



EXPLANATION

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

AM34 Nonplastic to slightly plastic sand, poorly graded, and silty soil fluvial deposits of Pleistocene age

M44 Slightly plastic silty and clayey soil derived from fluvial deposits of Pleistocene age

M4 Slightly plastic silty and clayey soil derived from marine sediments

M46 Slightly plastic to highly plastic silty and clayey soil derived from marine sediments

U Urban areas where soil has been altered by man

Z Poorly drained organic swamp soil

AR/Z Flood-plain deposits associated with swamp deposits

AM24/4 AM24 soil associated with diminutive amounts of M4 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

AM24/M46 AM24 soil associated with diminutive amounts of M46 soil

AM24/Z AM24 soil associated with swamp deposits

AM24/2 AM24 soil underlain by M4 soil

M4 AM4 soil underlain by nonplastic sandy soil derived from fluvial deposits of Pleistocene age

M46 AM4 soil underlain by nonplastic sandy soil derived from fluvial deposits of Pleistocene age

S3 Slightly plastic to highly plastic silty and clayey soil underlain by nonplastic sandy soil derived from Pleistocene age

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 5.

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 5; for general characteristics see table 5.

Primary observation well
Numerator is altitude of water table in September 1958. Denominator shows measured range in altitude of water table during 1956-62.

Secondary observation well
Numerator is altitude of the water table in September 1958 for wells in New Castle County and in October 1959 for wells in Kent County. Denominator shows estimated range in altitude of water table during 1956-62, based on measurements and comparison with primary observation-well records.

Domestic or farm well
Numerator is the altitude of the water table in September 1958 for wells in New Castle County and in October 1959 for wells in Kent County. Denominator shows estimated range in altitude of water table during 1956-62, based on measurements and comparison with primary and secondary observation-well records.

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 and October 1959 is shown in hydrograph (fig. 2).

Perennial stream
Bottom of stream channel 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.

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 Lozier (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 (A-B) or a diagonal bar (A/B). A horizontal bar indicates that the soil designated by the numerator underlies the soil designated by the denominator to 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 interposed 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. 372-388.

Lozier, D. R., 1950, A system for designating mapunits on engineering soil-maps in soil exploration and mapping: Highway Research Board Bull., 26, p. 17-35.

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

TABLE 1.—Explanation of letter symbols

| Symbols | Explanation |
|---------|--|
| AM | Surficial alluvial sands, Pleistocene age. |
| AR | Recent alluvial deposits. |
| M | Marine deposits. |
| U | Urban areas. |
| Z | Swamp deposit. |

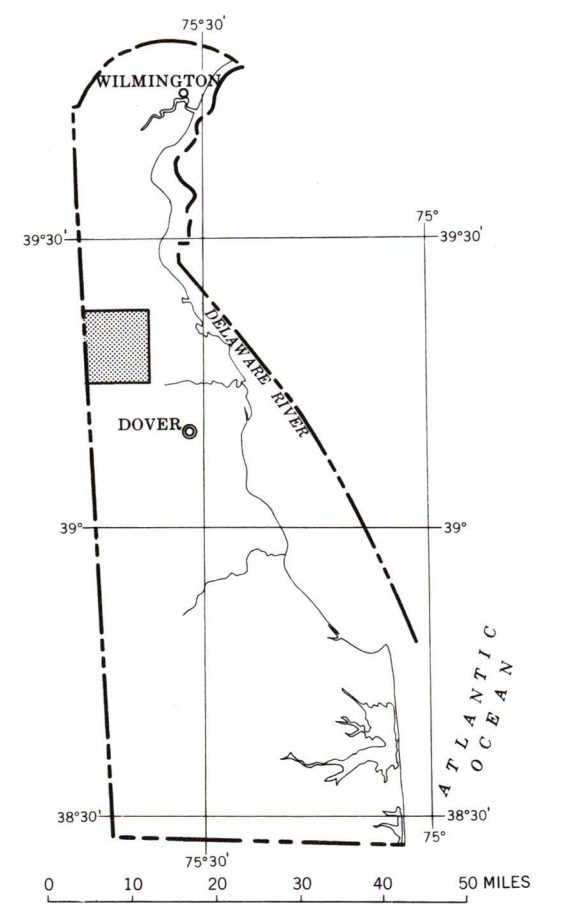


FIGURE 1.—Index map of Delaware showing location of the Clayton Area

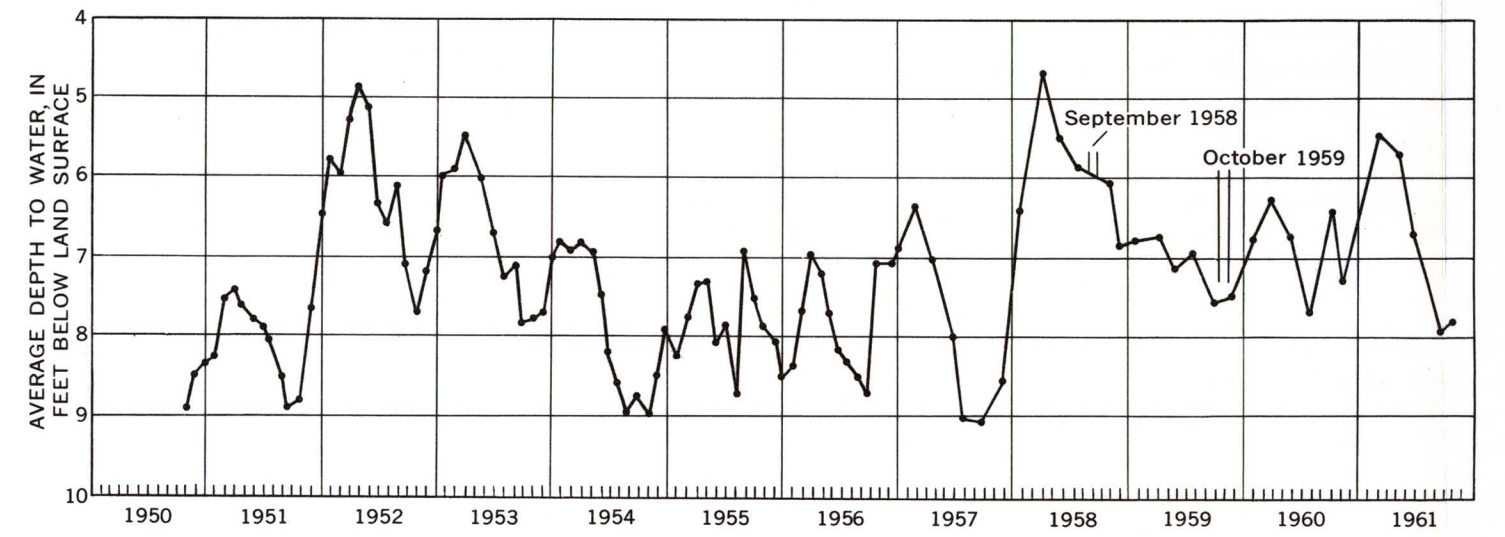


FIGURE 2.—Hydrograph showing average depth to water in 12 water-table wells in Delaware

TABLE 2.—Soils classification

| General classification | Granular materials (15 percent or less passing a No. 200 sieve) | | | Silt-clay materials (more than 15 percent passing a No. 200 sieve) | | | | | | | | |
|--|---|---------|---------|--|---------|---------|---------|---------|---------|---------|---------|---------|
| | A-1 | A-2 | A-3 | 4 | 5 | 6 | 7 | A-4 | A-5 | A-6 | A-7 | A-8 |
| Sieve analysis | | | | | | | | | | | | |
| Percent passing No. 40 sieve | 50 max. | 30 max. | 10 max. | 35 max. | 35 max. | 35 max. | 35 max. | 38 min. | 38 min. | 36 min. | 38 min. | 38 min. |
| Percent passing No. 100 sieve | 10 max. | 15 max. | 10 max. | 15 max. | 15 max. | 15 max. | 15 max. | 10 max. | 10 max. | 10 max. | 11 min. | 11 min. |
| Percent passing No. 200 sieve | 15 max. | 25 max. | 15 max. | 15 max. | 15 max. | 15 max. | 15 max. | 10 max. | 10 max. | 10 max. | 11 min. | 11 min. |
| Characteristics of fraction passing No. 40 sieve | Nonplastic | | | Plastic | | | | | | | | |
| Liquid limit | 40 max. | | | 40 max. | | | | | | | | |
| Plasticity index | 6 max. | | | 6 max. | | | | | | | | |
| Group index | 0 | | | 0 | | | | | | | | |
| General subgrade rating | Excellent | | | Poor | | | | | | | | |
| Material | Well-graded gravel and sand | | | Poorly graded, silty or clayey sand and gravel | | | | | | | | |

¹Plasticity index of A-1-5 subgroup is equal to or less than the liquid limit minus 30.

²Plasticity index of A-1-5 subgroup is greater than the liquid limit minus 30.

TABLE 3.—Results of laboratory analyses of soil samples

| Sample no. | Depth of soil (feet) | Cumulative percent passing | Mechanical analysis | | | Liquid limit | Plasticity index | Group | Classification | Map symbol |
|------------|----------------------|----------------------------|---------------------|---------|---------|--------------|------------------|-------|----------------|------------|
| | | | No. 40 | No. 100 | No. 200 | | | | | |
| 53 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 54 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 55 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 56 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 57 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 58 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 59 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 60 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 61 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 62 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 63 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 64 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 65 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 66 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 67 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 68 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 69 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 70 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 71 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 72 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 73 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 74 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 75 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 76 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 77 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 78 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 79 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 80 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 81 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 82 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 83 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 84 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 85 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 86 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 87 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 88 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 89 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 90 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 91 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 92 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 93 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 94 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 95 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 96 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 97 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 98 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 99 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |
| 100 | 0-4 | 98.0 | 88.4 | 81.1 | 28.4 | 10 | NP | A-2-4 | AM24 | |

TABLE 4.—Characteristics of the engineering soil types in the Clayton area

| Soil type | Description | Origin | Engineering properties | | | | Suitable compaction equipment |
|-----------|--|---|---|--|---|---|--|
| | | | Suitability as a subgrade ¹ | Suitability as an embankment material | Suitability as an embankment material | Compaction characteristics | |
| AM24 | Nonplastic to slightly plastic, sandy and silty soil. | Fluvial deposits of Pleistocene age. | Fair to good depending on amount of A-4 and A-2 present. | Poor if surface is on A-4, good to excellent depending on amount of A-4 and A-2 present. | 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 deposits of Pleistocene age. | Fair. | Poor to fair. | Fair to good depending on relative amounts of A-3 and A-4 present. | Fair to good depending on relative amounts of A-3 and A-4 present. | Rubber-tired equipment. |
| M4 | Slightly plastic, silty and clayey soil. | Marine deposits. | Poor to fair. | Poor to fair. | Poor to fair. | Poor to fair. | Rubber-tired equipment. |
| M46 | Slightly plastic to highly plastic, silty clay and clayey soil. | Marine deposits. | Not suitable to poor, depending on amount of A-6 material left after grading. | Not suitable if surface is A-4. | Not suitable to poor, depending on amount of A-6 and A-4 present. | Poor. | Sheep's-foot rollers. |
| U | Urban areas where soil has been altered extensively by man. | Undetermined. | Variable. | Variable. | Variable. | Variable. | Variable. |
| Z | Poorly drained soil rich in organic material. | Swamp deposits of recent age. | Not suitable. | Not suitable. | Not suitable. | Not suitable. | Variable. |
| AR/Z | Alluvial gravel, sand, silt, and clay mixed with organic material. | Alluvium and swamp deposits. | Variable. | Variable. | Variable. | Variable. | Variable. |
| AM24/4 | Nonplastic to slightly plastic sandy and silty soil associated with silty clayey soil of Pleistocene age. | Fluvial, alluvial and lacustrine deposits of Pleistocene age. | Not suitable to good, depending on amount of A-4 and A-2 material left after grading. | Not suitable if surface is A-4. | Not suitable to good, depending on relative amounts of A-4 and A-2 present. | Not suitable to good, depending on relative amounts of A-4 and A-2 present. | Rubber-tired equipment for AM24, sheep's-foot rollers for AM4. |
| AM24/2 | Nonplastic to highly plastic, silty clay and clayey soil associated with poorly drained soil rich in organic material. | Fluvial deposits of Pleistocene age and swamp deposits of recent age. | Not suitable to good, depending on amount of A-2 material left after grading. | Not suitable if surface is A-4. | Not suitable to good, depending on relative amounts of A-4 and A-2 present. | Not suitable to good, depending on relative amounts of A-4 and A-2 present. | Variable. |
| AM4/2 | Nonplastic to slightly plastic, sandy and silty soil. | Fluvial deposits of Pleistocene age. | Fair to good depending on amount of A-4 material left after grading. | Poor if surface is A-4. | 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. |
| AM46/2 | Nonplastic to highly plastic, silty clay and clayey soil. | Fluvial deposits of Pleistocene age. | Not suitable to good, depending on amount of A-4 material left after grading. | Not suitable if surface is A-4. | Not suitable to good, depending on relative amounts of A-4 and A-2 present. | Not suitable to good, depending on relative amounts of A-4 and A-2 present. | Rubber-tired equipment for AM46, sheep's-foot rollers for AM4. |

¹For soil types designated by two-digit numbers, these columns refer to the composite soil.

²When not subject to frost action. Frost will affect soils that contain appreciable silt and clay and have a high moisture content.

³Untreated. Additives may aid in stabilization of the sandy soils and minimize dusty conditions.

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

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1964