DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE DELAWARE GEOLOGICAL SURVEY
AND THE DELAWARE STATE HIGHWAY DEPARTMENT

HYDROLOGIC INVESTIGATIONS
ATLAS HA-80

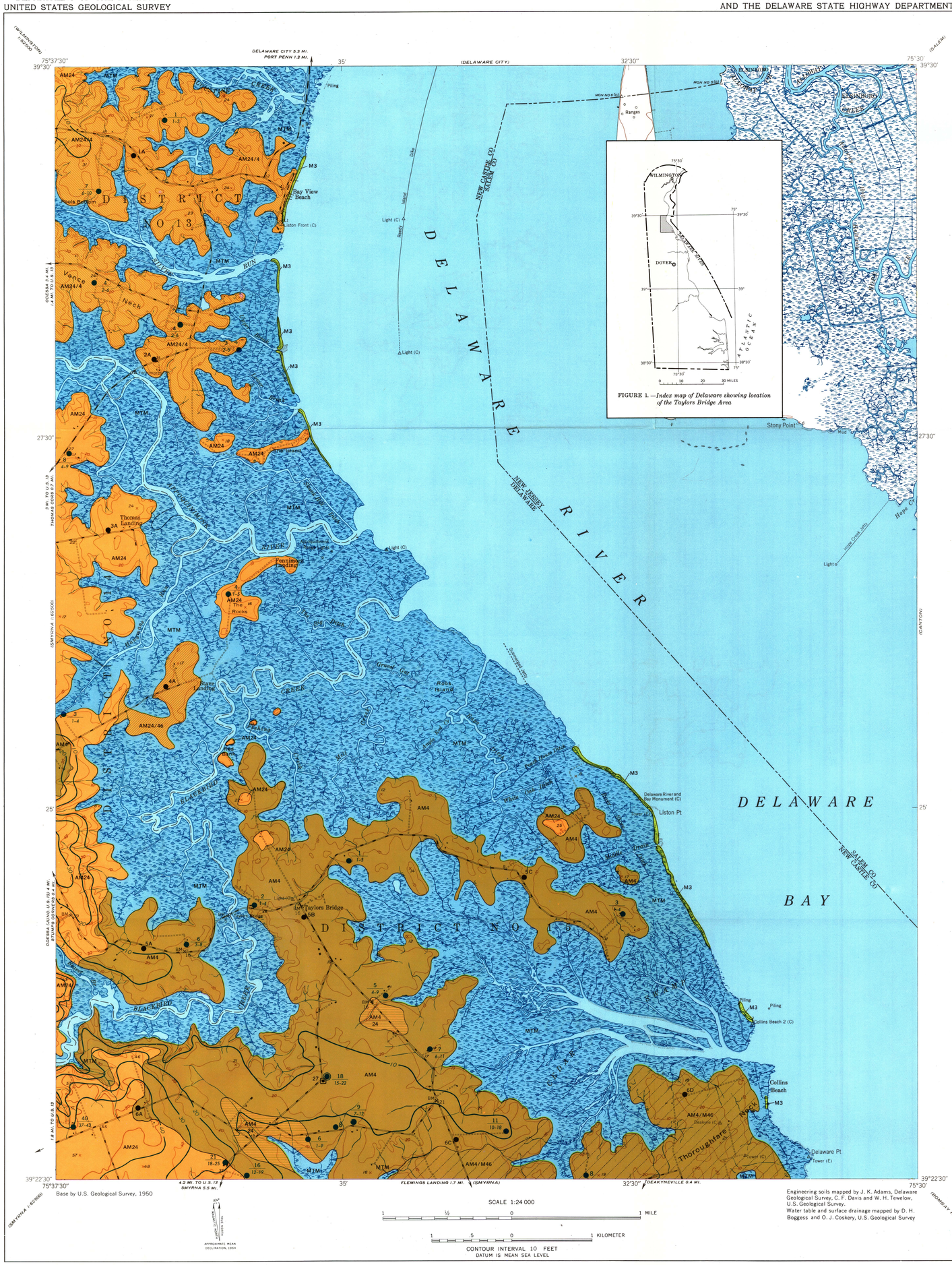

FIGURE 1.—*Index map of Delaware showing location of the Taylors Bridge Area*

Engineering soils mapped by J. K. Adams, Delaware Geological Survey, C. F. Davis and W. H. Tewelow, U.S. Geological Survey.
Water table and surface drainage mapped by D. H. Boggess and O. J. Coskery, U.S. Geological Survey

EXPLANATION

AM24 — Nonplastic to slightly plastic sandy and silty soil derived from fluvial deposits of Pleistocene age

AM4 — Slightly plastic silty and clayey soil derived from fluvial deposits of Pleistocene age

M3 — Nonplastic sandy soil derived from marine sediments

MTM — Marine tidal-marsh deposits

AM24/4 — AM24 soil associated with diminutive amounts of AM4 soil

AM24/46 — AM24 soil associated with diminutive amounts of slightly plastic to highly plastic silty and clayey soil derived from fluvial deposits of Pleistocene age

AM4/M46 — AM4 soil associated with diminutive amounts of slightly plastic to highly plastic silty and clayey soil derived from marine sediments

AM4 24 — AM4 soil underlain by AM24 soil

27 — Soil sample pit
Location and number of pit from which soil samples were obtained for laboratory analyses (see table 3). General characteristics are summarized in table 4

6D — Soil sample site
Location and number of secondary soil sample sites. Samples were collected with a one-inch-diameter long-core soil sampler. For results of laboratory analyses see table 3; for general characteristics see table 4

18 / 15-22 — Secondary observation well
Numerator is altitude of the water table in September 1958. Denominator shows estimated range in altitude of water table during 1950-62, based on measurements from 1957 to 1962 and comparison with primary observation-well records

1 / 1-3 — Domestic or farm well
Numerator is the altitude of the water table in September 1958. Denominator, where given, shows estimated range in altitude of water table during 1950-61, based on 1 or 2 measurements and comparison with primary and secondary observation-well records

40 — Water-table contour
Number shows altitude of water table in feet above mean sea level. Contour interval 10 feet. Relative position of water table in September 1958 is shown in hydrograph (Figure 2)

Perennial stream
Bottom of stream channel almost always below water table

Intermittent stream
Bottom of stream channel above water table part of the time and below water table part of the time

TABLE 1.—*Explanation of letter symbols*

Symbol	Explanation
AM	Surficial alluvial mantle, Pleistocene age.
M	Marine deposit.
MTM	Marine tidal marsh.

SOIL SYMBOLS

The map symbols used in this report to designate the various types of soils are a modification of the system used in the engineering soil survey of New Jersey (Rogers, 1955). The first part of the symbol is a letter, or group of letters, which identifies the parent material according to the classification developed by Lueder (1950) (see table 1). The second part of the symbol is a number which identifies the soil group according to the classification system adopted by the Highway Research Board (Allen and others, 1945) and used with some modifications by the Delaware State Highway Department (see table 2). A two-digit number indicates that two soil types are present within the same soil profile; for example, the symbol AM24 implies that both A-2 and A-4 soils are present in the same soil profile, but usually in different horizons.

Two different soil symbols may be combined by either a horizontal bar ($\frac{AM4}{24}$) or a diagonal bar (AM4/24). A horizontal bar indicates that the soil designated by the denominator underlies the soil designated by the numerator within a depth of 20 to 72 inches. If the letter symbol is omitted from the denominator, the parent material is the same as that shown for the numerator. A diagonal bar indicates that two soils are interspersed within the area so designated, but they are not present in the same soil profile. The predominant soil type is identified by the symbol that precedes the diagonal bar.

REFERENCES

Allen, Harold, and others, 1945, Report of committee on classification of materials for subgrades and granular type roads: Highway Research Board, 25th Ann. Mtg., Oklahoma City, 1946, Highway Research Board Proc., v. 25, p. 375-388.

Lueder, D. R., 1950, A system for designating map-units on engineering soil-maps in soil exploration and mapping: Highway Research Board Bull. 28, p. 17-35.

Rogers, F. C., 1955, Engineering soil survey of New Jersey, Report No. 1: Rutgers Univ. Eng. Research Bull. 15, 114 p.

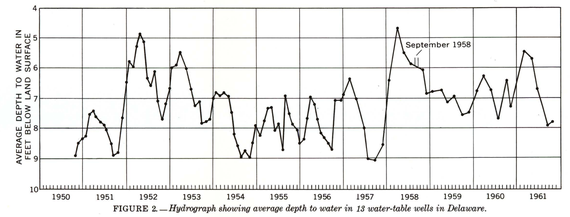

FIGURE 2.—*Hydrograph showing average depth to water in 13 water-table wells in Delaware.*

TABLE 2.—*Soils classification*

General classification	Granular materials (35 percent or less passing a No. 200 sieve)							Silt clay materials (more than 35 percent passing a No. 200 sieve)				
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7	A-8
	a	b		4	5	6	7				[1]5 [2]6	
Sieve analysis Percent passing No. 10 sieve	50 max.											
No. 40 sieve	30 max.	50 max.	51 min.									
No. 200 sieve	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.	36 min.	
Characteristics of fraction passing No. 40 sieve Liquid limit				40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 min.	42-400
Plasticity index	6 max.	6 max.	Nonplastic	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.	11 min.	0-50,
Group index	0		0	0		4 max.		8 max.	12 max.	16 max.	20 max.		
General subgrade rating	Excellent		Good	Good		Fair		Poor	Poor	Poor	Very poor		Unsatisfactory
Material	Well-graded gravel and sand		Clean sand and gravelly sand	Poorly graded, silty or clayey sand and gravel				Silty soil	Plastic silt	Plastic clay	Expansive plastic clay		Muck-peat

[1]Plasticity index of A-7-5 subgroup is equal to or less than the liquid limit minus 30.
[2]Plasticity index of A-7-6 subgroup is greater than the liquid limit minus 30.

TABLE 3—*Results of laboratory analyses of soil samples*

Sample pit and site nos.	Depth of interval sampled (inches)	Soil horizon	Liquid limit: NL, nonliquid — Mechanical analyses — Cumulative percent passing sieve— 3/4 in.	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Percent by weight — Silt	Clay	Liquid limit[1]	Plasticity index[2]	Plasticity index: NP, nonplastic — Moisture-density[3] — Maximum density (lbs. per cu ft)	Optimum moisture (percent)	Classification — HRB[4]	Unified[5]	Map symbol
27	0-6	A	100.0	100.0	99.7	95.9	86.7	------	------	22	3	113.0	12.0	A-4 (8)	ML	AM4
	6-42	B	100.0	100.0	99.9	99.3	97.1	70	25	29	7	119.0	12.6	A-4 (8)	CL	
	42-60	C	100.0	100.0	99.9	98.4	94.7	74	17	20	2	------	------	A-4 (8)	ML	
1A	0-8	A	------	------	99.4	96.1	90.5	------	------	<40	<4	------	------	A-4 (8)	ML	AM4
	8-30	B	------	------	97.8	96.0	86.2	------	------	30	4	------	------	A-4 (8)	ML	
	30-72	C	------	------	99.3	88.0	64.4	------	------	<40	<4	------	------	A-4 (6)	ML	
2A	0-8	A	------	------	99.4	89.0	66.0	------	------	<40	<4	------	------	A-4 (6)	ML	AM24
	8-56	B	------	------	99.3	90.7	75.3	------	------	<40	<4	------	------	A-4 (8)	ML	
	56-72	C	------	------	93.3	69.7	24.5	------	------	<40	<4	------	------	A-2-4 (0)	SM	
3A	0-16	A	------	------	97.0	76.7	49.3	------	------	<40	<4	------	------	A-4 (3)	SM	AM24
	16-42	B	------	------	89.8	73.6	51.4	------	------	<40	<4	------	------	A-4 (3)	ML	
	42-72	C	------	------	86.1	52.2	28.9	------	------	<40	<4	------	------	A-2-4 (0)	SM	
4A	0-16	A	------	------	99.3	92.7	74.3	------	------	<40	<4	------	------	A-4 (8)	ML	AM47
	16-44	B	------	------	97.4	88.4	70.8	------	------	42	13	------	------	A-7-6 (6)	ML	
	44-72	C	------	------	91.8	80.0	55.8	------	------	54	8	------	------	A-5 (5)	MH	
5A	0-8	A	------	------	99.7	88.8	68.1	------	------	<40	<4	------	------	A-4 (7)	ML	AM24
	8-24	B	------	------	97.8	84.6	62.9	------	------	<40	<4	------	------	A-4 (6)	ML	
	24-72	B-C	------	------	93.6	67.7	35.1	------	------	26	6	------	------	A-2-4 (0)	SM-SC	
5B	0-12	A	------	------	100	98.4	90.1	------	------	<40	<4	------	------	A-4 (8)	ML	AM4
	12-24	B	------	------	99.7	98.1	91.7	------	------	28	6	------	------	A-4 (8)	ML	
	24-72	C	------	------	99.6	96.8	87.5	------	------	22	2	------	------	A-4 (8)	ML	
5C	0-7	A	------	------	100	95.7	82.0	------	------	40	<4	------	------	A-4 (8)	ML	AM4
	7-24	B	------	------	99.9	94.9	78.2	------	------	40	<4	------	------	A-4 (8)	ML	
	24-72	B-C	------	------	96.8	92.2	55.8	------	------	20	4	------	------	A-4 (4)	ML	
6A	0-16	A	------	------	99.5	85.5	69.3	------	------	<40	<4	------	------	A-4 (7)	ML	AM4
	16-72	B	------	------	99.6	85.7	66.8	------	------	<40	<4	------	------	A-4 (6)	ML	
6C	0-12	A	------	------	99.8	98.0	91.4	------	------	<40	<10	------	------	A-4 (8)	------	AM4
	12-28	B	------	------	99.8	96.6	89.6	------	------	32	3	------	------	A-4 (8)	ML	
	28-72	C	------	------	99.5	95.0	88.2	------	------	22	2	------	------	A-4 (8)	ML	
6D	0-12	A	------	------	100	97.9	84.8	------	------	<40	<4	------	------	A-4 (8)	ML	AM4
	12-36	B[1]	------	------	100	99.6	89.0	------	------	25	4	------	------	A-4 (8)	ML	
	36-47	D	------	------	99.9	95.3	83.7	------	------	<40	<4	------	------	A-4 (6)	ML	
	47-72	B[2]	------	------	99.6	98.6	92.6	------	------	27	8	------	------	A-4 (8)	CL	

[1]Based on AASHO (American Association of State Highway Officials) Designation: T89-49.
[2]Based on AASHO Designation: T91-49.
[3]Based on AASHO Designation: T180-57.
[4]Highway Research Board system (see table 2); group index given in parentheses.
[5]Unified Soil Classification system: Technical Memorandum No. 3-357, v. 1, Waterways Experiment station, Corps of Engineers, March 1953.

TABLE 4.—*Characteristics of the engineering soil types in the Taylors Bridge Area*

Soil type	Description	Origin	Engineering properties — In place — Suitability as a subgrade[2]	Suitability as a wearing surface[3]	Disturbed[1] — Suitability as embankment material	Compaction characteristics	Suitable compaction equipment
AM24	Nonplastic to slightly plastic, sandy and silty soil.	Fluvial deposits of Pleistocene age.	Fair to good depending on amount of A-2 material left after grading.	Poor if surface is A-4. Good to excellent, depending on amount of binder present, if surface is A-2,	Fair to good depending on relative amounts of A-4 and A-2 present.	Fair to good depending on relative amounts of A-4 and A-2 present.	Rubber-tired equipment.
AM4	Slightly plastic, silty and clayey soil.	Fluvial and possibly eolian deposits of Pleistocene age.	Fair	Fair	Fair	Fair	Rubber-tired equipment.
M3	Nonplastic, well-sorted sand.	Marine deposits of Pleistocene or Recent age.	Fair	Fair	Fair	Poor	Vibratory equipment.
MTM	Soil rich in organic material and subject to inundation by high tides. No definite profile.	Tidal marsh deposits.	Variable	Variable	Variable	Variable	Variable.
AM24/46	Nonplastic to slightly plastic sandy and silty soil associated with slightly plastic to highly plastic silty and clayey soil.	Fluvial, paludal and lacustrine deposits of Pleistocene age.	Not suitable to good depending on amount of A-6 or A-2 material left after grading.	Not suitable if surface is A-6. Poor if surface is A-4. Good to excellent, depending on amount of binder present, if surface is A-2.	Not suitable to good depending on relative amounts of A-6, A-4, and A-2 present.	Poor to good depending on relative amounts of A-6, A-4, and A-2 present.	Rubber-tired equipment for AM24, sheep's-foot rollers for AM46.
AM4/M46	Nonplastic to slightly plastic silty soil associated with slightly plastic to highly plastic silty and clayey soil.	Fluvial and possibly eolian deposits of Pleistocene age and marine deposits.	Not suitable to fair depending on amount of A-6 or A-4 material left after grading.	Not suitable if surface is A-6. Poor if surface is A-4.	Not suitable to poor depending on relative amounts of A-6 and A-4 present.	Poor	Rubber-tired equipment for AM4, sheep's-foot rollers for M46.

[1]For soil types designated by two-digit numbers, these columns refer to the composite soil.
[2]When not subject to frost action. Frost will affect soils that contain appreciable silt and clay and have a high moisture content.
[3]Untreated. Additives may aid in stabilization of the sandy soils and minimize dusty conditions.

WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE TAYLORS BRIDGE AREA, DELAWARE

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