NEW JERSEY GEOLOGICAL SURVEY

5-6 wood

23-25 boulders (Qbn)

6-23 hard-packed gravel, weathered rock

25-43 weathered rock, hard-packed gravel

43-67 brown clay, tough (Qbnl or Qt)

0-26 sand and shells (af over Qm)

26-53 fine sand (Qm over Qbnl)

53-95 red clay (Qbnl)

95-98 gravel (Qt)

98-160 red sandstone

7-95 rock core

0-11 fill (af)

12-17 fine sand (af or Qm)

sand (Qbnl)

17-45 gray silt with some clay and fine

11-23 brown organic silt and peat (Qm)

23-34 green-gray silt, fine sand (Qm)

51-79 red-brown varved silt to fine sand

79-89 red-brown silt, some gravel (Qt)

89-90 shale bedrock

0-13 miscellaneous fill (af)

13-26 gray organic clay (Qm)

silt (Qbn)

3-17 gray clay, peat (Qm)

17-18 gray sand (Qm)

26-30 gray silty sand (Qm or Qbnl)

30-50 gray fine-to-medium sand, trace

50-52 red-brown silt, trace fine sand

(Qbn or Qbnl)

18-68 red sand and gravel (Qbnf)

0-8 red silt, trace gravel and rock

8-10 gray fine-to-medium sand (Qt)

fragments (Qt)

7-11 fine sand and clay (Qal)

Lovegreen, 5-12 gray organic silt, clay, meadow

95-120 shale

12-20 brown sand (Qal)

Lippincott, 8-42 dark-gray organic silty clay, trace

Gouda, 1995a 42-62 gray to grayish-red gravel, some

145-155 gravel (Qbnf)

170-174 decomposed rock

Lippincott, 13-23 dark-gray to black organic silt and clay

32-47 brown clayey silt (Qbnl)

silt (Qbnl)

Lippincott, 13-53 gray organic silty clay, trace fine sand

Gouda, 1995b 53-58 gray fine-to-medium sand, trace silt and

58-68 red clayey silt (Qbnl)

Lippincott, 8-21 red-brown sand, some clayey silt, a

Gouda, 1995b 21-22 red-brown rock fragments

Jacobs, and with plant roots (Qm)

Jacobs, and and shells (Qm)

at 89 refusal

Jacobs, and little fine gravel (Qbn)

Gouda, 1995a 23-32 dark-gray fine sand (Qm)

matrix (Qt)

11-13 medium sand and clay (Qal)

13-60 compact clay (Qhkl over Qbnl)

material, shells (Om)

20-95 reddish-brown varved clay and silt

shells, and fine sand (Qm)

62-103 grayish-red fine-to-medium sand, trace

116-145 grayish-red medium-to-fine sand, trace

155-170 cobbles and boulders with clayey sand

174-179 red sandstone and conglomerate

47-57 dark-brown fine-to-medium sand, little

57-87 dark reddish-brown silt to clayey silt,

trace fine sand (Qbnl)

at 98 refusal on rock

fine gravel (Qal or Qm)

68-89 red to grayish-red fine-to-medium sand,

some clay and silt (Qbnf)

87-98 brown cobbles and boulders (Qt)

silt (Qbn over Qbnl)

silt (Qbnl over Qbnf)

103-116 grayish-red clayey silt (Qbnl)

coarse-to-fine sand, trace silt (Qbn)

60-63 soft to hard shale rock

68-76 coarse-to-medium sand, trace silt

fragments (Qt or fill)

10-12 gray medium sand, red silt, rock

12-18 red silt and rock fragments (Qt)

and gravel (Qt)

0-3 brown silt, medium-to-fine sand (af)

34-51 red-brown fine sand, trace silt

45-77 red-brown silt with fine sand (Qbnl)

67-85 red clay, tough (Qbnl or Qt)

INTRODUCTION

Surficial deposits in the Jersey City quadrangle include alluvial, estuarine, and windblown (eolian) deposits of postglacial age, and glacial lacustrine deposits and till of late Wisconsinan age. These deposits are delineated on the accompanying map and sections and are described below. The glacial and postglacial events they record are also discussed below. Well and boring data used to draw bedrocksurface contours and to infer the subsurface distribution of the deposits are provided in table 1. The chronologic relationships of the deposits are shown on the correlation chart.

CORRELATION OF MAP UNITS

Qm	af				- Holocene
Qal	Qe	1			Į
Qhkl					late Wisconsinan stage
Qbnl	Qbn	Qbnf	Q+	Qty	of the Pleistocene

DESCRIPTION OF MAP UNITS

Postglacial Deposits--These include sediment deposited in estuaries and salt marshes (Qm), stream sediment deposited in former channels and floodplains beneath the salt-marsh sediment (Qal), windblown sediment blanketing parts of the west slope of the Palisades Ridge (Qe), and man-made fill (af). They were all deposited after glacial

After glacial lakes Hackensack and Bayonne drained (see below), streams cut shallow channels and plains into the exposed lake bottoms in places and deposited sandy alluvium (Qal). At the same time, and before return of vegetation stabilized surfaces, westerly winds entrained fine sand and silt from the former lake bottom in the Newark Bay area and deposited this sediment as a sheet along the base of the west slope of the Palisade Ridge (Qe). Faint dunes are visible in Lincoln Park and Holy Name cemetery, but urbanization has destroyed any evidence of dunes elsewhere. Merrill and others (1902) mapped several areas of dunes along the west base of the Palisades Ridge in Jersey City and Bayonne, and Russell (1880) described eolian sand deposits at several locations on the east side of the Palisades Ridge from Constable Hook to Hoboken. No evidence of these deposits remains. Most of those described by Russell (1880) were on outcrop areas of glacial-lake sand (unit Qbn, see below), and may have been largely wind-shaped glacial sand deposits rather than transported eolian sediment. Some of the sand beneath the salt-marsh deposits, mapped as alluvium, may also be windblown.

Deposition of the alluvial and windblown sediments gradually ended as sea level rose and marshes covered the former lake plains. The bedrock surface beneath the Hudson valley is lower than that beneath the Newark Bay-Kearny area, and the glacial sediment is not as thick, so the rising sea flooded the Hudson Valley long before it flooded the Newark Bay-Kearny lowland. Newman and others (1969) indicate tuarine conditions were present in the Hudson valley as long ago as 12,000 yrs B.P. (years before present). In the Hackensack valley just north of the quadrangle, salt-marsh deposition did not begin until about 2000 yrs B.P. (Heusser, 1963). Estuarine deposits are as much as 300 feet thick beneath the Hudson (sections AA', BB', CC') but are less than 40 feet thick in the Newark Bay-Kearny area. This marked difference in thickness is attributable to the greater depth of the Hudson Valley, and the longer period of estuarine deposition there. Estuarine deposition continues today.

Landfilling on the marsh deposits began shortly after permanent European settlement in the 1600s. The earliest areas of fill were likely along the Hudson in Hoboken and adjacent parts of Jersey City. The latter part of the nineteenth century, and early twentieth century, saw large-scale landfilling for railroad and shipping terminals and industrial development. By the 1920s almost all of the salt marsh, and some areas of open water, had been covered by fill. Some filling continues

- af ARTIFICIAL FILL--Artificially emplaced sand, gravel, silt, clay, and rock; and man-made materials including cinders, ash, brick, concrete, wood, slag, metal, glass, and trash. Color variable but generally dark brown, gray, or black. As much as 40 feet thick but generally less than 20 feet thick. Mapped only where it forms distinct landforms such as highway and railroad embankments, or where it covers salt-marsh deposits. The extent of fill is based on aerial photographs taken in 1979 and 1986. The extent of fill over salt-marsh deposits is based, in part, on the position of shorelines and salt marshes shown on maps by Douglas (1841), Vermuele (1897), and Merrill and others (1902). Fill is also present in all urban areas as a thin layer (generally less than 10 feet thick) of fill or mixed fill and natural material overlying the mapped surficial material.
- ESTUARINE AND SALT-MARSH DEPOSITS--Organic silt and clay, and salt-marsh peat, with some sand; black, dark brown, and dark gray. Contains some shells. As much as 300 feet thick in the Hudson valley. As much as 40 feet thick, but generally less than 20 feet thick, in the Newark Bay-Kearny area.
- Qal ALLUVIUM--Sand, silt, minor gravel; dark brown to gray. As much as 20 feet thick. In subsurface only, beneath unit Qm. Inferred from records of test borings (table 1).
- EOLIAN DEPOSITS--Fine sand, minor silt; very pale brown. As much as 30 feet thick (Salisbury and Peet, 1895) but generally less than 10 feet thick. Extent of deposits is based, in part, on mapping in Merrill and others (1902). In places these deposits may have been removed during urbani-

Glacial Deposits--These include till--a poorly-sorted, nonstratified sediment containing gravel clasts and boulders, deposited directly from glacial ice (Qt, Qty), and well-sorted, stratified sediments. The stratified sediments include sand and gravel laid down by glacial meltwater in glacial-lake deltas (Qbn) and fans (Qbnf) and varved silt, clay, and fine sand deposited on the bottoms of glacial lakes (Qbnl, Qhkl). All of these deposits are of late Wisconsinan age.

Before these deposits were laid down the underlying bedrock surface was shaped by glacial erosion. The topography of the bedrock surface

BEDROCK

VERTICAL EXAGGERATION X 10

(plotted at 50-foot contour intervals on the map) shows elongate glacially-scoured troughs that extend to more than 200 feet below sea level in the Newark Bay area and more than 300 feet below sea level beneath the Hudson River. To the south and to the north the bedrock surface in these troughs rises, and the trough forms die out (Parrillo, 1959; Stanford and others, 1990), indicating that they are true glacialscour features rather than buried fluvial valleys. They are eroded into outcrop belts of weak rock, including shale and arkosic sandstone of the Passaic and Lockatong Formations west of the Palisades ridge, arkosic sandstone of the Stockton Formation along the east base of the Palisades ridge, and schist beneath the Hudson River. Resistant diabase makes up the the Palisades Ridge. Parrillo (1959) and Love-

green (1974) show a buried valley crossing the Palisades Ridge at the

Bayonne-Jersey City boundary, but no test boring data verify this

valley, and outcrops in the area suggest that no valley is present. The

series of bedrock highs along the west bank of the Hudson from

Castle Point in Hoboken southward to Bayonne is formed on serpen-

During the late Wisconsinan advance, the Jersey City area was on the

east side of an ice lobe that was channelled between the Watchung

Mountains to the west and the Palisades Ridge to the east, and cen-

tered on the Hackensack valley (Salisbury, 1902; Stanford and Harp-

er, 1991). The orientation of striations, and the composition and dis-

tribution of till in the quadrangle, indicate that ice flowed southeaster-

ly here. Reddish-brown silty sand to sandy silt till ("Rahway till",

Qt), is derived from mudstone and sandstone bedrock. It forms a

nearly continuous blanket on the bedrock surface except in places on

the steep east slope of the Palisades Ridge, where it likely was never

deposited, and in the glacially-scoured troughs in the Hudson and

Newark Bay-Kearny lowlands, where it either was never deposited or

was later eroded by subglacial meltwater. In the Hoboken-Jersey City

area, east of the Palisades Ridge, the reddish-brown till grades into a

more yellowish, siltier till ("Rahway till, yellow phase", Qty) that

reflects incorporation of weathered serpentinite and diabase. This

yellow till likely underlies unit Qt in places on the Palisades Ridge,

and may be present in the subsurface elsewhere east of the Palisades.

Late Wisconsinan ice reached its southernmost position at Perth

Amboy, about 16 miles southwest of Bayonne, earlier than 20,000 yrs

B.P., based on radiocarbon dates of organic material at the bottom of

postglacial bogs in western New Jersey (Harmon, 1968; Cotter and

others, 1986), on concretions in glacial Lake Passaic sediments west

of the Watchung Mountains (Stone and others, 1989), and on organic

sediments beneath till on Long Island (Sirkin, 1986). A continuous

terminal moraine was deposited at the position of maximum advance

(fig. 1). As the ice front retreated, a series of glacial lakes formed,

dammed to the south by the moraine (Stanford and Harper, 1991).

One of these, Lake Bayonne, occupied the Arthur Kill, Newark Bay,

and upper New York Bay lowlands, and had an outlet over the mor-

aine at Perth Amboy (fig. 1). This outlet was gradually lowered by

erosion, and therefore the level of Lake Bayonne steadily declined. In

the Jersey City quadrangle, deltas deposited in Lake Bayonne have top

elevations 20 to 30 feet above sea level. Adjusting for postglacial

rebound of Earth's surface in response to release of the weight of the

glacier, these altitudes indicate the spillway at Perth Amboy had been

eroded to between 0 and 20 feet below sea level (using the rebound

rate of 3.5 feet/mile to the north from Stanford and Harper, 1991).

Deposits in Lake Bayonne include deltaic sand and gravel (Qbn),

lacustrine-fan sand and gravel (Qbnf), and lake-bottom silt, clay, and

Continued erosion of the outlet at Perth Amboy, and along the Arthur

Kill to the north, uncovered diabase bedrock at an elevation of 30 feet

below sea level in the Arthur Kill about 7 miles north of Perth

Amboy. The diabase halted further downcutting and formed the stable

spillway for Lake Hackensack (fig. 1). An auxiliary spillway was also

established across diabase in the Kill van Kull, just west of the quad-

rangle boundary (fig. 1). In the Jersey City quadrangle, Lake Hacken-

sack occupied the lowest parts of the Newark Bay-Kearny lowland.

Some lake-bottom silt and clay (Qhkl) in the northeastern corner of

the map area were deposited in Lake Hackensack. The lake drained

eastward into the Hudson Valley when the retreating ice front uncov-

ered Sparkill Gap, a deep gap through the Palisades Ridge, about 22

In the Hudson Valley, Lake Bayonne lowered to form Lake Hudson

when the retreating ice front uncovered the Hell Gate area in the East

River between Manhattan and Queens, about 5 miles east of Hoboken

(fig. 1). This event likely occurred when the ice front was just north

of the Hoboken area, because deltaic sand at the Lake Bayonne level

occurs in Hoboken but not north of there. Gneiss bedrock at Hell Gate

formed a stable spillway for Lake Hudson at an elevation of 30 feet

below sea level. In the Jersey City quadrangle the level of Lake

Hudson, corrected for rebound, was between 40 and 60 feet below sea

level (Newman and others, 1969; Stanford and Harper, 1991). Test

borings for the Holland Tunnel (borings 29-32 in table 1) did not

encounter any Lake Hudson deposits, and none are mapped in the

quadrangle. This absence is due to either nondeposition or removal of

deposits by later meltwater floods in the Hudson Valley (Newman and

others, 1969; Stanford and Harper, 1991). However, remnants of

lake-bottom sediment deposited in Lake Hudson may be present local-

ly beneath the estuarine deposits under the Hudson River and Upper

New York Bay. Lake Hudson persisted until the moraine dam at the

Narrows, about 6 miles south of Bayonne (fig. 1), was breached. The

timing of this event is uncertain, but breaching may have occurred as

long ago as about 15,500 yrs B. P., when large volumes of meltwater,

sourced from glacial lakes in the Great Lakes basin, discharged

Qhkl GLACIAL LAKE HACKENSACK LAKE-BOTTOM

DEPOSITS--Silt, clay, fine sand; gray to reddish-brown.

varved to thinly-layered. As much as 30 feet thick. In subsur-

face only (sections AA', DD'). Lower contact is an approx-

imate timeline marking the estimated position of the lake-

bottom surface when Lake Bayonne lowered to the Lake

Hackensack level. It does not represent a physical discontinu-

GLACIAL LAKE BAYONNE DEPOSITS--Deltaic, lake-

bottom, and lacustrine-fan deposits on both sides of the

Palisades Ridge. Deltaic deposits are of indistinct form and

include low sandy terraces rising to about 30 to 40 feet above

sea level at the west base of the Palisades Ridge in Jersey

City, and low sandy islands (including Ellis and Liberty

Islands) rising to about 30 feet above sea level along the west

shore of the Hudson from Constable Hook to Hoboken.

Lake-bottom sediment is continuous beneath units Qm and

Qhkl in the Newark Bay-Kearny lowland and generally

present beneath unit Qm between the Palisades and Hudson

River. It is also present, in places, beneath distal parts of

deltaic deposits (sections AA', BB', EE'). Lacustrine-fan

sediment is inferred from records of test borings and occurs

sparsely between the Palisades and the Hudson River. Some

of the mapped deltaic deposits may include lacustrine-fan

through the Hudson Valley (Ridge, 1991).

sediment in the subsurface.

fine sand (Qbnl).

miles north of Hoboken.

Qbnl Lake-bottom deposits--Silt, clay, and fine sand; gray to reddish-brown, thinly-layered to varved. Sediment is wellsorted and stratified. As much as 150 feet thick. In subsurface only (all sections).

and schist fragments. As much as 100 feet thick.

Deltaic deposits--Sand, reddish-yellow, light reddish-brown,

gray; some pebble gravel; minor cobble gravel. Sediment is

generally well-sorted and stratified. Gravel clasts are chiefly

red and gray sandstone and mudstone; with lesser amounts of

gneiss, diabase, quartz, quartzite, serpentinite, and schist.

Sand is chiefly quartz, feldspar, and red and gray mudstone

fragments; with lesser amounts of mica and gneiss, diabase,

- Dbnf Lacustrine-fan deposits--Sand, minor silt; reddish-brown to gray; and gravel. Sediment is moderately- to well-sorted, stratified. Sand and gravel composition likely similar to Qbn. As much as 100 feet thick. In subsurface only (sections AA'
- RAHWAY TILL--Reddish-brown to reddish-yellow silty sand to sandy silt, containing some to many subrounded and subangular pebbles and cobbles and few subrounded boulders. Poorly sorted, nonstratified, generally compact below the soil zone. As much as 50 feet thick. Gravel includes, in approximate order of abundance, red and gray mudstone and sandstone, gneiss, diabase (on and east of the Palisades Ridge), conglomerate, quartzite, and quartz. Sand is chiefly quartz, feldspar, and red and gray mudstone fragments; with lesser amounts of gneiss and diabase fragments. The clasts are derived from bedrock and preglacial surficial deposits to the north and northwest along the line of ice flow. Unit Qtt delineates areas where Qt is discontinuous and generally less than 10 feet thick. The extent of unit Qtt is based, in part, on
- RAHWAY TILL (YELLOW PHASE)--Till as above except that fine sediment is a reddish-yellow to yellow sandy silt to silt; and diabase and sepentinite clasts are more abund ant. Incorporates weathered diabase of the Palisades Ridge and weathered serpentinite in Hoboken. Gradational contact with unit Qt. As much as 20 feet thick.

Salisbury and Peet (1895) and Merrill and others (1902).

MAP SYMBOLS

- Contact--Solid where well-defined by landforms; dashed where approximate, gradational, or featheredged; dotted where concealed by fill. Some contacts are modified from Merrill and others (1902), and unpublished manuscript maps of C. E. Peet and R. D. Salisbury on file at the N. J. Geo-
- Striation--Observation at dot. Flag indicates data from Salisbury and Peet (1895). Elevation of bedrock surface in well or boring--Data from

Parrillo (1959). "Less-than" sign (<) indicates elevation of

bottom of boring that did not reach bedrock.

- Elevation of bedrock surface in well or boring--Data from Lovegreen (1974). Values are inferred from a bedrock topography map with a contour interval of 20 feet.
- Elevation of bedrock surface in well or boring--Data from (-5) files of the N. J. Geological Survey.
- Well with log in table 1--Location judged to be accurate (-95) within 100 feet. Elevation of bedrock surface in parentheses.
- Well with log in table 1--Location judged to be accurate (-74) within 500 feet. Elevation of bedrock surface in parentheses.
- Elevation of bedrock surface--Contour interval 50 feet. Shown only where depth to bedrock generally exceeds 50
- (r) Former bedrock outcrop-Outcrop noted on unpublished manuscript maps by C. E. Peet, R. D. Salisbury, and H. B.
- longer exposed. Well with log in table 1--On sections, projected to line of
- no dot indicates bedrock not reached.
- af/Qm unit underlying large areas of artificial fill and eolian depos-
- ω Surface water--On sections only.

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Large bedrock outcrop--May be partly covered by fill or maximum extent of glacial lake Kummel (on file at the N. J. Geological Survey) but no recessional ice margin

Depth to bedrock in well or boring--On sections, projected to line of section. Dot indicates bedrock surface penetrated, Unit to left of slash overlies unit to right--Shows extent of

Les, and Stuckenrath, Robert, 1986, The Wisconsinan history of the Great Valley, Pennsylvania and New Jersey, and the age of the "Terminal Moraine", in Cadwell, D. H. (ed.), The Wisconsinan stage of the first geological district, eastern New York: N. Y. State

and the adjacent county, describing minutely the course of rivers, brooks, the township and original patent lines, railways, turnpike carriage, and bridle roads, the present farm boundaries with the names of their proprietors, a correct plan of public grounds and gentlemen's country seats, the position of farm houses, forests, swamps and marshes, showing a complete view of the face of the county: Harmon, K. P., 1968, Late Pleistocene forest succession in northern

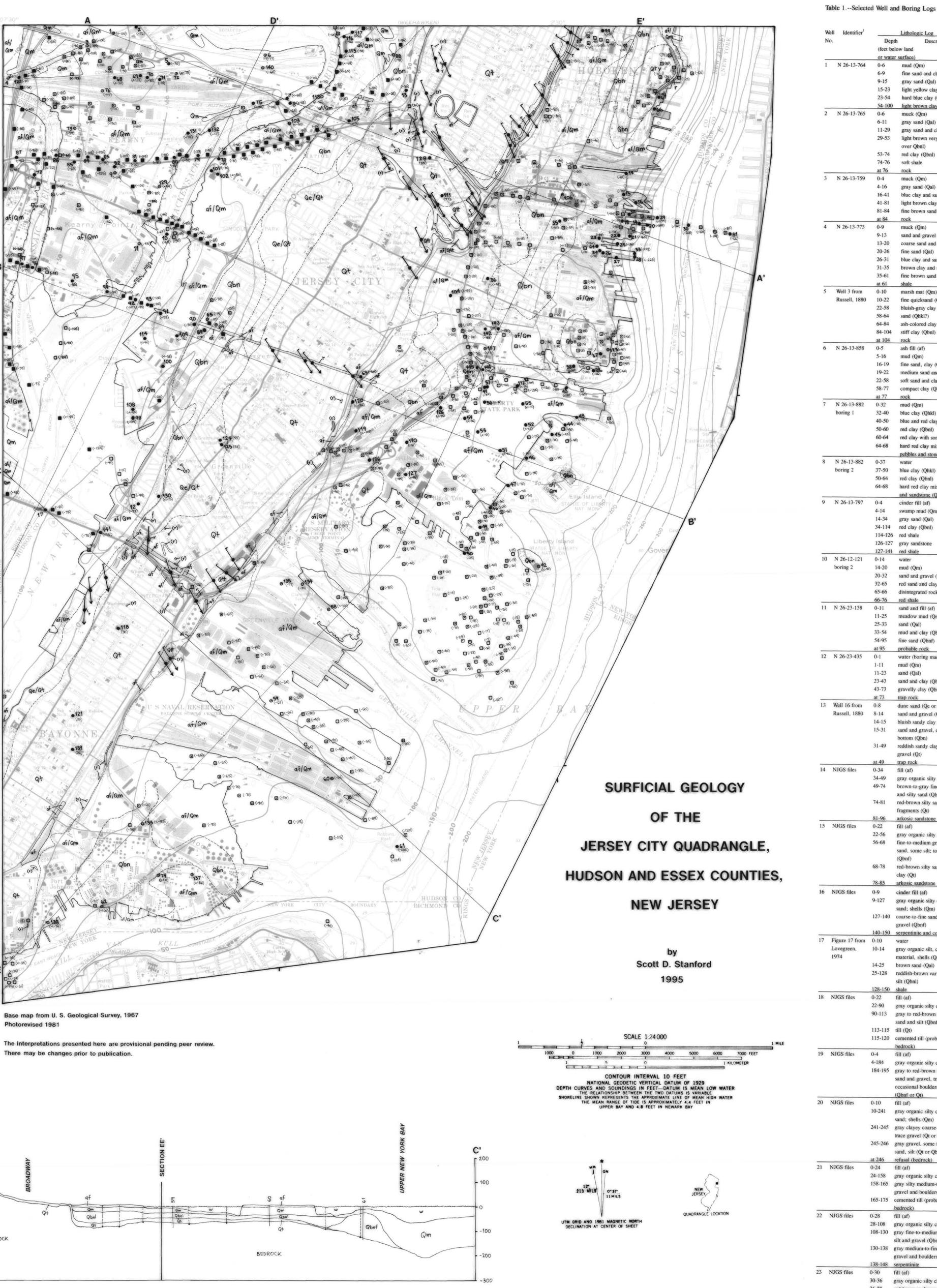
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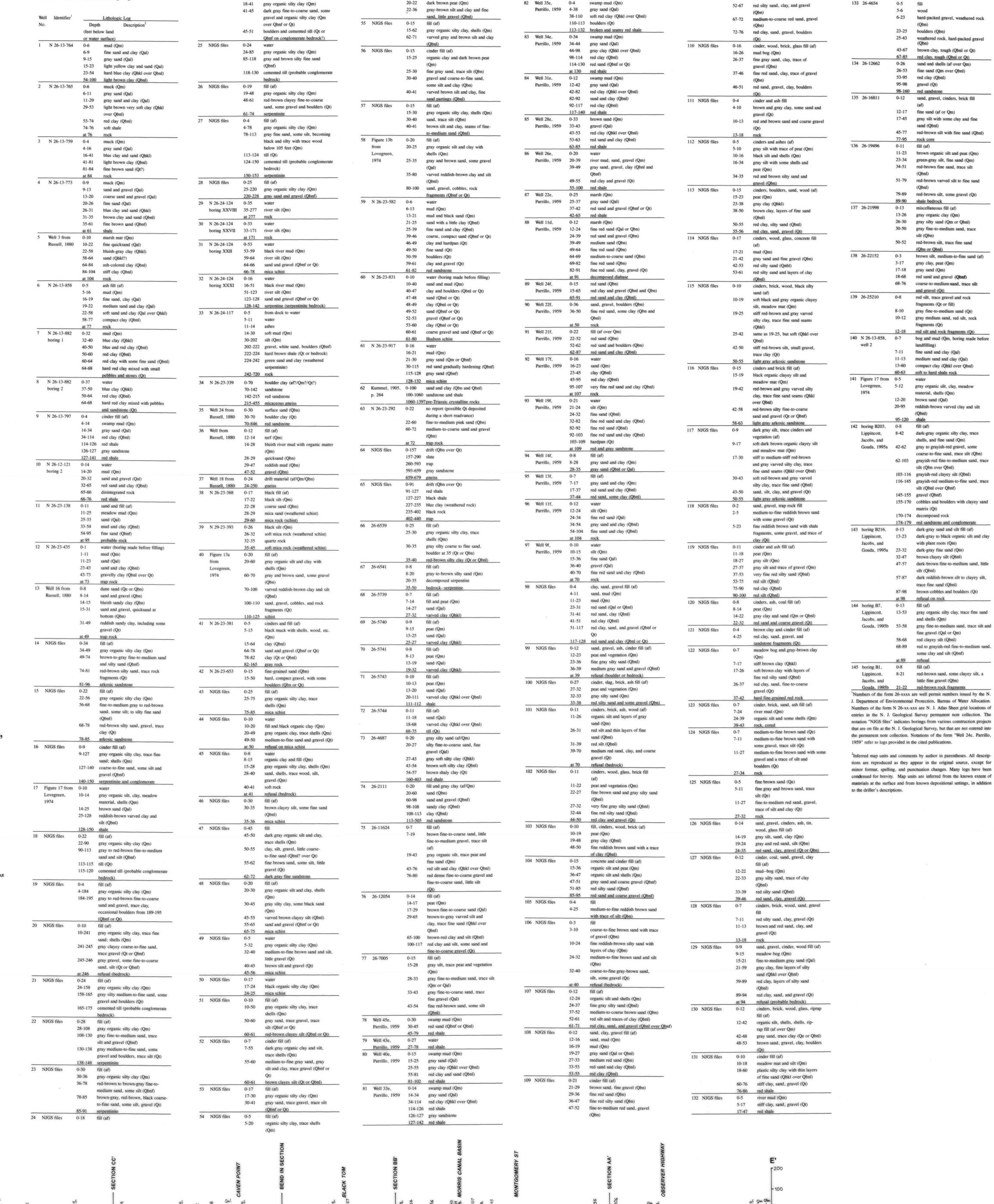
BEDROCK

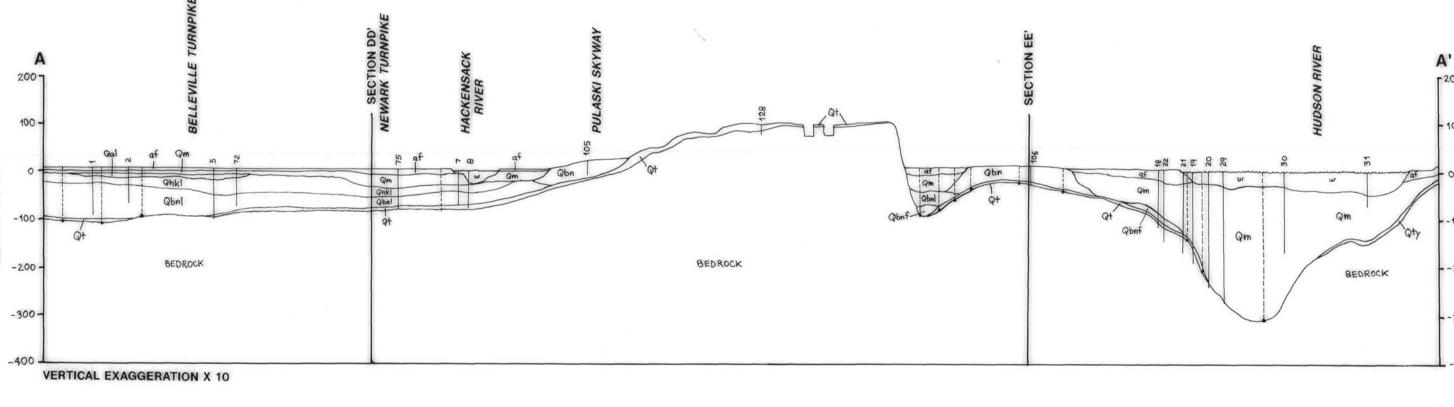
Figure 1.--Ice margins, glacial-lake spillways, and maximum extent of glacial lakes. Lakes are identified by the following abbreviations on their shorelines: Bn=Bayonne, Hk=Hackensack, Hd=Hudson. Placename abbreviations are: PA=Perth Amboy, AK=Arthur Kill, KK=Kill van Kull, Nr=Narrows, HG=Hell Gate. Recessional ice margins include: M1=last ice margin before Lake Bayonne lowered to the Lake Hudson level in the Hudson valley. Deltas in Lake Bayonne were deposited at Hoboken and on the west side of Jersey City. M2 = approximate position of ice margins at maximum extent of Lake Bayonne, before the stable Lake Hackensack level was estab-

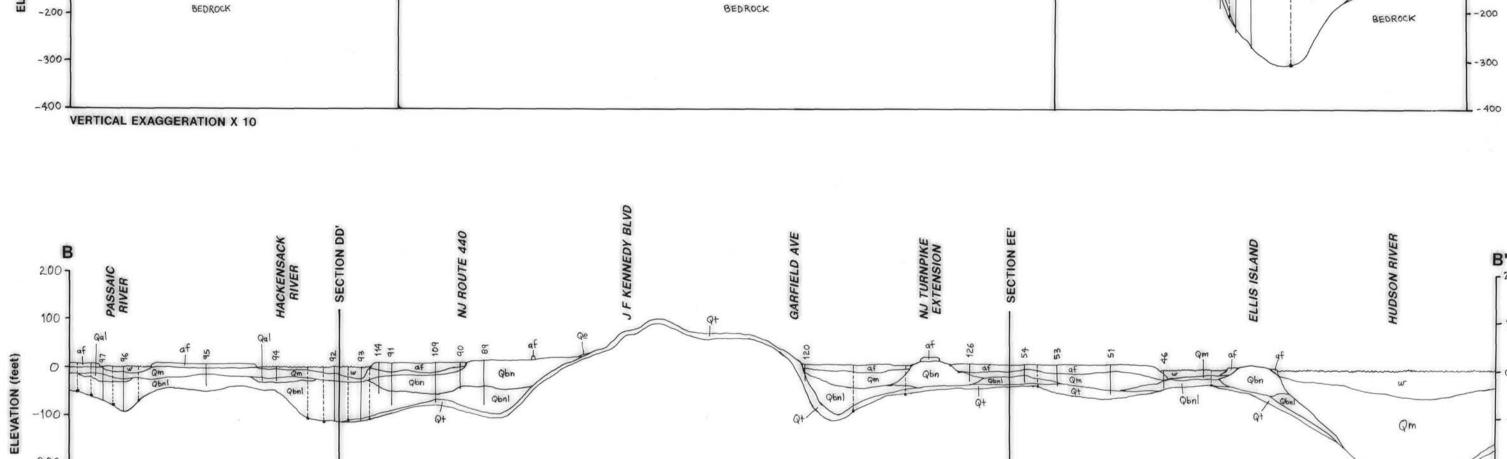
VERTICAL EXAGGERATION X 10

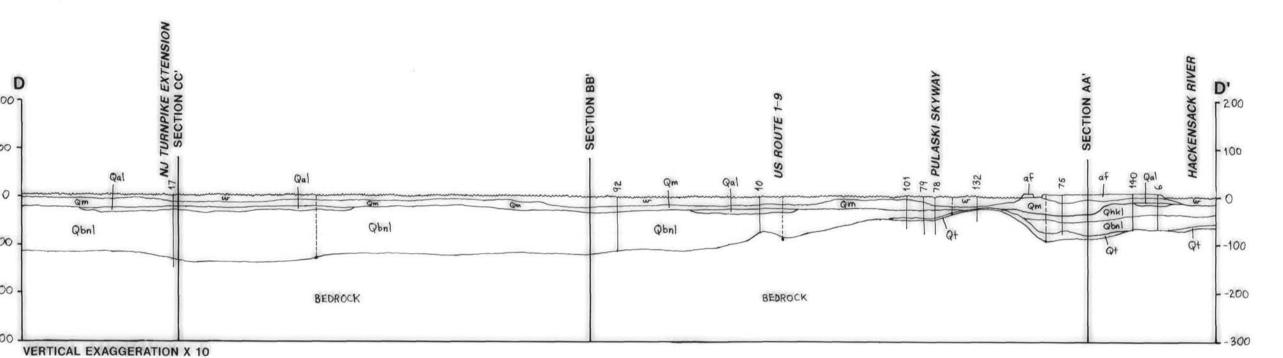
area of detail

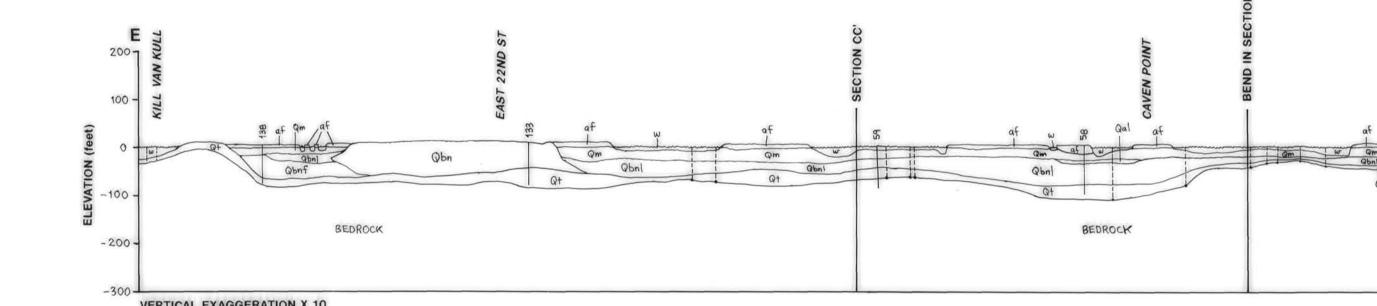












VERTICAL EXAGGERATION X 10