INTRODUCTION

SURFICIAL DEPOSITS AND GEOMORPHIC HISTORY

A long-term decline in sea level after deposition of the Cohansey led to the emergence of a coastal plain on the inner continental shelf. The Beacon Hill Gravel, which caps the highest elevations in the Coastal Plain, is the earliest record of the river drainage that followed the emergence of a coastal plain. While not present in the Ship Bottom and Long Beach NE Quadrangles, the Beacon Hill Gravel occurs to the west of the map area at elevations above 165 to 180 feet in western Ocean and eastern Burlington counties. Chert pebbles in the Beacon Hill containing fossils, including coral, brachiopods, and pelecypods, indicate that some of these rivers drained from Devonian rocks north of the Kittatinny and Shawangunk Mountains. Continued sea level decline in the late Miocene to early Pliocene and incision of the Beacon Hill led to the development of an upland from which local streams drained eastward into the Atlantic Ocean. These local streams reworked the Beacon Hill and, along with groundwater seepage, slope erosion, and channel erosion, deposited the reworked sand and gravel in channels, floodplains, and pediments. These deposits are mapped as Upland Gravel, High Phase (Tg). Due to topographic inversion, these deposits now cap the ridgetops in the northwestern part of the Ship Bottom Quadrangle at elevations between 110 and 130 feet. Lowering sea level in the late Pliocene to early Pleistocene led to more reworking of the Upland Gravel, High Phase. The same mechanisms that deposited the Upland Gravel, High Phase then deposited the Upland Gravel, Low Phase (TQg) in shallow valleys below the Upland Gravel, High Phase.

In the middle to late Pleistocene, there were at least two times when sea level was higher than its current level in the map area. During these periods, beach and estuarine sediments were deposited, forming terraces inland of the present bayshore. These deposits comprise the Cape May Formation and are divided into two units—the older Cape May 1 (Qcm1), with a maximum elevation of 70 feet, and the younger Cape May 2 (Qcm2), with a maximum elevation of 35 feet. Proceeding further eastward is the Cape May 2 platform deposit (Qcm2p), which slopes seaward and is onlapped along the bayshore by modern marsh deposits. Below the Cape May 2 platform deposit are the Cape May 2, fine-grained clay, silt and sand deposits (Qcm2f). These deposits are only present in the subsurface (sections AA' and BB'). Amino-acid racemization ratios (AAR), optically stimulated luminescence ages, and radiocarbon dates from the Delaware Bay area (Newell and others, 1995; Lacovara, 1997; O'Neal and others, 2000; O'Neal and Dunn, 2003; Sugarman and others, 2007) suggest that the Cape May 1 is of middle Pleistocene age (possibly marine-isotope stage [MIS] 11, 420 ka (thousand years), or MIS 9, 330 ka and that the Cape May 2 is of Sangamonian age (MIS 5, 125-80 ka). AAR data from vibracores off Long Beach Island, about 5 miles offshore of Harvey Cedars, indicate that the Cape May 2 correlate there is of Sangamonian age (Uptegrove and others, 2012).

During periods of cold climate in the middle and late Pleistocene, primarily because of permafrost, streams deposited sand and gravel in valleys and lowlands. These deposits now form terraces and fans on the Cape May platform. Permafrost inhibited the infiltration of rainfall and snowmelt, and the resulting increased groundwater seepage and slope erosion caused sediment deposition in valleys. The sediments today form the upper and lower terrace deposits (Qtu, Qtl). Only one small area of upper terrace is within the map area, on the northwest edge. Regionally the upper terraces are 5 to 30 feet above modern floodplains and grade to, or are onlapped by, the Cape May 2 marine terrace. This relationship indicates that the upper terrace deposits are of Cape May 2 or somewhat earlier age. Lower terrace deposits are more extensive in the map area and form fans that spread out from the mouths of valleys cut into the upland west of Route 9 onto the Cape May 2 platform. In well number 133, organic silt under 21 feet of sand and gravel fan deposits yielded a radiocarbon date of 34,890±960 years before present (GX-16789-AMS, Newell and others, 1995, calibrating to 41.7-37.5 cal ka, 95% certainty), indicating deposition of the fan after 37 cal ka, most likely during the late Wisconsinan glacial period. Radiocarbon dates from lower terrace deposits elsewhere in the New Jersey Coastal Plain also indicate deposition during the late Wisconsinan.

As permafrost melted at the end of the late Wisconsinan glacial period around 18 ka, forest regrew and hillslope erosion slowed. The volume of sand washing into valleys was greatly reduced, and streams could erode into the lower terraces. Incision and lateral erosion of the modern floodplain (Qals) were largely complete by the beginning of the Holocene at 11 ka, based on radiocarbon dates on basal peat in other alluvial wetlands in the region (Buell, 1970; Florer, 1972; Stanford, 2000).

Within the last 10 ka, sea-level rise led to the deposition of the most recent deposits in the map area. Extensive salt-marsh peat and muddy to sandy bay deposits (Qm) underlie the modern bayshore and bay. The inland limit of these deposits is well defined by the vegetation change from salt-marsh grasses and reeds to upland forest and shrub as visible on infrared imagery. They thicken seaward and are overlain by tidal-delta and barrier overwash sand (Qbo) beneath Long Beach Island. On the barrier island, the tidal-delta and barrier overwash sands are overlain by beach and dune sands (Qbs, Qbe). Residential development on the bayshore and barrier island created large areas of filled marshland. This fill consists largely of dredged sand and mud from unit Qm and, on Long Beach Island, from grading of units Qbo and Qbe. Sand and mud dredged from navigation channels is also disposed in diked impoundments on islands and along the bayshore (afd). The extent of fill on the bay side of Long Beach Island, and on the western bayshore, is based in part on marsh limits and shorelines shown on 1:21,120 scale maps from the 1880s on file at the N. J. Geological and Water Survey, and on aerial photographs from 1930.

DESCRIPTION OF MAP UNITS

ARTIFICIAL FILL—Sand, pebble gravel, minor clay and organic matter; 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 20 feet thick. In road and railroad embankments; dams; filled wetlands and low ground; and infilled sand and clay pits. Small areas of fill in urban areas are not mapped.

afd DREDGE SPOIL—Sand, silt, minor clay, gravel, and organic matter; gray to brown. As much as 10 feet thick (estimated). In diked impoundments, from dredging of channels.

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

Qm SALT-MARSH AND ESTUARINE DEPOSITS-- Peat, clay, silt, fine sand; brown, dark-brown, gray, black; minor medium-to-coarse sand and pebble gravel. Contains abundant organic matter and shells. As much as 50 feet thick; deposits at the surface along the eastern bayshore are generally less than 5 feet thick and overlie the fine-grained and platform deposits of the Cape May Formation, Unit 2. Deposited in salt marshes, tidal flats and bays during Holocene sea level rise, chiefly within the past 10 ka in the map area.

Qald DRY-VALLEY ALLUVIUM—Fine-to-medium sand and pebble gravel, minor coarse sand; very pale brown, light gray. As much as 5 feet thick. Sand and gravel consist of quartz. Deposits are relict and lack channels or other signs of surface water flow.

Qtl LOWER TERRACE DEPOSITS—Fine-to-medium sand, pebble gravel, minor coarse sand; light gray, brown, dark brown. As much as 30 feet thick. Sand and gravel are quartz. Form fans on the Cape May 2 platform. Include both stratified stream-channel deposits and unstratified pebble concentrates formed by seepage erosion of older surficial deposits. Peat less than 2 feet thick overlies the sand and gravel in places. The peat is younger than the sand and gravel and accumulates due to poor drainage. In places, gravel is more abundant in lower terrace deposits than in upper terrace deposits.

Qtu UPPER TERRACE DEPOSITS—Fine-to-medium sand, pebble gravel, minor coarse sand; very pale brown, brownish-yellow, yellow. As much as 10 feet thick. Sand and gravel are quartz. Form terraces and pediments with surfaces 5 to 30 feet above modern wetlands and floodplains.

BEACH-BARRIER DEPOSITS—Sand and minor gravel deposited by waves (Qbs), wind (Qbe), and tidal and storm flows (Qbo), during the Holocene.

Qbs BEACH SAND—Fine-to-medium sand with few (1-5%) shells and shell fragments and minor (<1%) to few fine-to-medium quartz pebbles; very pale brown, white, light gray. Bedding is typically planar laminations that dip gently seaward. As much as 15 feet thick. Gravel is more common on mainland bay beaches than on ocean beaches or barrier bay beaches.

Qbe DUNE SAND—Fine-to-medium sand with a few coarse sand grains and shell fragments; white, light gray, very pale brown. As much as 30 feet thick.

Qbo OVERWASH AND TIDAL-DELTA SAND—Fine-to-medium sand, few shells and shell fragments, minor coarse sand and fine-to-medium pebble gravel, and a trace (<1%) of rip-up clasts of peat; light gray, very pale brown. Unstratified to laminated to trough- and planar-tabular cross bedded. As much as 60 feet thick.

CAPE MAY FORMATION—Beach, nearshore, and estuarine deposits of middle and late Pleistocene age. Includes marine-terrace sand and gravel (Qcm1, Qcm2), platform sand (Qcm2p), and bay and estuarine clay, silt, and fine sand (Qcm2f).

Qcm2 CAPE MAY FORMATION, UNIT 2—Fine-to-medium sand, pebble gravel, minor coarse sand; yellow, very pale brown, yellowish-brown. Sand and gravel are quartz. As much as 40 feet thick. Forms a terrace with a maximum surface elevation of 35 feet. Is distinguished from adjacent units by scarps visible on LiDAR imagery. Includes beach, dune, tidal flat, tidal channel, shoreface, and fluvial sediment.

Qcm2p CAPE MAY FORMATION, UNIT 2, PLATFORM DEPOSIT—Fine-to-medium sand, with pebbles in places, minor clayey sand to sandy clay; very pale brown, light gray, yellowish-brown. As much as 30 feet thick. In places, the platform deposit is overlain by discontinuous black to dark brown freshwater peat and organic silt of Holocene age, generally less than 3 feet thick, that accumulate from groundwater seepage. Forms a platform that gently slopes bayward from the foot of the Cape May 2 terrace and extends beneath Holocene salt-marsh and estuarine deposits to the inner shelf. Includes beach, shoreface, and minor fluvial deposits laid down during sea-level decline from the Cape May 2 highstand.

Qcm2f CAPE MAY FORMATION, UNIT 2, FINE-GRAINED DEPOSITS—Clay, silt, fine sand, minor organic matter; light gray to gray. As much as 30 feet thick. In subsurface only, inferred from well records (sections AA', BB'). Deposited in a bay during sea-level rise to the Cape May 2 highstand.

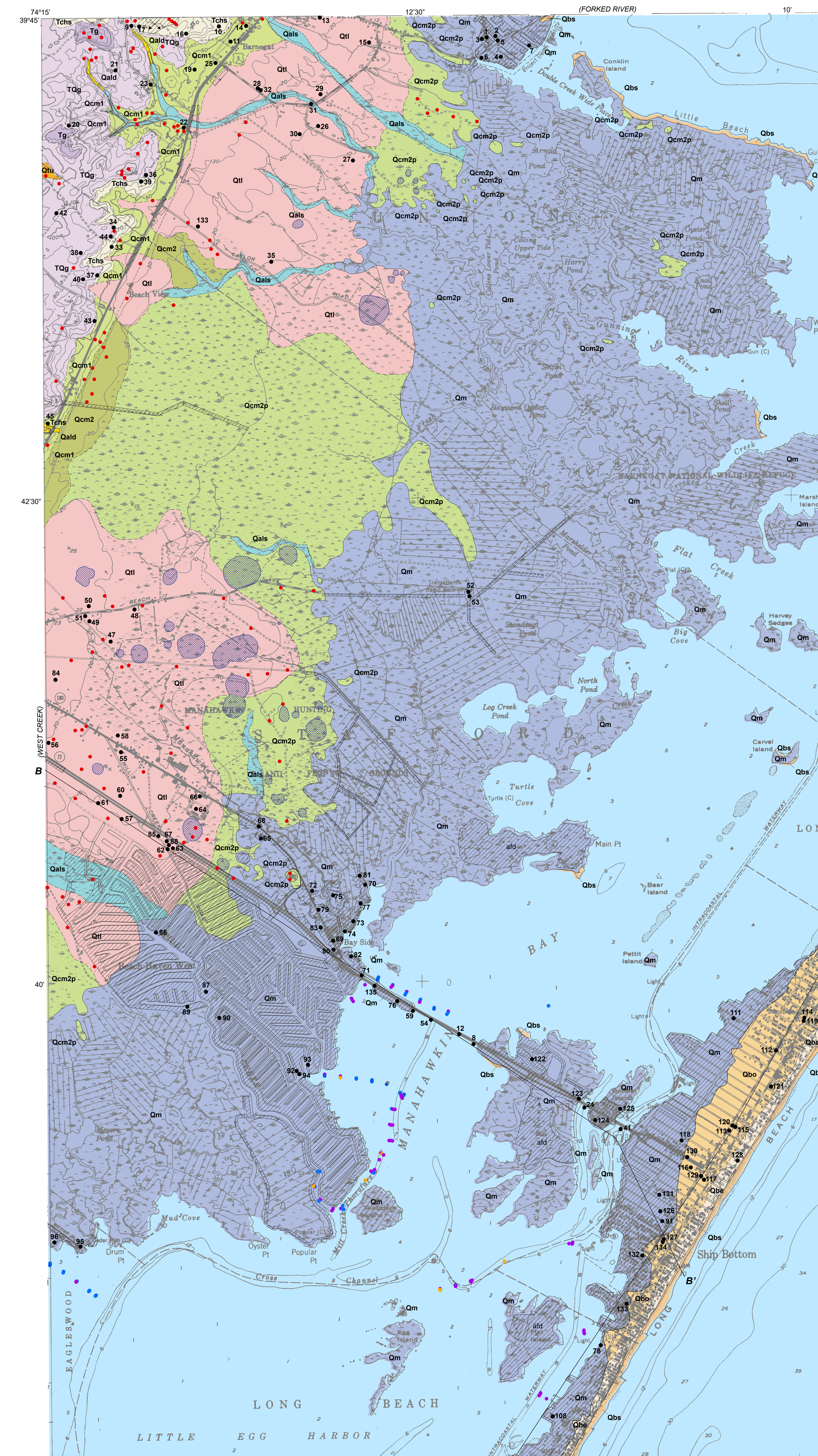
Qcm1 CAPE MAY FORMATION, UNIT 1—Fine-to-medium sand, pebble gravel, minor clayey sand, sandy clay, silty clay, and coarse sand; yellowish-brown, yellow, very pale brown, light gray. As much as 40 feet thick. Sand and gravel are quartz with minor weathered chert. Forms eroded terraces with a maximum surface elevation of 70 feet. Includes beach, dune, tidal flat, tidal channel, shoreface, and fluvial sediment.

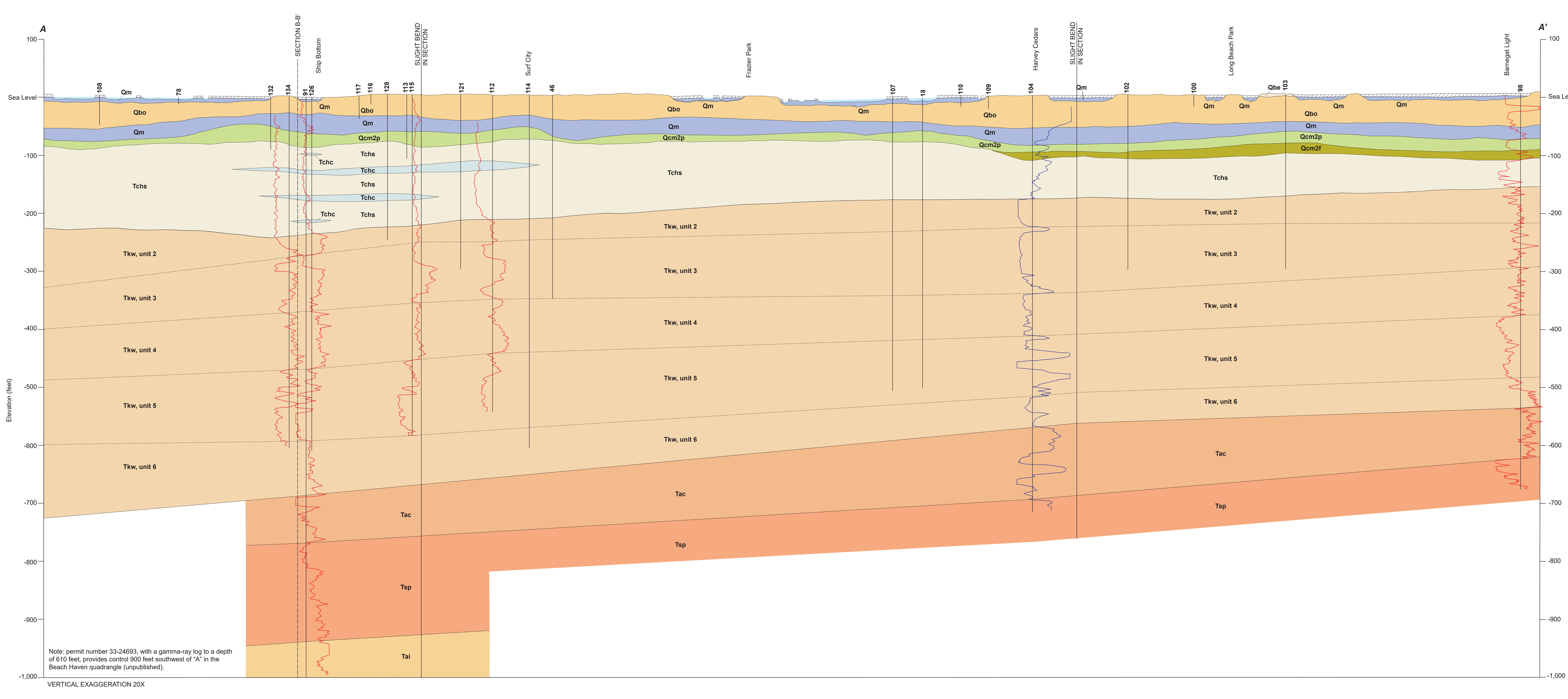
TQg UPLAND GRAVEL, LOWER PHASE—Fine-to-coarse sand, clayey in places, and pebble gravel; yellow, very pale brown, yellowish-brown. Clay sometimes forms a coating on sand grains. As much as 15 feet thick. Sand and gravel consist chiefly of quartz. Occurs as erosional remnants on hilltops between 70 and 110 feet in elevation.

Tg UPLAND GRAVEL, HIGH PHASE—Fine-to-coarse sand, clayey in places; pebble gravel; trace fine cobble gravel; yellow, yellowish-brown, reddish-yellow. Clay sometimes forms a coating on sand and pebble gravel. As much as 25 feet thick. Sand is primarily quartz with trace of weathered chert. Gravel is chiefly quartz. Occurs as erosional remnants on uplands above 100 feet in elevation.

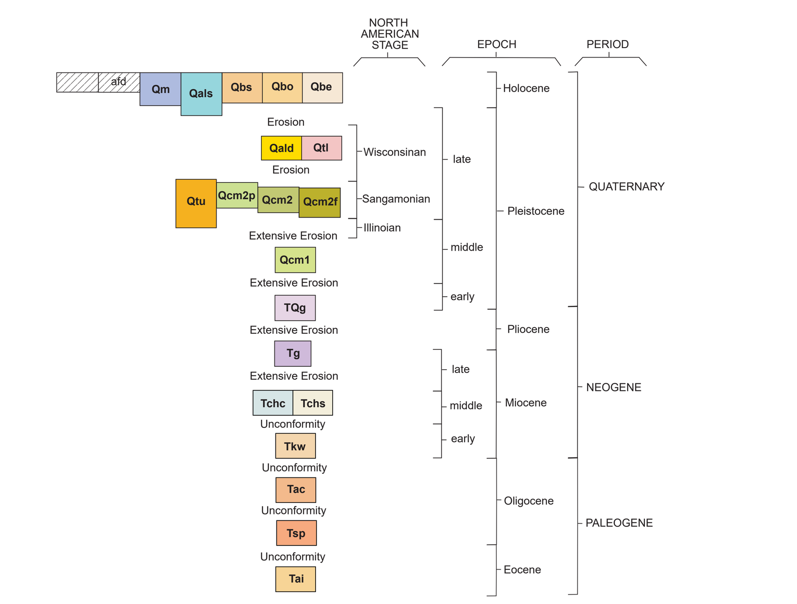
MAP SYMBOLS

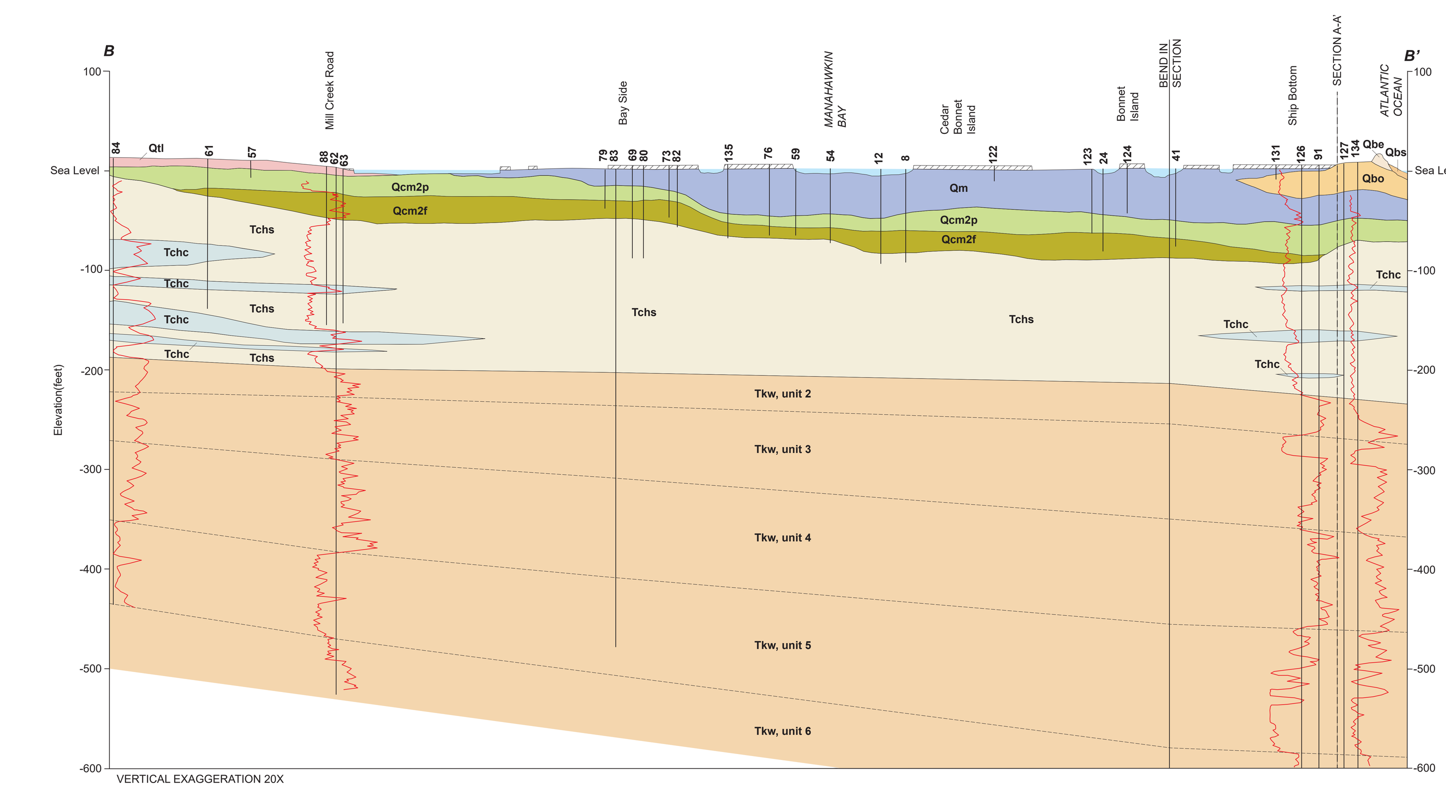
REFERENCES





CORRELATION OF MAP UNITS





GEOLOGY OF THE SHIP BOTTOM AND LONG BEACH NE QUADRANGLES OCEAN COUNTY, NEW JERSEY

By

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Geology of the Ship Bottom and Long Beach NE Quadrangles
Ocean County, New Jersey

New Jersey Geological and Water Survey
Open-File Map OFM 136
2021

Pamphlet with table 1 to accompany map

Table 1: Selected well and boring records. Bolded well numbers indicate well depicted on cross-section(s).

Well Number	Permit Number[1]	Formations Penetrated[2]
1	33-14423	30 Q+Tchs 70 Tchs 167 Tchc+Tchs+Tkw 180 Tkw
2	33-14490	22 Q 28 Tchs 34 Tchc 58 Tchs 90 Tchc 100 Tchs 179 Tchs+Tkw
3	33-17622	30 Q+Tchs 40 Tchs 50 Tchc 100 Tchs 140 Tkw
4	33-32039	48 Qm 69 Qcm2f 102 Tchs+Tchc 114 Tchs 190 Tkw
5	33-36779	16 Qm 34 Qcm2p 41 Qcm2f 70 Qcm2p 96 Tchs 200 Tchs+Tkw
6	33-38254	26 Qm 52 Tchs 123 Tchs+Tchc 142 Tchs 240 Tkw
7	33-44344	16 Qbo+Qm 43 Qcm2p 60 Qcm2f 69 Tchs 105 Tchc 240 Tkw
8	33-02356	section BB’ 11 Q 52 Tchs 63 Tchc 72 Tchs 81 Tchc 118 Tchs 193 Tkw
9	33-18499	35 Tchs
10	33-18587	5 Q 18 Tchs 35 Tchc 42 Tchs 51 Tchc 56 Tchs 63 Tchc 69 Tchs 72 Tchc 85 Tchs
11	33-18743	7 Q 16 Tchs 18 Tchc 34 Tchs 39 Tchc 43 Tchs 45 Tchc 49 Tchs 53 Tchc 63 Tchs
12	DOT W-10	section BB’ 55 Qm 95 Qcm2p 101 Tchs
13	33-33774	17 Q 42 Tchs 45 Tchs 56 Tchs 58 Tchc 72 Tchs 75 Tchc
14	33-36270	88 Tchs 94 Tchc 120 Tchs 145 Tkw
15	33-39725	7 Q 12 Tchs 13 Tchc 21 Tchs 24 Tchc 36 Tchs 51 Tchc 72 Tchs 15 Tchc 140 Tchs
16	33-40767	15 Q 20 Tchs 25 Tchc 80 Tchs
17	33-45065	25 Q 73 Tchs+Tchc 73 Tchc
18	53-128	section AA’ 11 Qbo+Qm 40 Qbo 55 Qm 120 Tchs 164 Tchs+Tchc 500 Tkw
19	33-43748	14 Q 50 Tchs 54 Tchc 63 Tchs
20	33-46169	25 Q 57 Tchs
21	33-46718	19 Tchs

22	33-07535	18 Q 50 Tchs
23	33-25689	23 Q 32 Tchs 35 Tchc 44 Tchs 52 Tchc 60 Tchs 66 Tchc 102 Tchs
24	DOT PB-4	section BB’ 55 Qm 80 Qcm2p
25	33-39343	18 Q 46 Tchs 50 Tchc 90 Tchs
26	33-19855	145 Tchs+Tchc+Tkw
27	33-21156, G	18 Q 22 Qcm2f 48 Qcm2p 62 Tchs 90 Tchs 118 Tchs 118 Tkw
28	33-22754	10 Q 60 Tchs
29	33-24404	6 Q 55 Tchs 107 Tchc 120 Tchs
30	33-31995	22 Q 30 Tchs 45 Tchc 85 Tchs 90 Tchc 110 Tchs 125 Tchc 160 Tchs+Tkw
31	33-32897	32 Q+Tchs+Tchc
32	33-46549	10 Q 85 Tchs 15 Tchc 160 Tchs
33	33-22600	60 Tchs+Tchc 75 Tchs
34	33-23559	15 Q+Tchs 28 Tchc 48 Tchs+Tchc 64 Tchs 70 Tchc 75 Tchs
35	33-23640	45 Q 80 Tchs
36	33-34229	15 Q 5 Tchs 66 Tchc 80 Tchs
37	33-34279	11 Q 21 Tchs 25 Tchc 42 Tchs 48 Tchc 59 Tchs 65 Tchc 85 Tchs
38	33-35251	17 Q 28 Tchs 41 Tchc 52 Tchs 56 Tchc 80 Tchs
39	33-35799	4 Q 60 Q+Tchs 65 Tchs 66 Tchc 80 Tchs
40	33-37790	11 Q 22 Tchs 29 Tchc 55 Tchs 62 Tchc 73 Tchs 83 Tchc 90 Tchs
41	DOT PB-5	section BB’ 55 Qm 75 Qcm2p
42	33-40085	18 Q+Tchs 20 Tchc 42 Tchs 60 Tchc 80 Tchs
43	33-43933	15 Q+Tchs 22 Tchc 45 Tchs 50 Tchc 80 Tchs
44	33-46113	3 Q 90 Tchs+Tchc 102 Tchc 155 Tchs 360 Tkw
45	33-40076	2 Q 60 Tchs 80 Tchc 120 Tchs
46	E201111657	section AA’ 43 Qbe+Qbo 62 Qm 200 Tchs 350 Tkw
47	33-25555	3 Qm 30 Qcm2p 50 Qcm2f 70 Tchs 90 Tchc 120 Tchs
48	33-27227	18 Q 24 Qcm2p 34 Qcm2f 40 Qcm2p 50 Qcm2f 70 Tchs
49	33-38946	23 Qcm2p 25 Qcm2f 65 Qcm2p 60 Qcm2f 105 Tchs
50	33-7847	35 Q 55 Qcm2 72 Qcm2f 100 Tchs
51	P200901329	2 Q 27 Qcm2p 36 Qcm2f 45 Qcm2p 52 Tchs
52	33-979, G	4 Q 36 Qcm2p 56 Qcm2f 84 Tchs 159 Tchs+Tchc 460 Tkw
53	33-13570	10 Q 32 Qcm2p 56 Qcm2f 97 Tchs 105 Tchs+Tchc 460 Tkw
54	DOT W-03	section BB’ 47 Qm 75 Qcm2p 82 Tchs
55	33-13265	35 Q 60 Tchs 90 Tchc 130 Tchs
56	33-19125	12 Q 38 Tchs+Tchc
57	33-29412	section BB’ 16.5 Qtl+Qcm2p

58	33-41061	19 Q 21 Qcm2f 50 Qcm2p 54 Qcm2f 135 Tchs
59	DOT RW-2	section BB’ 72 Qm
60	33-46382	5 Q 25 Qcm2p 47 Qcm2f 140 Tchs
61	P200801246	section BB’ 12 Qtl 25 Qcm2p 35 Qcm2f 47 Tchs 50 Tchc 110 Tchs 150 Tchc
62	33-10547, G	section BB’ 5 Qtl 25 Qcm2p 50 Qcm2f 110 Tchs 115 Tchc 145 Tchs 155 Tchc 160 Tchs 165 Tchc 195 Tchs 510 Tkw
63	33-1132	section BB’ 26 Q+Qcm2p 37 Qcm2p 46 Qcm2f 103 Tchs 109 Tchc 113 Tchs 115 Tchc 156 Tkw
64	33-13681	30 Q 60 Qcm2p 110 Qcm2f 150 Tchs
65	33-30735	5 Q 11 Qcm2p
66	33-41965	12 Q 30 Qcm2f 45 Qcm2p 100 Tchs
67	33-43846	12 Q 25 Qcm2p 35 Qcm2f 110 Tchs 140 Tkw
68	P200902675	9 Q 44 Qcm2f 56 Qcm2p 65 Qcm2f 80 Tchs
69	33-22443	section BB’ 35 Qm 40 Qcm2p 55 Qcm2f 90 Tchs
70	33-26940	12 Qm 18 Qcm2p 20 Qcm2f 75 Qcm2p+Tchs 94 Tchs
71	33-31957	17 Qm 27 Qcm2p 60 Qcm2f 62.5 Tchs
72	33-32488	9 Qm 16 Qcm2p 17 Qcm2f
73	33-32798	section BB’ 36 Qm 50 Qcm2p 54 Qcm2f 90 Tchs
74	33-33007	19 Qm 31 Qcm2p+Tchs 52 Tchc 90 Tchs 92 Tchs+Tchc
75	33-35659	20 Qm 36 Qcm2p 48 Qcm2f 80 Qcm2p+Tchs
76	DOT BH-3	section BB’ 58 Qm72 Qcm2p
77	33-36369	16 Qm 48 Qcm2p 60 Qcm2f
78	33-45284	section AA’ 12 Qm
79	33-39239	section BB’ 35 Qm
80	33-40082	section BB’ 19 Qm 36 Qcm2p 48 Qcm2f 65 Qcm2p 90 Tchs
81	33-40326	21 Qm 38 Qcm2p 56 Qcm2f 80 Tchs
82	33-41343	section BB’ 18 Qm 41 Qcm2p 50 Qcm2f
83	33-41864	section BB’ 18 Qm 36 Qcm2p 48 Qcm2f 180 Tchs 480 Tkw
84	33-41391, G	section BB’ 20 Qtl+Qcm2p 75 Tchs 105 Tchc 110 Tchsh 120 Tchc 135 Tchs 155 Tchc 160 Tchc 165 Tchs 175 Tchc 195 Tchs 505 Tkw
85	33-26436	40 Qtl+Qcm2p 60 Qcm2f 70 Tchs
86	E201413635	37 Qcm2p 54 Qcm2f 126 Tchs 250 Tkw
87	33-31681	10 Qm 55 Qcm2p 100 Tchs
88	33-45394	section BB’ 26 Qtl+Qcm2p 68 Qcm2f 90 Tchs 160 Tkw
89	P200903444	16 Qm 31 Qcm2p 56 Qcm2f 80 Qcm2+Tchs
90	P200904006	15 Qm 90 Qcm2+Tchs 120 Tchs
91	53-52, G	sections AA’, BB’ 5 Qm 35 Qbo 85 Qcm2p 90 Qcm2f 110 Tchs 115 Tchc 165 Tchs 175 Tchc 205 Tchs 210 Tchc 225 Tchc 600 Tkw

92	P200902428	16 Qm 33 Qcm2p 40 Qcm2f 61 Qcm2p 100 Tchs
93	P200905156	9 Qm
94	P200905794	23 Qm 46 Qcm2p 60 Qcm2f 193 Tchs+Tkw
95	33-38381	31 Qm+Qcm2p 48 Qcm2f 60 Qcm2p
96	33-43290	18 Qm 35 Qcm2p 60 Qcm2f 65 Tchs
97	33-6678, G	20 Qbo 40 Qm 63 Qcm2p 137 Tchs 540 Tkw 630 Tac 676 Tsp
98	33-7876, G	section AA’ 2 af+ Qm 5 Qbo 50 Qm 75 Qcm2p 95 Qcm2f 105 Tchs 150 Tkw 530 Tac 620 Tsp
99	P200802007	64 Qm 71 Qcm2p 118 Tchs 320 Tkw
100	33-22569	section AA’ 6 Qm 20 Qbo
101	E201514712	48 Qm 60 Qcm2p 124 Tchs 149 Tkw
102	E201610688	section AA’ 175 Q+Tchs 300 Tkw
103	P200902094	section AA’ 47 Qbo+Qm 62 Qm 110 Qcm2p+Tchs 154 Tchs+Tchc 182 Tchs 300 Tkw
104	33-674, R	section AA’ 75 Qbo+Qm 85 Qcm2p 100 Qcm2f 160 Tchs 560 Tkw 680 Tac 700 Tsp
105	33-1013	21 Qm 44 Qbo 54 Qm
106	33-1014	11 Qm 36 TQbo 40 Qm
107	33-1180	section AA’ 8 Qm 40 Qbo 60 Qm 160 Qcm2p+Tchs 200 Tchc 255 Tchs 508 Tkw
108	33-37844	section AA’ 4 af 51 Qm+Qbo
109	33-20904	section AA’ 20 Qbo
110	33-21218	section AA’ 8 af 20 Qm
111	P200802146	5 af 25 Qm 35 Qbo 50 Qm 110 Qcm2p 150 Tchs
112	33-1091, G	section AA’ 75 Qbo +Qm 90 Qcm2p117 Tchs 125 Tchc 215 Tchs
113	33-12431	section AA’ 42 Qbo 56 Qm 89 Qcm2p 102 Tchs 110 Tchs+Tchc
114	33-1268	section AA’ 34 Qbo 51 Qm 83 Qcm2p 88 Qcm2f 216 Tchs 607 Tkw
115	33-25686, G	section AA’ 75 Qbo +Qm 90 Qcm2p117 Tchs 125 Tchc 215 Tchs
116	33-30787	section AA’ 12 Qm 42 Qbo
117	33-35759	section AA’ 1 af 17 Qbo
118	33-38155	11 Qm
119	33-41645	30 Qbo 48 Qm 52 Qcm2p 183 Tchs+Tchc 570 Tkw
120	53-00003	42 Qbo 69 Qm 78 Qcm2p 186 Tchs 561 Tkw
121	E201603951	section AA’ 43 Qbo 62 Qm 100 Qcm2p+Tchs 206 Tchs 300 Tkw
122	33-28381	section BB’ 3 af 14 Qm
123	33-31951	section BB’ 45 Qm 62 Qcm2p
124	33-39236	section BB’ 33 Qm 42 Qcm2p
125	33-40483	40 Qm
126	33-1723, G	sections AA’, BB’ 4 af 5 Qm 30 Qbo 65 Qm 86 Qcm2p 146 Tchs 616 Tkw

127	33-219	section BB' 4 Qbo 50 Qm 60 Qcm2p 190 Tchs 200 Tchc 210 Tchs 605 Tkw
128	33-25840	section AA' 45 Qbo 71 Qm 135 Qcm2p+Tchs 233 Tchs 250 Tkw
129	33-28533	2 af 15 Qbo
130	33-29937	5 Qm 12 Qbo
131	33-31840	section BB' 2 Qm 10 Qbo
132	33-31852, G	section AA' 8 Qbo 25 Qm 55 Qcm2p 75 Qcm2f 90 Tchs
133	Ship Bottom 1 Newell and others (1995)	21 Qtl 53 Qcm2p 74 Tchs 96 Tkw
134	33-42213, G	sections AA', BB' 85 Qbo+Qm 98 Qcm2p 120 Tchs 125 Tchc 160 Tchs 165 Tchc 220 Tchs 605 Tkw
135	DOT BH-1	section BB' 53 Qm 64 Qcm2p 72 Tchs

Bolded well numbers indicate well depicted on cross-section(s).

1) Numbers of the form 33-xxxxx, 53-xxxxx, Pxxxxxxxxx, or Exxxxxxxxx are N. J. Department of Environmental Protection well-permit numbers. Identifiers prefixed by "DOT" are bridge borings from the N. J. Department of Transportation. A "G" following the identifier indicates that a gamma-ray log is available for the well, an "R" indicates that a resistivity log is available.

2) Number is depth (in feet below land surface) of base of unit indicated by abbreviation following the number. Final number is total depth of well rather than base of unit. For example, "88 Tchs 94 Tchc 120 Tchs 145 Tkw" indicates Tchs from 0 to 88 feet below land surface, Tchc from 88 to 94 feet, Tchs from 94 to 120 and Tkw from 120 to the bottom of the hole at 145 feet. Formation abbreviations and the corresponding drillers' descriptive terms used to infer the formation are: Q=yellow and white sand and gravel surficial deposits, undifferentiated west of the bayshore area (units TQg, Qtu, Qtl, Qals, Qcm1, Qcm2). Stacked surficial units along the bayshore and on the barrier beaches are differentiated as follows: Qcm2 (includes Qcm2 and Qcm2p), Qbe, Qbs=yellow, white, gray sand and gravel, Qm=peat, meadow mat, and gray to brown mud, Qcm2f=gray to brown clay, silt, fine sand. Bedrock formations are: Tchs=white, yellow, gray, brown (minor red, orange) fine, medium, and coarse sand (and minor fine gravel) of the Cohansey Formation, Sand Facies; Tchc=yellow, white, gray (minor red, orange) clay, silty clay, and sandy clay of the Cohansey Formation, Clay-Sand Facies; Tkw=gray and brown clay, silt and sand of the Kirkwood Formation. A "+" sign indicates that units are mixed or interbedded. For wells with gamma-ray or resistivity logs, units are shown on the cross section indicated.

Units are inferred from drillers' or geologists' lithologic descriptions on well records filed with the N. J. Department of Environmental Protection, or provided in the cited publications, or from geophysical well logs where lithologic descriptions are not available or are of poor quality. Units shown for wells may not match the map and sections due to variability in drillers' descriptions and the thin, discontinuous geometry of many clay beds. In many well logs, surficial deposits cannot be distinguished from Cohansey sands; thus, the uppermost Tchs unit in well logs generally includes overlying surficial deposits.