as 25 feet thick. Occurs as erosional remnants on interfluves and hilltops, and as more continuous deposits on uplands adjacent to the Beacon Hill Gravel, between 110 and 180 feet in elevation. Includes stratified and cross-bedded stream-channel deposits (fig. 3) and poorly stratified to unstratified pebble concentrates formed by washing of sand and clay from the Beacon Hill Gravel by groundwater sapping or surface runoff (upper material in fig. 4).









CORRELATION OF MAP UNITS

GEOLOGY OF THE BROOKVILLE QUADRANGLE OCEAN COUNTY, NEW JERSEY

by
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2011