SOIL SURVEY OF

Passaic County, New Jersey

United States Department of Agriculture
Soil Conservation Service
In cooperation with
New Jersey Agricultural Experiment Station
and
Cook College, Rutgers University

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1967–69. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made cooperatively by the Soil Conservation Service and the New Jersey Agricultural Experiment Station and Cook College of Rutgers University. It is part of the technical assistance furnished to the Northeast Jersey Soil Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Passaic County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the woodland suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and the woodland groups.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the section "Town and Country Planning."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed, their morphology, and how they are classified in the section "Formation, Morphology, and Classification of the Soils."

Newcomers in Passaic County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication.

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SOIL SURVEY OF PASSAIC COUNTY, NEW JERSEY

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SOILS SURVEYED BY LESTER L. SEGLIN AND ROY A. SHOOK, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION AND COOK COLLEGE OF RUTGERS UNIVERSITY

PASSAIC COUNTY is in the northern part of New Jersery (fig. 1). It occupies approximately 199.5 square miles, including 7.5 square miles of water area.

Passaic County, in the heart of the New York-New Jersey metropolitan area, is shaped like a bent hourglass. It consists of two contrasting areas. The upper half of the county is sparsely populated, is wooded, and has stony, rough, and steep topography. Scattered throughout this area are ponds, lakes, and reservoirs (fig. 2). The lower half of the county is generally marked by low relief and contains 90 percent of the population and most of the industrial and commercial land (fig. 3).

In 1969 the population of Passaic County was approximately 468,000. About 280,000 of these people lived in the cities of Clifton, Passaic, and Paterson.

Of the county's 122,880 acres, 1,518, or 1.2 percent, is farmland. The average size of a farm is 25.3 acres. Farming is characteristically highly specialized, mainly in nursery, vegetable, poultry, dairy, and fruit products. The number of farms decreased from 120 in 1964 to 60 in 1969. Of these, 41 were classified as commercial.

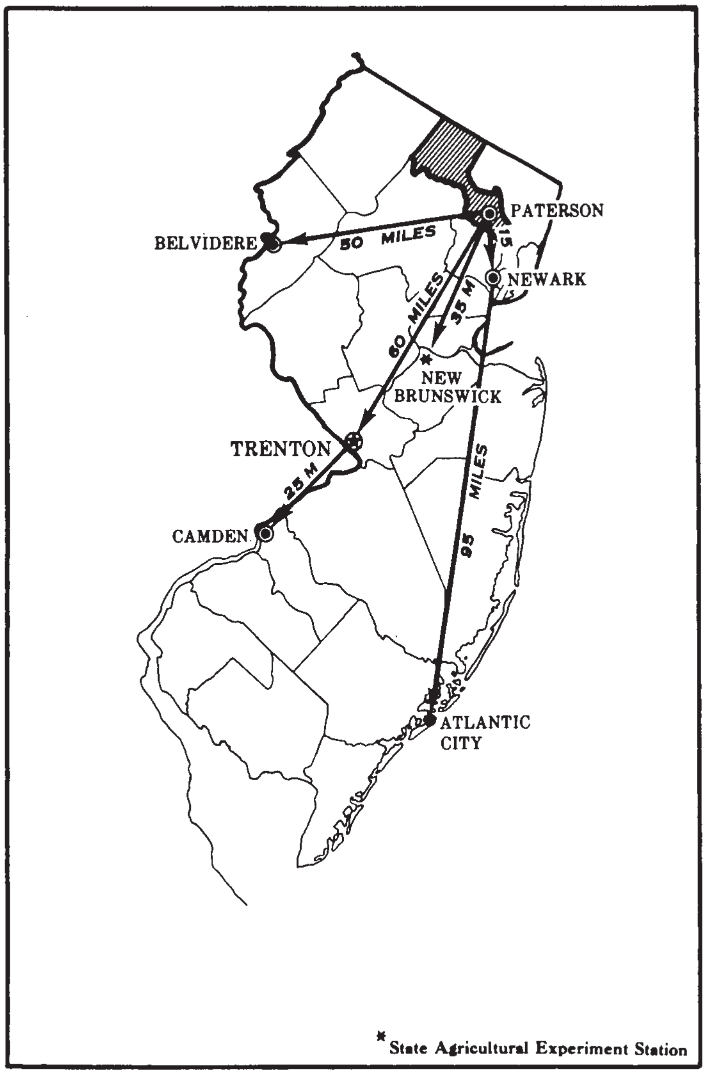

Figure 1.—Location of Passaic County in New Jersey.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Passaic County, where they are located, and how they can be used. They went into

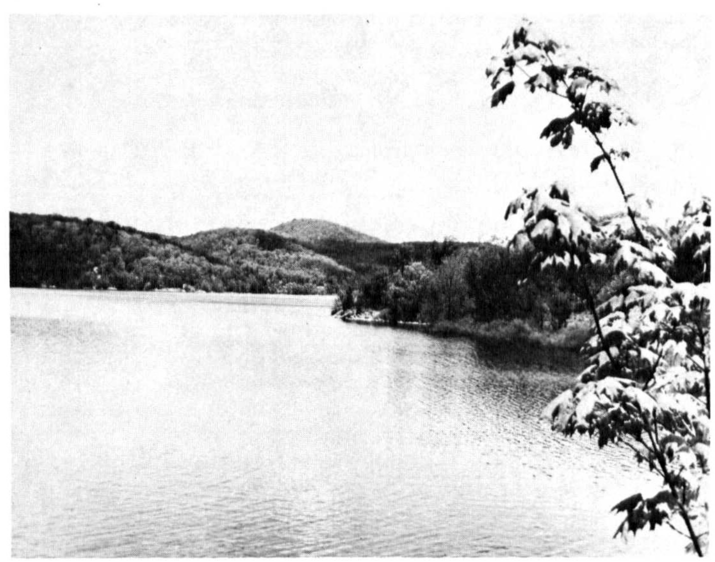

Figure 2.—Wanaque Reservoir, Passaic County.

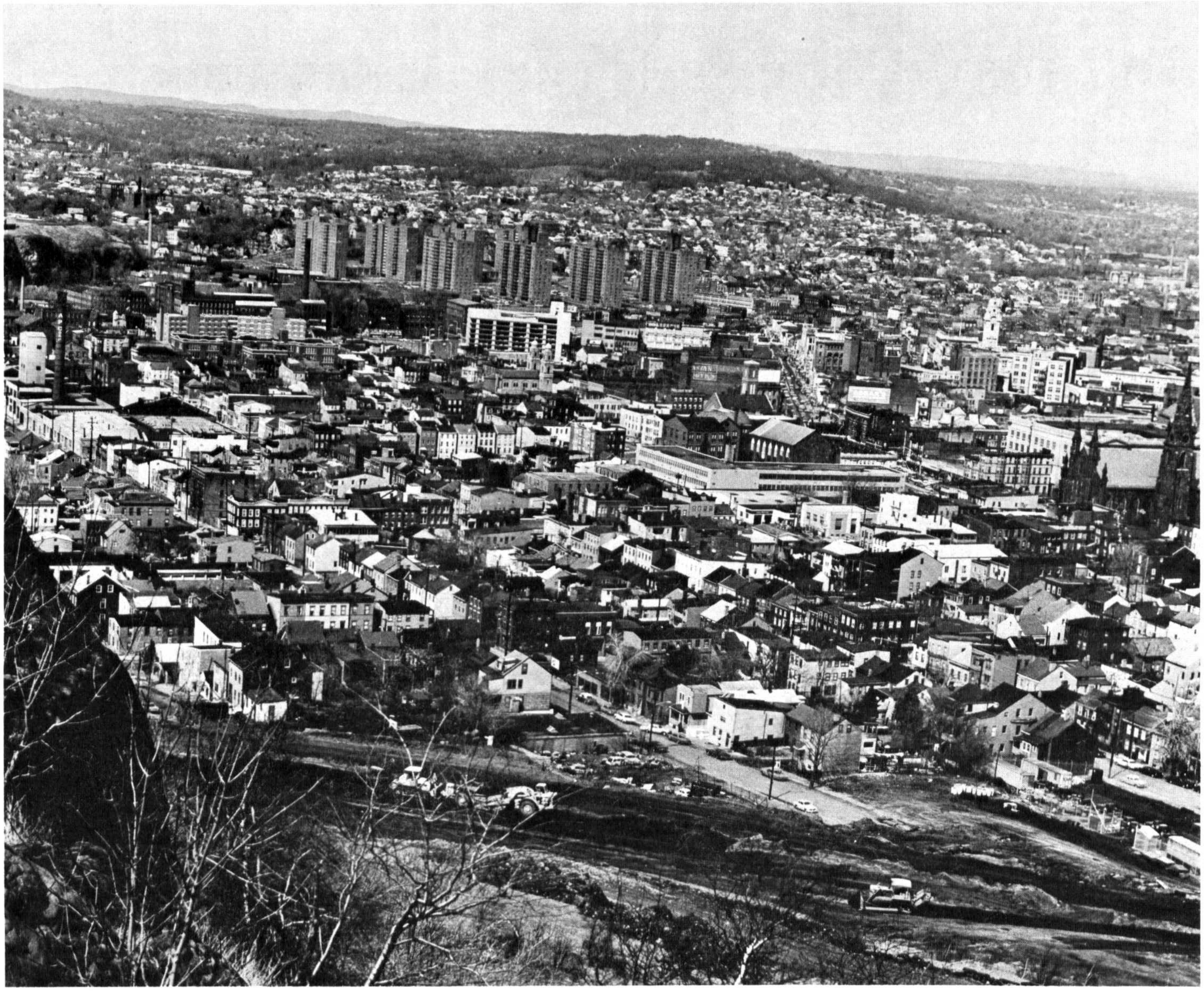

Figure 3.—View east from Garrett Mountain. This area is used for industrial, residential, and commercial purposes.

the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Haledon and Preakness, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man.

On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Boonton stony silt loam, 3 to 8 percent slopes, is one of several phases within the Boonton series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit is shown on the soil map of Passaic County: soil complexes.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Holyoke-Rock outcrop complex, 3 to 15 percent slopes, is an example.

In most areas surveyed are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Alluvial land is a land type in this county.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or to a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Passaic County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The soil associations in Passaic County are discussed in the following pages.

1. Rockaway-Rock outcrop-Hibernia association

Gently sloping to very steep, moderately well drained and somewhat poorly drained, very stony or extremely stony soils and gently sloping to very steep rock outcrops

This association is mostly in the Highlands in the northern part of the county. Elevation ranges from 400 to 1,200 feet. Areas of Rock outcrop are generally at the higher elevations.

This association makes up 50 percent of the county. About 40 percent of it is Rockaway soils, 20 percent is Rock outcrop, and 10 percent is Hibernia soils. The rest is Ridgebury and Netcong soils and small areas of other soils.

Rockaway soils are mainly moderately well drained, but they are well drained in places. Slopes range from 3 to 25 percent. These soils are generally on hilltops and upper parts of hillsides. They are very stony or extremely stony. The subsoil is slowly permeable. In winter and spring excess water moves laterally above the firm subsoil and is released if the soils are excavated.

Rock outcrop is mostly hard granitic gneiss. Most areas are at the higher elevation where slopes are steep. These areas are severely limited for use in urban development. Excavations for roads, foundations, utilities, septic systems, and wells generally require blasting. Where rock outcrops are numerous, they limit accessibility.

Hibernia soils are somewhat poorly drained, and they are extremely stony. Slopes range from 3 to 15 percent. These soils are on lower parts of the landscape than the steeper, adjacent soils. The subsoil is slowly permeable. In winter and spring excess water moves laterally above the firm subsoil and is released if the soils are excavated.

Netcong soils are well drained and are only slightly limited for use in urban development. A seasonal high water table severely limits the use of Ridgebury soils for urban development.

The gently sloping and sloping Rockaway soils have fewer limitations for use in residential development than other soils in this association, especially if community sewage and water are available. Careful design and installation of onsite septic fields are needed because of the likelihood of lateral water movement and of pollution of adjacent water resources.

2. *Swartswood-Norwich-Wurtsboro association*

Nearly level to very steep, moderately well drained to poorly drained, very stony or extremely stony soils

This association is mostly in the Highlands in the northwestern part of the county. Elevation ranges from 750 to 1,000 feet.

This association makes up 10 percent of the county. About 60 percent is Swartswood soils, 10 percent is Norwich soils, and 10 percent is Wurtsboro soils. The rest is Chenango, Rockaway, and Ridgebury soils.

Swartswood soils are mostly moderately well drained, but some are well drained. Slopes range from 3 to 45 percent. These soils are on tops and sides of hills. They are very stony or extremely stony.

Norwich soils are poorly drained. Slopes range from 0 to 8 percent. These soils are in low positions in the landscape. They are extremely stony.

Wurtsboro soils are moderately well drained or somewhat poorly drained. Slopes range from 3 to 15 percent. These soils are extremely stony.

Chenango and Rockaway soils are well drained or moderately well drained. Ridgebury soils are poorly drained.

The soils in this association have a slowly permeable subsoil because of a fragipan. This fragipan slows downward movement of water and causes it to move laterally. In places water is released in excavations.

The less steeply sloping Swartswood soils have fewer limitations for urban development than the other soils in this association. Wurtsboro and Norwich soils have a seasonally high water table and are extremely stony.

3. *Swartswood-Rock outcrop association*

Gently sloping to very steep, well drained and moderately well drained, very stony or extremely stony soils and steep to very steep rock outcrops

This association is in the steepest part of the Highlands in the northwestern part of the county. Elevation ranges from 1,000 to 1,490 feet.

This association makes up 5 percent of the county. About 50 percent is Swartswood soils and 30 percent is Rock outcrops. The rest is Carlisle, Norwich, Chenango, and Wurtsboro soils.

Swartswood soils are well drained and moderately well drained. Slopes range from 3 to 45 percent but are mostly more than 15 percent. These soils are on tops and sides of hills. They are very stony or extremely stony. The stones are closely spaced angular sandstone. The lower part of the subsoil is firm, which causes excess water to move laterally.

Sandstone outcrops and hard conglomerate are generally on mountaintops and adjacent escarpments.

Carlisle and Norwich soils are poorly drained. Chenango soils are well drained, and Wurtsboro soils are moderately well drained or somewhat poorly drained.

The assocation is mostly wooded. Some areas are State forests. Soil features that severely limit use of the soils for urban development are rock outcrops, steep slopes, stoniness, and, in Swartswood soils, the slowly permeable subsoil.

4. *Urban land-Boonton-Riverhead association*

Gently sloping and sloping altered soils and gently sloping to steep, well drained and moderately well drained soils

This association is mostly in the urbanized part of the county. Elevation ranges from 10 to 400 feet.

This association makes up 25 percent of the county. About 50 percent of it is Urban land, 15 percent is Boonton soils, and 10 percent is Riverhead soils. The rest is Pompton, Whippany, and Parsippany soils.

Urban land is used for residential, commercial, or industrial purposes. During construction most of the original soil properties were altered by excavation or filling.

Boonton soils are well drained or moderately well drained, and they are stony or very stony. Slopes range from 3 to 30 percent. These soils are on side slopes. They have a slowly permeable fragipan in the lower part of the subsoil. This fragipan slows the downward movement of water and causes it to move laterally in winter and spring.

Riverhead soils are well drained. Slopes range from 3 to 15 percent. These soils are on intermediate positions in valleys. The surface layer is sandy loam, and the substratum is gravelly sand that is rapidly permeable.

Pompton, Whippany, and Parsippany soils have a fluctuating seasonal high water table that limits use for urban development.

Nearly all of the acreage of this association is used for urban development. Most areas of Boonton and Riverhead soils were developed as separate projects, so the soil was not disturbed nearly so much as it is when large areas are developed all at one time. Riverhead soils are well drained and are only slightly limited for use in urban developments.

5. *Boonton-Haledon-Haledon, wet variant, association*

Nearly level to steep, well-drained to poorly drained, mainly stony or very stony soils

This association is in the southern part of the county. Elevation ranges from 300 to 600 feet.

This association makes up 5 percent of the county. About 30 percent is Boonton soils, 15 percent is Haledon soils, and 15 percent is Haledon, wet variant, soils. The rest is Urban land, Holyoke soils, and quarries.

Boonton soils are on side slopes. They are well drained or moderately well drained. Slopes range from 3 to 30 percent. These soils are stony or very stony. They have a slowly permeable subsoil that slows the downward movement of water and causes it to move laterally in winter and spring.

Haledon soils are somewhat poorly drained. Slopes range from 3 to 15 percent. These soils are on toe slopes. They are very stony. They have a firm, slowly permeable subsoil that slows downward movement of water and causes it to move laterally.

Haledon, wet variant, soils are poorly drained. Slopes range from 0 to 8 percent. These soils are in low positions on the landscape. They have a firm subsoil that slows downward movement of water and causes it to move laterally. Holyoke soils are shallow to bedrock.

Part of this association is in idle fields, woods, parks, and golf courses. Other areas have been used for industrial, commercial, or residential development. Stoniness, steep slopes, and drainage are the main limitations of these soils to use for urban development.

6. *Holyoke-Rock outcrop association*

Gently sloping to very steep, well-drained soils that are shallow to bedrock and gently sloping to very steep rock outcrops

This association is basalt bedrock outcrops and soils between the outcrops that generally have bedrock at a depth of less than 20 inches. Elevation ranges from 300 to 800 feet.

This association makes up 5 percent of the county. About 50 percent is Holyoke soils, and 20 percent is Rock outcrops. The rest is Boonton, Haledon, and Haledon, wet variant, soils.

Holyoke soils are well drained. Depth to bedrock is less than 20 inches. Slopes range from 3 to 35 percent. The soils are on tops or sides of hills and occur in intricate patterns with Rock outcrops.

Rock outcrops are basalt. Slopes range from 3 to 35 percent in areas of Rock outcrop. In most places the basalt is hard. Blasting is required for excavations.

Boonton, Haledon, and Haledon, wet variant, soils are deep. Haledon, wet variant, soils are poorly drained. Haledon and Boonton soils are well drained to somewhat poorly drained. They are stony to very stony.

This association has severe limitations for most urban developments. Limitations are caused by hard rock outcrops, shallow soil over hard bedrock, and steep slopes. Rock outcrops affect accessibility, road construction, and excavations for foundations, utility lines, septic systems, and water wells. Individual houses are feasible in places on the deeper soils and on the lower parts of slopes.

Descriptions of the Soils

In this section each soil series of Passaic County is described in detail, and the mapping units in that series are described briefly. Unless specifically mentioned otherwise, it is assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, colors given in the descriptions are those of a moist soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land, for example, does not belong to a soil series, but nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and woodland group in which the mapping unit has been placed.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*12*).[1]

Alluvial land

Alluvial land (Ae) consists mostly of somewhat poorly drained and poorly drained soils on flood plains 3 to 8 feet above the normal stream level. These soils are flooded one or more times each year, generally for periods of 2 to 5 days. During these periods all kinds of material are deposited throughout the flooded areas. Slopes range from 0 to 3 percent.

The soil material and surface characteristics of Alluvial land are quite variable within short distances. The top 12 inches of the profile is generally silt loam or fine sandy loam. The surface layer is

[1] Italic numbers in parentheses refer to Literature Cited, p. 68.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Alluvial land	860	0.7
Boonton stony silt loam, 3 to 8 percent slopes	920	.7
Boonton stony silt loam, 8 to 15 percent slopes	700	.6
Boonton very stony silt loam, 15 to 30 percent slopes	570	.5
Braceville gravelly silt loam, 0 to 5 percent slopes	300	.2
Carlisle muck	1,390	1.1
Chenango silt loam, 3 to 8 percent slopes	850	.7
Chenango silt loam, 8 to 15 percent slopes	310	.3
Haledon very stony loam, 3 to 8 percent slopes	620	.5
Haledon very stony loam, 8 to 15 percent slopes	600	.5
Haledon very stony silt loam, wet variant, 0 to 3 percent slopes	480	.4
Haledon very stony silt loam, wet variant, 3 to 8 percent slopes	600	.5
Hibernia extremely stony loam, 3 to 15 percent slopes	5,850	4.8
Holyoke-Rock outcrop complex, 3 to 15 percent slopes	3,870	3.1
Made land, sanitary land fill	50	(1)
Muck, shallow	770	.6
Netcong extremely stony loam, 3 to 15 percent slopes	1,380	1.1
Netcong extremely stony loam, 15 to 25 percent slopes	480	.4
Norwich extremely stony silt loam, 0 to 3 percent slopes	1,490	1.2
Norwich extremely stony silt loam, 3 to 8 percent slopes	470	.4
Otisville sandy loam, 3 to 15 percent slopes	220	.2
Otisville gravelly sandy loam, 15 to 30 percent slopes	160	.1
Parsippany silt loam, sandy loam substratum	1,470	1.2
Pits, sand and gravel	670	.5
Pompton fine sandy loam, 0 to 5 percent slopes	840	.7
Preakness silt loam	1,020	.8
Ridgebury extremely stony loam, 0 to 3 percent slopes	3,270	2.7
Ridgebury extremely stony loam, 3 to 8 percent slopes	1,670	1.4
Riverhead sandy loam, 3 to 8 percent slopes	1,620	1.3
Riverhead sandy loam, 8 to 15 percent slopes	520	.4
Rockaway very stony sandy loam, 3 to 8 percent slopes	1,980	1.6
Rockaway very stony sandy loam, 8 to 15 percent slopes	1,380	1.1
Rockaway extremely stony sandy loam, 3 to 15 percent slopes	8,050	6.6
Rockaway extremely stony sandy loam, 15 to 25 percent slopes	3,300	2.7
Rockaway-Rock outcrop complex, 3 to 15 percent slopes	12,200	9.9
Rock outcrop-Holyoke complex, 15 to 35 percent slopes	2,090	1.7
Rock outcrop-Rockaway complex, 15 to 35 percent slopes	12,300	10.0
Rock outcrop-Swartswood complex, 15 to 45 percent slopes	2,670	2.2
Swartswood very stony fine sandy loam, 3 to 8 percent slopes	2,340	1.9
Swartswood very stony fine sandy loam, 8 to 15 percent slopes	950	.8
Swartswood extremely stony fine sandy loam, 3 to 8 percent slopes	1,030	.8
Swartswood extremely stony fine sandy loam, 8 to 15 percent slopes	1,330	1.1
Swartswood extremely stony fine sandy loam, 15 to 25 percent slopes	1,300	1.1
Swartswood-Rock outcrop complex, 3 to 15 percent slopes	4,090	3.3
Urban land-Boonton complex, gently sloping	11,600	9.5
Urban land-Boonton complex, sloping	3,970	3.2
Urban land-Riverhead complex, gently sloping	12,600	10.3
Urban land-Rockaway complex	3,430	2.8
Whippany silt loam, sandy loam substratum, 0 to 5 percent slopes	290	.2
Wurtsboro extremely stony silt loam, 3 to 8 percent slopes	1,170	1.0
Wurtsboro extremely stony silt loam, 8 to 15 percent slopes	380	.3
Quarries	420	.3
Total	122,880	100.0

(1) Less than 0.05 percent.

several feet thick, and it is underlain by coarse sand and gravel.

Included with this land type in mapping were areas where the surface layer is coarse sand. Also included were areas of well drained to moderately well drained soils on higher positions of the flood plain.

The soils in this land type have a seasonal high water table that generally ranges from 1/2 to 3 1/2 feet in depth. In summer, however, depth to the water table ranges from 1 to 5 feet.

Most areas of this land type are wooded. Flooding is the major limitation to use. Capability unit VIw-46; woodland group 4w.

Boonton Series

The Boonton series consists of gently sloping to steep loamy soils that have a fragipan in the lower part of the subsoil. These soils are moderately well drained and well drained. They are on the sides of the three basalt ridges in the southern part of the county and in adjacent areas. The soils formed in glacial till derived principally from basalt, sandstone, shale, and granitic gneiss. Most of this acreage is in urban areas. Small areas are wooded or are idle fields. The trees in the wooded areas are dominantly red oak, red maple, ash, dogwood, and birch.

In a representative profile the surface layer is dark-brown silt loam about 8 inches thick. The upper part of the subsoil is dark yellowish-brown fine sandy loam about 7 inches thick. The middle part is dark-brown gravelly loam and gravelly fine sandy loam about 15 inches thick. The lower part of the subsoil, part of a fragipan that extends into the substratum, is mottled, dark reddish-brown gravelly sandy loam that is firm and brittle and is about 20 inches thick. The substratum, between depths of about 50 and 60 inches, is dark reddish-brown gravelly sandy loam that is very firm and brittle.

Permeability is moderate above the fragipan and slow in the fragipan. Late in winter, early in spring, and during periods of high precipitation, water above the fragipan moves laterally. A perched water table is at a depth of 1 1/2 to 4 feet. The dense, slowly permeable fragipan and the perched water table limit the use of these soils for onsite septic filter fields. Slips are a concern on roadbanks and on other slopes where the soil has been scalped, stockpiled, and redeposited directly on the fragipan. These stony and very stony soils have limitations for use as lawns and landscaped areas. The steep slopes are a severe limitation for some uses.

Representative profile of Boonton stony silt loam, 3 to 8 percent slopes, in Totowa Borough; 0.2 mile northeast of Totowa Road on Brookmans Lane and 585 feet east of Brookmans Lane, in idle pasture:

Ap—0 to 8 inches, dark-brown (10YR 4/3) silt loam; moderate, fine and medium, granular structure; very friable; common uncoated sand grains; many fibrous roots and common medium and coarse roots; many pores; 5 percent subangular stones, cobblestones, and pebbles; very strongly acid; clear, smooth boundary.

B1—8 to 15 inches, dark yellowish-brown (10YR 4/4) fine sandy loam; weak, medium, subangular blocky structure; very friable; many coated sand grains; many fibrous roots and common medium and coarse roots; common fine pores; 10 percent coarse fragments; very strongly acid; clear, wavy boundary.

B21—15 to 23 inches, dark-brown (7.5YR 4/4) gravelly loam; moderate, medium, subangular blocky structure; friable; common, thin, discontinuous clay films on horizontal and vertical ped faces; few thick clayfilms lining pores; common fibrous roots and a few medium and coarse roots; common fine pores; 15 percent pebbles and few cobblestones; strongly acid; clear, wavy boundary.

B22t—23 to 30 inches, dark-brown (7.5YR 4/4) gravelly fine sandy loam; weak, coarse and medium, subangular blocky structure; friable; few, thin, discontinuous clay films on horizontal and vertical ped faces; common fibrous roots and few medium and coarse roots; 20 percent coarse pebbles and few cobblestones; strongly acid; abrupt, smooth boundary.

Bx—30 to 50 inches, dark reddish-brown (5YR 3/4) gravelly sandy loam; few, fine, distinct, brown (7.5YR 5/2) mottles; strong, very thick, platy structure; very firm; brittle; common, thin and thick, discontinuous clay films on ped faces; few roots between peds; few discountinuous pores; 20 percent pebbles and few cobblestones and stones; strongly acid; gradual, wavy boundary.

Cx—50 to 60 inches, dark reddish-brown (5YR 3/4) gravelly sandy loam; weak, medium and thick, platy structure in upper part of horizon and massive in lower part; very firm; brittle; 25 percent pebbles and few cobblestones; slightly acid.

The thickness of the solum ranges from 40 to 60 inches. The depth to bedrock ranges from 6 to 10 feet. The depth to the fragipan ranges from 24 to 36 inches. Coarse fragments of basalt, granitic gneiss, red sandstone, and sale make up 5 to 35 percent of the profile and commonly increase with depth. Few to common stones are in the Ap horizon and a few are in the B horizon. The natural acidity decreases with depth from very strongly acid in the upper part of the solum to slightly acid in the Cx horizon.

The B horizon is fine sandy loam, sandy loam, loam, and silt loam. It is gravelly in places. Hue is 10 YR or 7.5YR, value is 4 or 5, and chroma is 4 to 6. Mottles range from none to common, and few low-chroma mottles are present. The C horizon ranges from sandy loam to fine sandy loam. It is gravelly in places.

Boonton soils are near Haledon; Haledon, wet variant; Holyoke; and Riverhead soils. Where low-chroma mottling is present in Boonton soils, it is at a greater depth than the mottling in Haledon soils. Boonton soils are much deeper than Holyoke soils. Unlike Riverhead soils, Boonton soils are very firm in the lower part of the subsoil.

Boonton stony silt loam, 3 to 8 percent slopes (BrB).—This soil has the profile described as representative of the series. Stones on the surface are 30 to 100 feet apart. Included in mapping were small areas of Holyoke, Haledon, and more sloping Boonton soils. Also included were areas of a soil that is similar to the Boonton soil but that lacks a fragipan.

The main soil features that affect the use of this soil are the dense, firm, slowly permeable fragipan and the content of stones. The hazard of erosion is slight if this soil is cleared. Capability unit IIe-5; woodland group 3o.

Boonton stony silt loam, 8 to 15 percent slopes (BrC).—This soil has a profile similar to the one described as representative of the series. Stones on the surface are 30 to 100 feet apart. Included in mapping were small areas of Boonton soils that are more sloping or less sloping than this soil and areas of Holyoke and Haledon soils. The Holyoke soils are shallower than this Boonton soil and the Haledon soils are wetter. Also included were areas of a soil that is similar to this Boonton soil but that lacks a fragipan.

The main characteristics that affect the use of this soil are the dense, firm, slowly permeable fragipan; slope; and the content of stones. The hazard of erosion is moderate if these soils are cultivated. Capability unit IIIe-5; woodland group 3o.

Boonton very stony silt loam, 15 to 30 percent slopes (BsD).—This soil has a profile similar to the one described as representative of the series, but stones on the surface are 5 to 30 feet apart. Included in mapping were areas of less sloping Boonton soils and areas of Holyoke soils. Also included were areas of soils that are similar to this Boonton soil but that lack a fragipan.

Most areas of this steep Boonton soil are wooded. In places homes have been built on this soil. The main soil features that affect the use of this soil are slope, stones, and the fragipan. Because control of erosion is difficult, a permanent cover of vegetation, such as grasses, trees, or shrubs, should be kept on this soil. Capability unit VIs-19; woodland group 3o.

Braceville Series

The Braceville series consists of moderately well drained loamy soils that have a weakly developed fragipan in the lower part of the subsoil. These nearly level to gently sloping soils are in the valleys in the rough, stony, and rocky Highlands in the northwestern part of the county. The soils formed in glacial outwash that was subseqeuntly reworked or influenced by slow-moving water during the glacial era. The glacial outwash is composed principally of conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. These soils are in idle farms, in communities, or are wooded.

In a representative profile the surface layer is dark-brown gravelly silt loam about 7 inches thick. The upper part of the subsoil is yellowish-brown gravelly silt loam about 10 inches thick. The middle part is mottled, yellowish-brown gravelly loam about 7 inches thick. The lower part of the subsoil is a mottled, brown gravelly loam fragipan that is very firm and brittle. It is about 14 inches thick. The substratum, between depths of 38 and 60 inches, is dark grayish-brown and grayish-brown gravelly loamy sand.

Permeability is moderate above the fragipan and slow in the fragipan. Water moves laterally above the fragipan late in winter, early in spring, and when the soil above the fragipan approaches saturation. Available water capacity is moderate. The soil is a good source of gravel and sand. A seasonal high water table ranges in depth from 1½ to 3 feet and remains high for several months late in winter and early in spring. Sidewalls of excavations collapse readily in these soils. The soils are not suitable as an aggregate for cement where the shale content is high or strongly weathered. The seasonal high water table is the most limiting soil property where these soils are used for community development. The rapid permeability in the substratum causes a hazard of pollution if these soils are used for onsite septic disposal systems.

Representative profile of Braceville gravelly silt loam, 0 to 5 percent slopes, in a wooded area in West Milford Township, 20 feet south of Kanouse Road and 1,560 feet east of intersection of Kanouse Road and Hilltop Road:

O1—3 inches to 2, leaf litter; original form easily discernible.

O2—2 inches to 0, black (5YR 2/1) decayed vegetation; origin barely discernible; extremely acid; abrupt, smooth boundary.

A1—0 to 7 inches, dark-brown (10YR 3/3) gravelly silt loam; weak, medium, subangular blocky structure parting to moderate, medium and coarse, granular; very friable; many uncoated sand grains; many, medium, fibrous roots; many fine pores; 20 percent pebbles and few cobblestones; very strongly acid; clear, wavy boundary.

B21—7 to 17 inches, yellowish-brown (10YR 5/6) gravelly silt loam; weak, medium, subangular blocky structure parting to moderate, medium, granular; friable; many, medium, fibrous roots; many fine pores; 25 percent pebbles and cobblestones; very strongly acid; clear, wavy boundary.

B22—17 to 24 inches, yellowish-brown (10YR 5/6) gravelly loam; common, coarse and medium, faint, pale-brown (10YR 6/3) mottles; weak, medium, subangular blocky structure; few, medium, fibrous roots; common fine pores; 30 percent pebbles and cobblestones; very strongly acid; abrupt, smooth boundary.

Bx—24 to 38 inches, brown (10YR 5/3) gravelly loam; many, coarse, prominent, yellowish-brown (10YR 5/6) mottles and many, coarse, prominent, gray (10YR 5/1) mottles; weak, thick, platy structure; very firm; brittle; thin patchy clay films on ped faces in mottled areas; few noncontinuous pores; 35 percent coarse pebbles; strongly acid; gradual, wavy boundary.

IIC—38 to 60 inches, dark grayish-brown (10YR 4/2) intermixed with grayish-brown (10YR 5/2) gravelly loamy sand; few, fine and medium, dark reddish-brown (2.5YR 3/4) mottles; massive; firm in place, friable when removed; common fine pores; 45 percent pebbles and cobblestones; medium acid.

The thickness of the solum ranges from 30 to 40 inches. The depth to bedrock is generally more than 10 feet. Depth to the fragipan ranges from 15 to 30 inches. Coarse fragments, some as large as cobblestones, make up 5 to 30 percent of the soil material near the surface, 20 to 50 percent of the lower part of the B horizon, and 25 to 65 percent of the C horizon. Coarse fragments consist of conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. Natural reaction ranges from very strongly acid at the surface to neutral in the C horizon.

In cultivated areas the Ap horizon is generally dark yellowish-brown (10YR 4/4). In the B horizon are brownish colors that have a hue of 10YR and 2.5Y and a value and chroma of 4/4, 5/3, 5/4, and 5/6. The B2 horizon ranges from gravelly silt loam to gravelly fine sandy loam, and the Bx horizon ranges from gravelly sandy loam to gravelly loam. Mottles are below a depth of 16 to 24 inches. In places low-chroma mottles are common to many but are not dominant on ped surfaces above a depth of 20 inches. The C horizon ranges from dark grayish brown (10YR 4/2) or dark brown (10YR 3/3) to grayish brown (10YR 5/2). The IIC horizon is stratified, and it ranges from very gravelly sand to gravelly loamy sand.

These soils formed in glacial outwash material that has had the upper few feet reworked or influenced by slow-moving water during the glacial era. The water-reworked part of the soil is that part that has the higher percentage of clay, silt, and very fine sand. Soil-formation processes are reflected in this part of the profile to a greater degree than in the soil material deeper in the profile.

Braceville soils are near Chenango and Preakness soils that also formed in glacial outwash, and near Swartswood, Wurtsboro, and Norwich soils that formed in glacial till. Braceville soils have a mottled subsoil that Chenango soils lack. They lack the gray-colored subsoil common to Preakness and Norwich soils. Braceville soils, unlike Swartswood and Wurtsboro, have a loose, stratified substratum.

Braceville gravelly silt loam, 0 to 5 percent slopes (BtA).—This soil has the profile described as representative of the series. Included in mapping were slightly wetter areas where gray mottling is closer to the surface than it is in Braceville soils. Also included were areas of Chenango, Preakness, and Norwich soils. The Preakness and Norwich soils are wetter than Braceville soils and in places need more drainage improvement than Braceville soils.

This soil has been farmed but is now mostly in urban use. Some areas are wooded. High-value crops or plants need some drainage in places to prevent waterlogging above the fragipan. The main soil feature that affects the use of this soil is the fragipan. It causes slow permeability and a seasonally perched water table. Rapid permeability in the substratum creates a hazard of pollution if used for onsite septic filter fields. Capability unit IIw-24; woodland group 3o.

Carlisle Series

The Carlisle series consists of deep, very poorly drained muck. These nearly level soils are in depressions and in low areas bordering lakes, ponds, and streams. In most places they are subject to annual flooding. The soils formed in the partly decayed remains of plant debris that have gradually accumulated over a period of thousands of years.

In a representative profile the surface layer is highly decomposed black muck about 12 inches thick. Below this, to a depth of about 48 inches, is dark reddish-brown spongy and fibrous muck that contains woody coarse fragments. Between depths of 48 and 60 inches, the organic material is moderately decomposed, spongy and fibrous, dark reddish-brown muck. It is composed mostly of herbaceous plant remains.

Permeability is rapid. Available water capacity is high. These soils remain saturated unless drained. If drained they subside. They are unstable and highly compressible. The water table is at the surface late in fall to late in spring. It is at a depth of 2 feet in summer. These soils are not farmed. They have potential for excavated ponds that can be used for irrigation or as habitat for fish and other wildlife.

Representative profile of Carlisle muck, in West Milford Township; 2,200 feet west of intersection of Macopin and West Brook Roads:

Oa1—0 to 12 inches, black (5YR 2/1, broken face and rubbed) sapric material; about 20 percent fibers, 5 percent when rubbed; moderate, coarse, granular structure; friable; slightly acid; gradual, wavy boundary.

Oa2—12 to 30 inches, dark reddish-brown (5YR 2/2, broken face and rubbed) sapric material, changes to black on exposure; about 30 percent fibers, less than 10 percent when rubbed; weak, coarse, subangular blocky structure; 15 percent woody coarse fragments, 1/4 inch to 6 inches in diameter; medium acid; gradual, wavy boundary.

Oa3—30 to 48 inches, dark reddish-brown (5YR 2/2, broken face and rubbed) sapric material; about 30 percent fibers, less than 10 percent when rubbed; massive; 15 percent woody fragments, 1/4 inch to 6 inches in diameter, in a matrix of herbaceous material; medium acid; gradual, wavy boundary.

Oa4—48 to 60 inches, dark reddish-brown (5YR 2/2, broken face and rubbed) hemic material; about 50 percent fibers, 15 percent when rubbed; massive; mostly herbaceous material; slightly acid.

The thickness of the organic deposit is more than 51 inches. Woody coarse fragments are throughout most profiles and make up 0 to 30 percent of each horizon. These coarse fragments range from 1/4 inch to 6 inches in diameter. They are the remains of twigs, branches, logs, and stumps. The reaction of the subsurface tier ranges from medium acid to mildly alkaline.

The upper 12 inches is generally sapric material but ranges to hemic in some profiles. The next 23 inches ranges from black (5YR 2/1 or N 2/0) to dark brown (10YR 3/3). Broken faces darken quickly if they are exposed to the air. This layer is mostly decomposed, and it is less than 10 percent fibers when rubbed. Thin layers of less decomposed, more fibrous material are also in this layer. Structure ranges from granular to blocky in the upper part but is massive at a depth of more than 30 inches. Below a depth of 35 inches the soil is generally more fibrous and less decomposed, but in many profiles it is similar to the horizon above.

Carlisle soils are near Hibernia, Norwich, Parsippany, Preakness, Ridgebury, and shallow muck soils. Carlisle soils, unlike these soils, have an organic layer at the surface that is more than 51 inches thick.

Carlisle muck (Ca).—This soil has the profile described as representative of the series. Included in mapping were shallow muck around the edges of areas of this soil and many areas of muck that has calcareous marl between depths of 30 and 72 inches. Also included were Alluvial land and Preakness soils.

Most areas are wooded. The trees in the wooded areas are elm, red maple, and other water-tolerant species. Many areas have only small trees, shrubs, and perennial weeds.

Drainage is needed if this soil is cultivated. Many areas are too small to drain economically. In most areas a drainage outlet is extremely costly to obtain. Capability unit IIIw-41; woodland group 5w.

Chenango Series

The Chenango series consists of well-drained, loamy soils that have a substratum of very gravelly sand. These gently sloping to strongly sloping soils are in valleys in the rough, stony, and rocky Highlands in the northwestern part of the county. They formed in glacial outwash that was reworked by slower moving water. The outwash material is composed principally of conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. Large areas of these soils are in urban use. Many areas are idle farmland.

In a representative profile the surface layer is very dark grayish-brown silt loam about 2 inches thick. The subsurface layer is dark yellowish-brown silt loam about 6 inches thick. The upper part of the subsoil is yellowish-brown gravelly silt loam 12 inches thick. The lower part is dark yellowish-brown and olive-brown gravelly silt loam 6 inches thick. The substratum, between depths of 26 and 60 inches, is mixed brownish and grayish very gravelly sand.

The available water capacity is moderate. Permeability is moderate in the subsoil and rapid in the substratum. These soils are generally a source of sand and gravel. Use of the gravel as aggregate for concrete depends on the percentage and degree of weathered shale and sandstone. These soils have slight to moderate limitations for most community development. If used for onsite septic effluent disposal, rapid permeability in the substratum is a pollution hazard.

Representative profile of Chenango silt loam, 3 to 8 percent slopes, in a wooded area in West Milford Township; 100 feet west of Kanouse Road, 1,480 feet southeast of intersection of Kanouse and Conklin Roads:

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, granular structure; friable; dark organic stains on sand grains; many uncoated sand grains; many, medium and fine, fibrous roots; many fine pores; 10 percent pebbles and cobblestones; very strongly acid; clear, smooth boundary.

A2—2 to 8 inches, dark yellowish-brown (10YR 4/4) silt loam; weak, fine and medium, subangular blocky structure; friable; many uncoated sand grains; many, medium and fine, fibrous roots; many fine pores; 10 percent pebbles and cobblestones; strongly acid; clear, smooth boundary.

B2—8 to 20 inches, yellowish-brown (10YR 5/6) gravelly silt loam; weak, fine and medium, subangular blocky structure; friable; few, thin, patchy silt films on ped faces; common, medium and fine, fibrous roots; common fine pores; 25 percent pebbles and cobblestones; very strongly acid; clear, smooth boundary.

B3—20 to 26 inches, dark yellowish-brown (10YR 4/4) and olive-brown (2.5Y 4/4) gravelly silt loam; massive; loose; thin patchy silt films on gravel surfaces; few fibrous roots; common fine and medium pores; 40 percent pebbles and cobblestones; very strongly acid; gradual, wavy boundary.

IIC—26 to 60 inches, grayish-brown (2.5Y 5/2), light olive-brown (2.5Y 5/4, 5/6), light brownish-gray (2.5Y 6/2), and light yellowish-brown (2.5Y 6/4) very gravelly sand; single grained; loose; sand grains uncoated; very few fibrous roots in upper 6 inches; 60 percent pebbles and cobblestones; very strongly acid.

The thickness of the solum ranges from 24 to 34 inches. Depth to bedrock is generally more than 10 feet. The content of coarse fragments ranges from 5 to 15 percent in the A horizon, from 20 to 60 percent in the B horizon, and from 60 to 70 percent in the C horizon. Coarse fragments consist of conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. Natural reaction is very strongly acid throughout.

The Ap horizon is generally dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4). The B horizon ranges from strong brown (7.5YR 5/6) to olive brown 2.5Y 4/4). The B2 horizon is fine sandy loam, loam, or silt loam, and gravelly analogs. The C horizon has a hue of 2.5Y or 5Y, a value of 2 to 6, and a chroma of 1 to 6.

Chenango soils are near Braceville, Preakness, and Swartswood soils. They lack mottling that is common to all of the associated soils.

Chenango silt loam, 3 to 8 percent slopes (CkB).—This soil has the profile described as representative of the series. Included in mapping were areas of Braceville, Preakness, Swartswood, and more sloping Chenango soils. The Braceville, Preakness, and Swartswood soils are wetter than Chenango soils and need drainage in places.

Many areas of this soil have been cultivated. This soil has slight limitations for most uses in community development. A soil feature that limits use is the rapid permeability of the substratum. This causes a hazard of pollution if the soil is used for onsite septic disposal systems. The soil is suited to most crops and plants grown in the area. The hazard of erosion is slight. Capability unit IIe-7; woodland group 3o.

Chenango silt loam, 8 to 15 percent slopes (CkC).—This soil has a profile similar to the one described as representative for the series, except that where the soil is adjacent to the steep side slopes of rough terrain, a few stones and boulders are on the surface. Also, in areas close to the steep, rough terrain, bedrock is at a depth of 6 to 10 feet. Included in mapping were areas of Swartswood and Chenango soils. Also included were a soil that is similar to Swartswood soil except that it lacks a fragipan and, in places, soils that have slopes of more than 15 percent.

Many areas of this soil have been cultivated. Some areas are now wooded. The soil generally has slight or moderate limitations for most uses in community development, but limitations for sanitary landfills are severe. Development limitations are caused mainly by slope. Rapid permeability in the substratum causes a hazard of pollution if this soil is used for onsite septic disposal systems. The hazard of erosion is moderate if the soil is cleared. Capability unit IIIe-7; woodland group 3o.

Haledon Series

The Haledon series consists of somewhat poorly drained loamy soils that have a fragipan in the lower part of the subsoil. These gently sloping to strongly sloping soils are in waterways and on toe slopes near the three basalt ridges in the southern part of the county. The soils formed in glacial till derived mainly from basalt, red sandstone, shale, and granitic gneiss.

In a representative profile the surface layer is very dark grayish-brown cobbly loam about 8 inches thick. The upper part of the subsoil is mottled, yellowish-brown cobbly loam 8 inches thick. The middle part is mottled, yellowish-brown and brown cobbly loam 14 inches thick. The lower part of the subsoil is a fragipan. It consists of 8 inches of mottled, dark brown, firm and brittle gravelly sandy loam over 7 inches of mixed, brownish and grayish, very firm gravelly sandy loam. The substratum, between depths of 45 and 72 inches, is a very firm, dark-brown, gravelly sandy loam fragipan.

Permeability is moderate above the fragipan and slow in the fragipan. Depth to the seasonally high water is ½ to 1½ feet. The table rises in fall and remains high until spring. The water is perched over the fragipan. Many areas of the Haledon soils are in urban use. Some areas are idle fields or are wooded. Trees in the wooded areas are generally oak, maple, birch, and ash. Slips are a concern on roadbanks and on other slopes where the soil was excavated, stockpiled, and redeposited directly on the fragipan. Slow permeability in the fragipan causes water to flow laterally above it. Water flowing into excavations is a concern where the soils are used for basements and septic effluent systems. Stones are a concern in lawn and landscaping projects.

Representative profile of Haledon cobbly loam in an area of Haledon very stony loam, 3 to 8 percent slopes, in Wayne Township; 10 feet west of unimproved dirt road and 1,000 feet north of junction of dirt road with Paterson-Hamburg Turnpike which is 1,600 feet east of entrance to North Jersey Country Club:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) cobbly loam; moderate, medium, granular structure; very friable; many roots; common fine pores; 25 percent coarse fragments of stones, cobblestones, and gravel; medium acid; clear, wavy boundary.

B21t—8 to 16 inches, yellowish-brown (10YR 5/4) cobbly loam; common, coarse and medium, distinct, dark-brown (7.5YR 4/4) and common, fine and medium, faint, brown (10YR 5/3) mottles; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; moderate, medium, subangular blocky structure; friable; slightly sticky; common roots that decrease with depth; thin, discontinuous, dark-brown (7.5YR 4/4) clay films on ped faces and in sand and pebble niches; common fine pores; 20 percent coarse fragments, mainly coarse gravel and cobblestones but some stones; medium acid; gradual, wavy boundary.

B22t—16 to 30 inches, yellowish-brown (10YR 5/4) and brown (7.5YR 4/4) cobbly loam; common, coarse, distinct, dark-brown (7.5YR 3/2) and common, fine, faint, pale-brown (10YR 6/3) mottles; few, fine, distinct, light brownish-gray (10YR 6/2) and grayish-brown (10YR 5/2) mottles that increase in number with depth; moderate, medium, subangular blocky structure; friable; few fibrous roots; few fine pores; thin, discontinuous, dark-brown (7.5YR 4/4) clay films on ped faces and common bridging with semiwaxy clay films; 20 percent coarse fragments, mainly cobblestones and gravel; medium acid; abrupt, smooth boundary.

Bx1—30 to 38 inches, dark-brown (7.5YR 4/4) gravelly sandy loam; streaks and splotches of yellowish-brown (10YR 5/4); weak, very thick, platy structure; firm; few fibrous roots between peds; very few fine pores; thin, discontinuous, waxy and semiwaxy clay films and silt coats on plate surfaces; continuous bridging of dull materials of silt, very fine sand, and clay within plates; few, fine, black (10YR 2/1) stains on ped surfaces; 20 percent coarse fragments, mainly gravel; medium acid; clear, smooth boundary.

Bx2—38 to 45 inches, variegated, dark-brown (7.5YR 4/4), light brownish-gray (10YR 6/2), strong-brown (7.5YR 5/6), yellowish-brown (10YR 5/6), and brown (10YR 5/3) gravelly sandy loam; moderate, very thick, platy structure; very firm; very few fine pores; thin, continuous clay films on ped surfaces; few, fine, black (10YR 2/1) stains on clay films; 20 percent coarse fragments, mainly gravel; medium acid; abrupt, smooth boundary.

Cx—45 to 72 inches, dark-brown (10YR 4/3) gravelly sandy loam; massive; very firm; few fine pores; 30 percent coarse fragments; dominantly gravel; slightly acid.

The thickness of the solum ranges from 42 to 60 inches. Depth to bedrock ranges from 6 to 10 feet. Depth to the fragipan ranges from 24 to 36 inches. The solum is 10 to 25 percent coarse fragments and the Cx horizon 15 to 35 percent. Stones are few to common and commonly decrease with depth. The coarse fragments are mostly basalt and granitic gneiss and lesser amounts of red sandstone and shale. Unlimed soils range from medium acid in the A horizon to slightly acid in the C horizon.

The B2 horizon ranges from yellowish brown (10YR 5/6) to dark brown (7.5YR 4/4). Mottles are few to many and are yellowish, brownish, or grayish. Low-chroma mottles are in the upper 10 inches of the B2 horizon. The B2 and Bx horizons are loam, silt loam, gravelly sandy loam, and the cobbly analogs of these textures. The Bx horizon is dark yellowish brown (10YR 4.4) or dark brown (7.5YR 4/4). Mottles are brown, yellow, and gray.

Haledon soils are near Boonton, Holyoke, Pompton, and Haledon, wet variant, soils. Haledon soils have low-chroma mottles in the upper 10 inches of the B2 horizon that Boonton soils lack or have deeper in the profile. Haledon soils lack the low-chroma matrix colors common in the upper part of the subsoil of Haledon, wet variant, soils. Haledon soils are much deeper to bedrock than Holyoke soils. The very firm lower part of the B horizon in the Haledon soils distinguishes it from Pompton soils.

Haledon very stony loam, 3 to 8 percent slopes (HcB).—This soil has the profile described as representative of the series. The stones on the surface are 5 to 30 feet apart. Included in mapping were areas of Haledon and Boonton soils and Haledon, wet variant, soils. Also included were Rockaway soils in the northern sections of the basalt ridges. The Pompton soils are at lower positions on the landscape where glacial outwash soils occur. A soil similar to the Haledon soil except that it lacks stones is included in the southern sections of the basalt ridges where lacustrine soils occur.

This soil has moderate to severe limitations for most community development. Limitations are caused mainly by a seasonal high water table; stoniness; and the firm, dense, slowly permeable fragipan. These features also limit the production of plants and crops. Because of the content of stones, this soil is poorly suited to plant production. High-value crops and plants need drainage improvement. Capability unit VIs-19; woodland group 3w.

Haledon very stony loam, 8 to 15 percent slopes (HcC).—This soil has a profile similar to the one described as representative for the series. Stones on the surface are 5 to 30 feet apart. Included in mapping were areas of less sloping Haledon soils and areas of Boonton, Holyoke, and Haledon, wet variant, soils. Also included were Rockaway soils in the northern sections of the basalt ridges and Pompton soils at lower positions on the landscape.

This soil has moderate to severe limitations for most uses in community development. Limitations are caused primarily by stoniness; slope; a seasonal water table; and the firm, dense, slowly permeable fragipan. Seepage is a hazard where excavations are made. Erosion control is a concern if this soil is cleared. In addition, the stone content and perched water table make this soil poorly suited to farming and plant production in general. Capability unit VIs-19; woodland group 3w.

Haledon Series, Wet Variant

The Haledon series, wet variant, consists of poorly drained, loamy soils that have a fragipan in the lower part of the subsoil. These nearly level to gently sloping soils are in waterways and depressions and on toe slopes near the three basalt ridges in the southern part of the county. The soils formed in glacial till derived mainly from basalt, granitic gneiss, red sandstone, and shale. They are mostly wooded and are in State- or county-owned land used for recreation, such as parks and golf courses. The dominant trees are maple, ash, birch, and oak.

In a representative profile the surface layer is very dark gray silt loam about 3 inches thick. The subsurface layer is mottled, grayish-brown and dark-gray silt loam about 7 inches thick. The upper part of the subsoil is light brownish-gray loam about 4 inches thick. The middle part is mottled, gray sandy clay loam about 10 inches thick. The lower part of the subsoil is a fragipan of very firm and brittle, mottled, dark yellowish-brown and yellowish-brown gravelly sandy loam. It is about 18 inches thick. The substratum, between depths of 42 and 72 inches, is reddish-brown gravelly loam.

Permeability is slow. Water is perched at or near the surface much of the year. The high water table causes severe limitations for most uses in community development. Available water capacity is moderate. This soil has a potential for excavated ponds.

Representative profile of Haledon silt loam, wet variant, in an area of Haledon very stony silt loam, wet variant, 3 to 8 percent slopes, in Wayne Township; 10 feet south of dirt road, 1,680 feet west of Wayne Township municipal buildings:

A1—0 to 3 inches, very dark gray (10YR 3/1) silt loam; moderate, coarse, granular structure; friable; few uncoated sand grains; common medium and fine roots; common fine pores; 10 percent stones, cobblestones, and pebbles; very strongly acid; clear, smooth boundary.

A2g—3 to 10 inches, grayish-brown (10YR 5/2) and dark-gray (10YR 4/1) silt loam; common, fine, distinct, brownish-yellow (10YR 6/6) and olive-yellow (2.5YR 6/6) mottles; moderate, coarse, granular structure; friable; few fine and medium roots; common fine pores; 10 percent coarse fragments; very strongly acid; clear, wavy boundary.

B1g—10 to 14 inches, light brownish-gray (2.5YR 6/2) loam; many, fine and medium, prominent, yellowish-brown (10YR 5/4) and brownish-yellow (10YR 6/6) mottles; moderate, medium, subangular blocky structure; friable; slightly plastic; thin, discontinuous clay coatings on ped faces; continuous bridging within peds of clay, silt, and very fine sand; few fine roots; few fine pores; 10 percent cobblestones and pebbles; strongly acid; clear, wavy boundary.

B2tg—14 to 24 inches, gray (5Y 6/1) sandy clay loam; many, medium and coarse, prominent, brownish-yellow (10YR 6/6) mottles; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; friable; plastic; thin, discontinuous clay films on ped faces; common clay bridges between grains within peds; few fine roots; few fine pores; 10 percent cobblestones and pebbles; slightly acid; gradual, wavy boundary.

IIBx—24 to 42 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) gravelly sandy loam; many, coarse, prominent, brown and grayish-brown mottles; weak, thick, platy structure; very firm; brittle; few black (10YR 2/1) stains on ped surfaces; few patchy clay films on ped faces; few clay bridges between grains within peds; few, fine, discontinuous pores; 25 percent pebbles and cobblestones; slightly acid; abrupt, smooth boundary.

IIC—42 to 72 inches, reddish-brown (5YR 4/4) gravelly loam; few grayish-brown and reddish-gray mottles; weak, very thick, platy structure in upper part and massive in lower part; very firm; brittle; 25 percent coarse gravel mixed with a few cobblestones; neutral.

The thickness of the solum ranges from 35 to 52 inches. Depth to the fragipan ranges from 20 to 30 inches. Depth to bedrock is more than 6 feet. Coarse fragments range from 5 to 20 percent in these soils. Stones are few to common. The coarse fragments consist mainly of basalt and granitic gneiss and lesser amounts of red sandstone and shale. In unlimed areas of these soils reaction is strongly acid to very strongly acid in the A horizon, slightly acid to strongly acid in the B horizon, and neutral in the C horizon.

The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2 or 2.5Y 3/2). The A2g horizon ranges from dark gray (10YR 4/1) to grayish brown (2.5Y 5/2). Mottles range from brownish yellow (10YR 6/6 and 6/8) and yellowish brown (10YR 5/8) to olive yellow (2.5Y 6/8).

The Bg horizon ranges from sandy loam to clay loam. The Bx horizon is brown (10YR 5/3) to dark brown (7.5YR 4/4). Mottles in the Bx horizon range from common to many and are brownish or grayish. The Bx horizon is sandy loam, loam, or gravelly analogs of these textures.

The C horizon ranges from yellowish-brown (10YR 5/4) to reddish-brown (5YR 4/3) gravelly loamy sand to sandy loam.

Haledon, wet variant, soils are near Holyoke, Boonton, Haledon, and Preakness soils. These soils have a low-chroma matrix in the upper part of the subsoil that is lacking in Holyoke, Boonton, and Haledon soils. Haledon, wet variants, unlike Preakness soils, are very firm in the lower part of the B horizon.

Haledon very stony silt loam, wet variant, 0 to 3 percent slopes (HdA).—This soil has the profile described as representative of the Haledon series, wet variant. The surface layer is commonly 3 percent stones. Stones on the surface are 5 to 30 feet apart. Subsurface stone content decreases with depth. Included in mapping are areas of Haledon, Whippany, and Parsippany soils; more sloping Haledon, wet variant, soils; and Muck, shallow.

Most areas of this soil are wooded. Some have been used for industrial sites. A high percentage of the areas are used for parks and golf courses. The soils generally have severe limitations for use in community development. Limitations are caused mainly by the seasonal high water and stones. Wetness and stoniness make this soil poorly suited for farming and plant production in general. Capability unit VIs-19, woodland group 4w.

Haledon very stony silt loam, wet variant, 3 to 8 percent slopes (HdB).—This soil has a profile similar to the one described as representative for the Haledon series, wet variant. The surface layer is commonly 3 percent stones. Stones on the surface are 5 to 30 feet apart. Subsurface stone content normally decreases with depth. Included in mapping were areas of Haledon and Boonton soils and areas of less sloping Haledon, wet variant, soils.

Most of this soil is wooded and is used as parks or golf courses. The soil generally has severe limitations for uses in community and recreational development. Limitations are caused mainly by seasonal high water, stone content, and surface seepage during periods of heavy precipitation. Wetness, stoniness, and a moderate erosion hazard make this soil poorly suited to plant production. Capability unit VIs-19; woodland group 4w.

Hibernia Series

The Hibernia series consists of extremely stony, somewhat poorly drained soils that have a fragipan in the lower part of the subsoil. These gently sloping to strongly sloping soils occupy areas of the rough, stony, and rocky Highlands in the northern part of Passaic County. These soils are generally near drainageways. They formed in glacial till derived mainly from granitic gneiss and lesser amounts of conglomerate, sandstone, and shale. Most areas are wooded. Other areas are in idle fields, farmland, and homesites. Large tracts are in State forests or parks or privately owned reservoir watersheds. The trees in the wooded areas are mainly upland oaks, red maple, and beech.

In a representative profile the surface layer is very dark grayish-brown cobbly loam about 5 inches thick. Many stones and boulders 1 to 5 feet in diameter are on the surface. The upper part of the subsoil is yellowish-brown cobbly sandy loam about 20 inches thick. The lower part is a firm and brittle, dark yellowish-brown, gravelly sandy loam fragipan about 11 inches thick. The upper part of the substratum is light olive-brown gravelly sandy loam about 26 inches thick. The lower part, between depths of 62 and 72 inches, is brown and light olive-brown gravelly loamy sand.

Permeability is moderate to moderately rapid above the fragipan and slow in the fragipan. Water is perched over the fragipan from late in winter until early in spring. Depth to the seasonally high water table is ½ to 1½ feet. The dense, firm, slowly permeable fragipan and the seasonal perched water cause severe limitations for onsite septic filter fields. Available water capacity is moderate. Boulders and the content of stones cause severe limitations for many urban uses.

Representative profile of Hibernia cobbly loam in an area of Hibernia extremely stony loam, 3 to 15 percent slopes, in West Milford Township; 20 feet west off of Lud Day Road, 1.83 miles north of intersection of Lud Day and Stickels Roads:

A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) cobbly loam; weak, fine, granular structure; very friable; many fibrous and fine roots; common fine pores; common uncoated sand grains; 30 percent stones, cobblestones, and pebbles; very strongly acid; clear, wavy boundary.

B1—5 to 9 inches, yellowish-brown (10YR 5/6) cobbly sandy loam; weak, medium, subangular blocky structure; friable; many uncoated sand grains; common fibrous and fine roots; common fine pores; patchy silt coats on pebbles and faces of peds; some clean grains; discontinuous bridging with silt and very fine sand; 20 percent stones, cobblestones, and pebbles; strongly acid; clear, wavy boundary.

B21t—9 to 16 inches, yellowish-brown (10YR 5/4) cobbly sandy loam; common, fine and medium, faint to distinct, yellowish-brown (10YR 5/6), strong-brown (7.5YR 5/8), and light yellowish-brown (2.5Y 6/4) mottles; moderate, medium, subangular blocky structure; friable; dark-brown (7.5YR 4/4), thin, patchy clay films on ped faces; common fibrous and few fine roots; common fine pores; 20 percent stones, cobblestones, and pebbles in about equal proportions; strongly acid; clear, wavy boundary.

B22t—16 to 25 inches, yellowish-brown (10YR 5/6) cobbly sandy loam; common, fine and medium, distinct, strong-brown (7.5YR 5/8), grayish-brown (10YR 5/2), and light brownish-gray (2.5Y 6/2) mottles; moderate, medium, subangular blocky structure; friable; few fibrous and fine roots; few fine pores; thin, discontinuous, dark-brown (7.5YR 4/4) clay films on ped faces; 20 percent stones, cobblestones, and pebbles in about equal proportions; strongly acid; clear, smooth boundary.

Bx—25 to 36 inches, dark yellowish-brown (10YR 4/4) gravelly sandy loam; coarse, wedge-shaped, elongated mottles having strong-brown (7.5YR 5/8) exteriors and light yellowish-brown (2.5Y 6/4) to light brownish-gray (2.5Y 6/2) interiors; weak, thick, platy structure; firm; brittle; few, very fine, discontinuous pores; few strong-brown to yellowish-red stains on plates; 25 percent pebbles, stones, and cobblestones; strongly acid; gradual, wavy boundary.

Cl—36 to 62 inches, light olive-brown (2.5Y 5/4) gravelly sandy loam; common, coarse, distinct, light brownish-gray (2.5Y 6/2), yellowish-brown (10YR 5/8), and dark-brown (7.5YR 4/4) mottles; massive; firm; few, very fine, discontinuous pores; 25 percent pebbles, stones, and cobblestones; strongly acid; clear, smooth boundary.

C2—62 to 72 inches, brown (10YR 5/3) and light olive-brown (2.5Y 5/4) gravelly loamy sand; single grained; loose; 40 percent pebbles, stones, and cobblestones; strongly acid.

The thickness of the solum ranges from 24 to 40 inches. Depth to granitic gneiss bedrock is variable, but it generally ranges from 6 to 10 feet. Depth to the fragipan ranges from 18 to 30 inches. Coarse fragments up to cobblestone size range from 10 to 35 percent throughout the solum and 50 percent in the C horizon. Stones and boulders are few to common. Coarse fragments consist of granitic gneiss, conglomerate sandstone, and shale. In unlimed areas reaction of the soils is strongly acid or very strongly acid.

The Al horizon ranges from very dark gray (10YR 3/1) to dark brown (10YR 3/3 or 7.5YR 3/2). The Ap horizon is dark brown (10YR 3/3). The B horizon above the Bx horizon ranges from dark brown (7.5YR 4/4) to yellowish-brown (10YR 5/4 or 5/6). Grayish, brownish, or yellowish mottles are throughout the B2 horizon. The B horizon ranges from loam to sandy loam and the gravelly and cobbly analogs of texture in this range. The Bx horizon ranges from dark brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) to olive brown (2.5Y 4/4). The C horizon is brownish and grayish. Hue is 10YR to 5Y, value is 4 to 5, and chroma is 1 through 4.

Hibernia soils are near Netcong, Rockaway, Ridgebury, and Pompton soils. They have mottling throughout the B2 horizon that is lacking in Netcong soils and is deeper in Rockaway soils. Hibernia soils lack the low-chroma matrix common to Ridgebury soils. They have a very firm lower B horizon that is lacking in Pompton soils.

Hibernia extremely stony loam, 3 to 15 percent slopes (HpC).—This soil has the profile described as representative of the series. Stones on the surface generally range from 1 foot to 5 feet in diameter, but stones larger than 2 feet in diameter are the most abundant. They are 2 to 5 feet apart. Stone content decreases with depth. Rock outcrops are present in a few places. Included in mapping were areas of Netcong, Rockaway, and Ridgebury soils. Small areas of Swartswood and Pompton soils were also included in places.

Most areas of this soil are wooded. This soil has severe limitations for most uses in community development. The limitations are caused mainly by boulder and stone content and seasonal high water. Accessibility is generally difficult because of the surrounding rough and rocky areas. The high stone content limits the use of this soil for crops and plant production. Capability units VIIs-34; woodland group 3x.

Holyoke Series

The Holyoke series consists of well-drained soils that are shallow to basalt bedrock (fig. 4). These soils are gently sloping to very steep and are on sides and tops of the three basalt ridges in the southern part of the country. Rock outcrops are present throughout, and a number of active and abandoned quarries are in the area. The soils formed in glacial material derived mainly from basalt, sandstone, shale, and granitic gneiss. Some areas of these soils are in the county park system. Wooded areas generally contain oak, maple, and hemlock trees.

In a representative profile, the surface layer is dark-brown silt loam about 3 inches thick. The upper part of the subsoil is brown gravelly silt loam about 5 inches thick. The lower part is strong-brown gravelly silt loam about 8 inches thick. Basalt bedrock is at a depth of about 16 inches.

Permeability is moderate, and available water capacity is low. Shallowness to bedrock and the presence of rock outcrops cause severe limitations for use of the soils for community and recreational development.

Representative profile of Holyoke silt loam, in a wooded area of Holyoke-Rock outcrop complex, 3 to 15 percent slopes, in Wayne Township; 3,200 feet southwest of junction of Paterson Avenue and Oldham Road and 1,260 feet east of Oldham Road:

Figure 4.—Basalt rock quarry in Holyoke soil showing shallow depth to bedrock. This quarry is in West Paterson in the vicinity of Garrett Mountain.

A1—0 to 3 inches, dark-brown (10YR 3/3) silt loam; weak, fine, granular structure; very friable; organic-matter stains on sand grains; many fine and medium roots; many fine and medium pores; 10 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

B21—3 to 8 inches, brown (7.5YR 4/4) gravelly silt loam; moderate, medium and coarse, granular structure; very friable; many fine and medium roots; common fine pores; 15 percent coarse fragments; very strongly acid; clear, wavy boundary.

B22—8 to 16 inches, strong-brown (7.5YR 5/6) gravelly silt loam; weak, medium, subangular blocky structure; very friable; common fine and medium roots; common fine pores; 20 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

IIR—16 inches, smooth-surfaced basalt bedrock; few thin fractures.

The thickness of the solum and the depth to basalt bedrock range from 10 to 20 inches. Angular gravel in the solum ranges from 5 to 20 percent. Composition of the coarse fragments is dominantly basalt and lesser amounts of granitic gneiss, red sandstone, and shale. Stones and cobblestones are few to common. In unlimed areas reaction is very strongly acid or strongly acid.

The Al horizon has a hue of 7.5YR or 10YR, a value of 3 or 4, and a chroma of 2 or 3. The B horizon has a hue of 7.5YR, a value of 4 to 6, and a chroma of 4 to 8. The B horizon is very fine sandy loam, silt loam, and, infrequently, loam. The basalt bedrock is commonly massive, and fractures are few or absent.

Holyoke soils are near Boonton, Haledon, and Haledon, wet variant, soils. Unlike these soils, Holyoke soils are shallow to bedrock.

Holyoke-Rock outcrop complex, 3 to 15 percent slopes (HrC).—This complex consists of basalt bedrock outcrops and Holyoke soils.

The Holyoke soil has the profile described as representative for the Holyoke series. The outcrops make up 10 to 30 percent of each mapped area. Most areas of this complex have been left in almost natural conditions. Included in mapping were areas, as much as 60 percent of which have been disturbed by man. The extent of disturbance and the uses made of this complex vary. Some areas contain shallow to deep cuts and fills for highways and buildings. Paving is extensive in a few areas.

This complex is used mainly for parks, recreational purposes, and building sites. Bedrock outcrops and the shallow depth to hard rock severely limit the potential uses of this complex. Blasting is needed for excavations in most places. The rock outcrops and shallow depth to bedrock in the Holyoke soil severely limit the use of this complex for plant production. Capability unit VIIs–22; woodland group 4x.

Made Land, Sanitary Land Fill

Made land, sanitary land fill (Ma), consists of areas where refuse has been dumped. The refuse contains such materials as metal, glass, concrete, stone, wood, and garbage. In places the material has alternating layers of soil, and it commonly is covered with a soil material of varying thickness. Areas of this land type settle unevenly, and gas forms in places as materials decompose. Where the soil cover is 1 to 2 feet thick, grasses, shrubs, or trees can be grown. Not assigned to a capability unit or woodland group.

Muck, Shallow

Muck, shallow (Ms), has an organic surface layer ranging from 16 to 50 inches in thickness and underlain by alluvium. This soil is nearly level. The organic part is typically a mixture of decomposed herbaceous and woody plant residue and many woody fragments. The depth to and texture of the alluvium is variable within small areas. The texture commonly is sand or gravelly sand, loam, silt loam, or clay. In many areas the alluvium is successive layers of contrasting textures, ranging from a few inches to 2 feet in thickness. Included in mapping were small areas of Carlisle, Parsippany, or Preakness soils.

In the northern part of Passaic County, areas of Muck are in a nearly natural condition, and they are mostly wooded. In the southern part most areas have been cleared and at least partly drained or filled. Cleared areas are within residential or industrial developments. In most places Muck, shallow, is subject to annual flooding. Very poor drainage, generally ponded conditions, and an unstable and compressible organic surface layer are the main limitations.

Muck, shallow, is near Parsippany, Preakness, Carlisle, Ridgebury, and Norwich soils. It has an organic surface layer 16 to 51 inches thick that distinguishes it from all nearby soils. Capability unit VIIw–41; woodland group 5w.

Netcong Series

The Netcong series consists of deep, well-drained, extremely stony soils. These gently sloping to steep soils are on sides of valleys in the rough, stony, and rocky Highlands in the northern part of the county. They formed in glacial till derived mainly from granitic gneiss and lesser amounts of conglomerate, sandstone, and shale. Most areas are wooded. Large tracts of the wooded areas are in State forests, parks, and in watersheds above reservoirs. The trees in the wooded areas are mainly upland oaks, red maple, and beech.

In a representative profile the surface layer is very dark gray gravelly loam about 2 inches thick. The subsurface layer is dark yellowish-brown gravelly loam about 3 inches thick. The upper part of the subsoil is dark-brown gravelly sandy loam about 3 inches thick. The middle part is strong-brown gravelly sandy loam about 14 inches thick. The lower part of the subsoil is yellowish-brown gravelly sandy loam 14 inches thich. The substratum, between depths of 36 and 60 inches, is light yellowish-brown and pale-brown cobbly loamy sand.

Permeability is moderately rapid or moderate. Available water capacity is moderate. The principal soil features that affect use of these soils are the content of boulders and stones and slope. Many areas of these soils are surrounded by rough and rocky land, making accessibility for developments costly or economically prohibitive.

Representative profile of Netcong gravelly loam in an area of Netcong extremely stony loam, 3 to 15 percent slopes, in Ringwood Borough; 10 feet west of Skylands Road, 0.3 mile east of the intersection of Skylands Road and Stetsons Road:

A1—0 to 2 inches, very dark gray (10YR 3/1) gravelly loam; weak, medium, granular structure; very friable; common uncoated sand grains; many fine pores; 20 percent pebbles, cobblestones, and stones; stones on the surface range from 1 to 6 feet in diameter; very strongly acid; clear, smooth boundary.

A2—2 to 5 inches, dark yellowish-brown (10YR 4/4) gravelly loam; weak, medium, granular structure; very friable; few sand grains having very dark gray (10YR 3/1) organic stains; many uncoated sand grains; common fine pores; 20 percent coarse pebbles, cobblestones, and stones; very strongly acid; clear, smooth boundary.

B1—5 to 8 inches, dark-brown (7.5YR 4/4) gravelly sandy loam; weak, fine and medium, subangular blocky structure; friable; few uncoated grains; few thin clay and silt loams on ped faces; common fine pores; 20 percent pebbles and cobblestones; strongly acid; clear, wavy boundary.

B2—8 to 22 inches, strong-brown (7.5YR 5/6) gravelly sandy loam, 20 percent discontinuous inclusions of brown (7.5YR 5/4) gravelly loam; moderate, medium, subangular blocky structure; friable; common fine pores; patchy clay films on peds and clay bridging between grains within the finer textured areas; 20 percent pebbles and cobblestones; strongly acid; gradual, wavy boundary.

B3—22 to 36 inches, yellowish-brown (10YR 5/6) gravelly sandy loam; weak, medium, subangular blocky structure; very friable; common fine pores; 25 percent pebbles and cobblestones; strongly acid; gradual, wavy boundary.

C—36 to 60 inches, light yellowish-brown (2.5Y 6/4) and pale-brown (10YR 6/3) cobbly loamy sand; single grained; loose; many uncoated sand grains; 30 percent cobblestones and pebbles; strongly acid; gradual, wavy boundary.

The thickness of the solum ranges from 30 to 48 inches. Depth to granitic bedrock is variable but generally ranges from 6 to 10 feet. Coarse fragments up to cobblestone in size make up 10 to 35 percent of the soil material. Stones and boulders are few to common and commonly decrease with depth. Coarse fragments consist of granitic gneiss, conglomerate, sandstone, and shale. In unlimed areas reaction is strongly acid or very strongly acid.

In the A1 horizon color ranges from very dark gray (10YR 3/1) to dark brown (10YR 3/3). In the A2 horizon it ranges from dark brown (10YR 4/3 or 7.5YR 4/4) to yellowish brown (10YR 5/4), and in the Ap horizon it ranges from dark brown (10YR 4/3 or 7.5YR 4/2) to dark yellowish brown (10YR 4/4). The B horizon ranges from dark brown (7.5YR 4/4) to yellowish brown (10YR 5/6) in color, and it is generally lighter colored in the lower part. The upper part of the B horizon is sandy loam or loam, with or without gravel and cobblestones. The lower part of the B horizon ranges to loamy sand in places. In the C horizon color ranges from light yellowish brown (10YR 6/4) to grayish brown (2.5Y 5/2). Texture is loamy sand to sand and the cobbly or gravelly analogs of texture in this range.

Netcong soils are near Rockaway, Hibernia, Ridgebury, and Riverhead soils. They lack the mottling commonly in Rockaway, Hibernia, and Ridgebury soils and the stratified sand and gravel substratum of Riverhead soils.

Netcong extremely stony loam, 3 to 15 percent slopes (NkC).—This soil has the profile described as representative of the series. Stones on the surface typically range from 1 foot to 6 feet in diameter, and similar stones make up 5 to 10 percent of the material in the soil profile. Stones are 2 to 5 feet apart. Stone content decreases with depth. Rock crops out in a few places. Included in mapping were areas of Rockaway, Hibernia, and more sloping Netcong soils. Also included were small areas of Riverhead and Swartswood soils.

Stones and boulders are limitations for individual homesites and low-intensity community development. The combined effect of boulders, stones, and the surrounding rough and rocky land that makes accessibility difficult increases limitations of this soil for many uses in community development. The abundance of stones and boulders severely limits the use of this soil for cultivation. Lawn establishment and other landscape operations are severely limited. Capability unit VIIs-22; woodland group 3x.

Netcong extremely stony loam, 15 to 25 percent slopes(NkD).—This soil has a profile similar to the one described as representative for the series. Stones on the surface typically range from 1 foot to 6 feet in diameter, and similar stones make up 5 to 10 percent of the material in the soil profile. Stones are 2 to 5 feet apart. Stone content decreases with depth. Bedrock crops out in a few places. Included in mapping were areas of Rockaway, Hibernia, and less sloping Netcong soils. Also included were small areas of Riverhead and Swartswood soils.

This soil has severe limitations for most uses in community development. Limitations are caused by slope and the content of stones and boulders. An additional limitation is the surrounding rough and rocky land that makes accessibility difficult. The steep slopes and abundance of stones and boulders severely limit the use of this soil for cultivation. Lawn establishment and other landscape operations are severely limited. Capability unit VIIs-22; woodland group 3x.

Norwich Series

The Norwich series consists of poorly drained soils that have a fragipan in the lower part of the subsoil. These nearly level to gently sloping soils are in waterways or depressions and on toe slopes of the rough stony and rocky Highlands in the northwestern part of the county. The soils formed in glacial till derived mainly from conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. Most areas are wooded. Other areas are in urban uses or are abandoned fields that are reverting to wooded areas. Large tracts of wooded areas are in State parks and municipal reservoir watersheds.

In a representative profile the surface layer is dark-brown gravelly silt loam about 4 inches thick. The upper part of the subsoil is mottled, light brownish-gray gravelly loam 7 inches thick. The middle part is light olive-gray gravelly loam 7 inches thick. The lower part of the subsoil is a fragipan. It consists of 10 inches of mottled, very firm and brittle, dark-brown gravelly sandy loam over 17 inches of mottled, firm and brittle, dark-brown and dark-gray gravelly sandy loam. The substratum, between depths of 45 and 60 inches, is reddish-gray and strong-brown gravelly sandy loam.

Permeability is slow in the fragipan and moderately rapid below it. The high water table influences vertical water movement. Available water capacity is moderate. Late in winter and early in spring, the water table is at or near the surface. The water table is at a depth of 2 feet or less most of the year. During periods of high precipitation, ponding generally occurs. Seasonal high water, stones and boulders, and accessibility limit the potential uses of these soils. Many areas of these soils are surrounded by rough and rocky land, making accessibility for development costly or economically prohibitive.

Representative profile of Norwich gravelly silt loam, in a wooded area of Norwich extremely stony silt loam, 0 to 3 percent slopes, in West Milford Township; 500 feet southeast of intersection of Clinton Road and Clinton Brook:

O1—3 inches to 2, leaf litter.

O2—2 inches to 0, black (N 2/0) decayed vegetation; abrupt, smooth boundry.

A1—0 to 4 inches, dark-brown (10YR 4/3) gravelly silt loam; weak, medium, granular structure; very friable; organic stains on sand grains; many uncoated sand grains; many fine and medium roots; many fine pores; 20 percent stones, pebbles, and cobblestones; strongly acid; clear, smooth boundary.

B21g—4 to 11 inches, light brownish-gray (2.5Y 6/2) gravelly loam; many, fine and medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few uncoated sand grains; few silt coats on ped faces and gravel surfaces; common fine and medium roots; few fine pores; 30 percent coarse fragments; strongly acid; gradual, wavy boundary.

B22g—11 to 18 inches, light olive-gray (5Y 6/2) gravelly loam; few, medium, faint, greenish-gray (5GY 5/1) mottles and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few uncoated sand grains; few silt coats on ped faces and pebble surfaces; few fine and medium roots; few fine pores; 30 percent coarse fragments; strongly acid; clear, smooth boundary.

IIBx1—18 to 28 inches, dark-brown (7.5YR 4/2) gravelly sandy loam; many, strong-brown (7.5YR 5/6), light olive-gray (5Y 6/2), and pale-olive (5Y 6/3) horizontally banded mottles; moderate, very thick, platy structure; very firm, brittle; many uncoated sand grains; few thin silt coats and clay films on ped faces and pebble surfaces; few, discontinuous, fine pores; 40 percent coarse fragments; medium acid; gradual, wavy boundary.

IIBx2—28 to 45 inches, dark-brown (7.5YR 4/2) intermixed with dark-gray (5YR 4/1) gravelly sandy loam; many, coarse, prominent, dark yellowish-brown (10YR 3/4) and gray (10YR 6/1) mottles; weak, very thick, platy structure in the upper part and massive at a depth of 42 inches; firm, brittle; many uncoated sand grains; silt coats on ped faces and pebble surfaces; few, fine, discontinuous pores; 40 percent coarse fragments; medium acid; gradual, wavy boundary.

IIC—45 to 60 inches, reddish-gray (5YR 5/2) intermixed with strong-brown (7.5YR 5/6) gravelly sandy loam; massive; very friable; few, fine, black stains on pebble surfaces; many uncoated sand grains; few silt caps on pebble surfaces; 45 percent coarse fragments; strongly acid.

The thickness of the solum ranges from 36 to 46 inches. Depth to fragipan ranges from 18 to 24 inches. Depth to bedrock is variable and commonly ranges from 6 to 10 feet. Coarse fragments up to cobblestone size range from 5 to 20 percent in the A horizon, 10 to 35 percent in the Bg horizon, and 15 to 45 percent in the Bx and C horizons. Boulders and stones are few to common throughout the A horizon and down into the C horizon. Coarse fragments consist mainly of conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. In unlimed areas reaction of the soils is strongly acid or medium acid.

In the A horizon color ranges from very dark grayish brown to dark brown in a hue of 10YR. In the Bg horizon it ranges from light olive gray (5Y 6/2) to dark grayish brown (10YR 4/2). High-chroma mottles range from few to many. The Bg horizon ranges from silt loam to loam or the gravelly analogs of texture in this range. The Bx horizon ranges from reddish brown (5YR 4/3) to brown (7.5YR 5/2). The Bx horizon ranges from gravelly sandy loam to gravelly loam. The IIC horizon ranges from 5YR to 10YR in hue. In general, a hue of 5YR is more likely with increasing depth.

Norwich soils are near Swartswood and Wurtsboro soils. The low-chroma matrix colors commonly in the subsoil of Norwich soils distinguish them from Swartswood and Wurtsboro soils.

Norwich extremely stony silt loam, 0 to 3 percent slopes (NpA).—This soil has the profile described as representative of the series. Stones commonly range to larger than 5 feet in diameter and generally make up 10 to 15 percent of the soil material in the profile. Stones on the surface are 2 to 5 feet apart. Bedrock crops out in a few places. Included in mapping were areas of Wurtsboro, Braceville, Preakness, Whippany, and more sloping Norwich soils. Also included were areas of a soil in which the fragipan is at a depth of 24 to 32 inches.

The main soil feature that limits the use of this soil for many community development purposes is the seasonal high water. The content of stones and boulders also affects most uses. In addition, accessiblity is generally difficult because of the surrounding rough and rocky land. Lawn establishment and landscape operations are severely limited by the high content of stones. Capability unit VIIs-45; woodland group 5w.

Norwich extremely stony silt loam, 3 to 8 percent slopes (NpB).—This soil has a profile similar to the one described as representative of the series. Stones commonly range to larger than 5 feet in diameter and generally make up 10 to 15 percent of the soil material. Stones on the surface are 2 to 5 feet apart. Rock crops out in a few places. Late in winter and early in spring, seepage areas are numerous. Included in mapping were areas of Wurtsboro, Braceville, Preakness, Whippany, and less sloping Norwich soils. Also included were areas of a soil that has a fragipan at a depth of 24 to 32 inches.

The main soil features that limit use of this soil for most community development uses are the seasonal high water and the content of stones and boulders. Accessibility is generally difficult because of the surrounding rough and rocky land. The poor drainage and the high content of stones severely limit landscape operations and lawn establishment. Capability unit VIIs-45; woodland group 5w.

Otisville Series

The Otisville series consists of excessively drained soils that have a sandy and gravelly subsoil and substratum. These gently sloping to steep soils are on sides of valleys. They formed in glacial outwash derived mainly from granitic gneiss and lesser amounts of conglomerate, sandstone, and shale.

In a representative profile the surface layer is dark-brown sandy loam about 10 inches thick. The upper part of the subsoil is yellowish-brown gravelly sandy loam about 5 inches thick. The lower part is light yellowish-brown gravelly loamy sand about 8 inches thick. The substratum, between depths of 23 to 60 inches, is very gravelly sand.

Permeability is moderately rapid in the surface layer and upper part of the subsoil and rapid in the lower part of the subsoil in the substratum. The rapid permeability of the substratum is a potential pollution hazard if the soil is used for onsite septic filter fields. Available water capacity is low. These soils are a source of gravel and sand. Limitations for use in community, recreation, and industrial development range from slight to severe, depending on the use and the slope of the soil. These soils have been used for sand and gravel mining, farming, and housing sites. Limited areas are wooded.

Representative profile of Otisville sandy loam, 3 to 15 percent slopes, in an idle farm field, in Ringwood Borough; 500 feet southwest of intersection of Erskine Road and Skyline Drive, 10 feet from gravel pit:

Ap— 0 to 10 inches, dark-brown (10YR 3/3) sandy loam; weak, fine, granular structure; very friable; dark-colored organic stains on sand grains; many uncoated sand grains; many roots; many fine pores; 10 percent pebbles; very strongly acid; abrupt, smooth boundary.

B2—10 to 15 inches, yellowish-brown (10YR 5/8) gravelly sandy loam; weak, fine, granular structure; very friable; few, thin, dark-brown (7.5YR 4/4) silt coats on pebble surfaces; many uncoated sand grains; common roots; many fine pores; 35 percent pebbles and few cobblestones; strongly acid; clear, wavy boundary.

B3—15 to 23 inches, light yellowish-brown (10YR 6/4) gravelly loamy sand; single grained; loose; silt caps on gravel; few roots; 40 percent coarse fragments, dominantly pebbles but a few cobblestones; very strongly acid; gradual, wavy boundary.

C—23 to 60 inches, mixed colors of 5Y hue that have a value of 4 to 6 and a chroma of 1 to 4, very gravelly sand; single grain; loose; 65 percent coarse fragments, mixture of pebbles and cobblestones; very strongly acid.

The thickness of the solum ranges from 16 to 30 inches. Depth to bedrock is commonly more than 10 feet. Granitic gneiss bedrock underlies the soil in the northern section of the county; but basalt, granitic gneiss, or red sandstone and shale underlie the soil in the southern part. Coarse fragments make up 10 to 30 percent of the A horizon, more than 35 percent of the B horizon, and 35 to 70 percent of the C horizon. Coarse fragments are dominantly granitic gneiss and lesser amounts of conglomerate, sandstone, and shale. In unlimed areas reaction of the soil is strongly acid or very strongly acid.

In the Ap horizon color commonly is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). If present, the A1 horizon ranges from 1 to 4 inches in thickness and is generally very dark grayish brown (10YR 3/2). In the B2 horizon color ranges from dark brown (7.5YR 4/4) to strong brown (7.5YR 5/6) and yellowish brown (10YR 5/8). In the B3 horizon it ranges from light yellowish brown (10YR 6/4) to olive yellow (2.5Y 6/6). The C horizon ranges from gravelly or very gravelly sand to cobbly sand. It generally reflects the color of individual grains and has a hue of 2.5Y or 5Y, a value of 4 to 6, and a chroma of 1 to 5.

Otisville soils are near Riverhead, Pompton, Preakness, Netcong, Rockaway, and Boonton soils. Otisville soils contain higher amounts of gravel and have a thinner solum than Riverhead soils. They lack the mottling that is common in Pompton and Preakness soils. The loose stratified substratum in Otisville soils distinguishes them from Netcong, Rockaway, and Boonton soils.

Otisville sandy loam, 3 to 15 percent slopes (OrC).—This soil has the profile described as representative of the series. Surface stones and boulders on this soil are generally the result of gravitational movement from areas in a higher position in the landscape. Included in mapping were Riverhead, Pompton, Hibernia, Rockaway, Netcong, Boonton, and more sloping Otisville soils. Also included were small areas of similar, but unnamed, soils that have a sandy loam subsoil less than 7 inches thick.

This soil has slight to moderate limitations for most uses in community development. The principal soil features that limit the use of this soil are rapid permeability, low available water capacity, and low fertility. Capability unit IVs–12; woodland group 3o.

Otisville gravelly sandy loam, 15 to 30 percent slopes (OsD).—This soil has a profile similar to the one described as representative for the series, but the gravel in the surface layer ranges from 20 to 30 percent. Surface stones and boulders on this soil are generally the result of gravitational movement from areas in a higher position in the landscape. Depth to bedrock generally increases from about 6 feet at the crest of the slope to more than 10 feet at the base. Included in mapping were Riverhead, Rockaway, Netcong, Boonton, and less sloping Otisville soils. Also included was a similar soil that has a sandy loam subsoil less than 7 inches thick.

This soil has moderate to severe limitations for most uses in community development. Slope and rapid permeability make use of this soil for septic filter fields a potential pollution hazard. Establishment of vegetative cover for landscaping requires special consideration because of insufficient fine materials for water and nutrient retention. The principal soil features that limit the use of this soil are slope, gravel content, low available water capacity, and low natural fertility. Capability unit VIs–12; woodland group 3o.

Parsippany Series

The Parsippany series consists of deep, nearly level, poorly drained soils that have a moderately fine textured or fine textured subsoil underlain by coarser material. The soils are subject to annual flooding. They formed in glacial lake sediment of silty and clayey material and underlying material commonly of glacial outwash origin. These soils have been used for farming and industrial development. Some areas are wooded.

In a representative profile the surface layer is very dark brown silt loam about 7 inches thick. The upper part of the subsoil is mottled, dark-gray silty clay loam about 6 inches thick. The middle part is mottled, brown clay about 9 inches thick. The lower part of the subsoil is mottled, strong-brown loam about 10 inches thick. The upper part of the substratum is yellowish-red silt loam about 8 inches thick. The lower part, between depths of 40 and 60 inches, is grayish-brown sandy loam.

Permeability is slow in the subsoil and moderately slow or moderate in the substratum. Available water capacity is high. Annual flooding from slowly rising river and stream waters is common in areas near streams. Late in winter and early in spring, water is perched at or near the surface. Ponding is likely during periods of high precipitation. Drainage outlets are needed, and in places these are difficult to establish. Limitations for community, recreational, and industrial development are mainly caused by the

Figure 5.—An area of poorly drained Parsippany soil that is being filled in to reduce roadbuilding and dwelling limitations.

flooding hazard and the seasonally high perched water table (fig. 5).

Representative profile of Parsippany silt loam in a wooded area in Wayne Township; on east side of Dey Road, 2,660 feet southeast of intersection of Parrish Drive and Dey Road:

A1—0 to 7 inches, very dark brown (10YR 2/2) silt loam; moderate, medium and coarse, granular structure; very friable; many roots; many fine, medium, and coarse pores; very strongly acid; abrupt, smooth boundary.

B21t—7 to 13 inches, dark-gray (10YR 4/1) silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; few, thin, patchy clay films on ped faces; many roots; common pores; strongly acid; clear, smooth boundary.

B22tg—13 to 22 inches, brown (7.5YR 5/2) clay; many, medium, distinct, yellowish-red (5YR 5/6) mottles; moderate, medium and coarse, subangular blocky structure; firm, plastic and sticky; discontinuous thin clay films on ped faces; medium acid; clear, smooth boundary.

B3t—22 to 32 inches, strong-brown (7.5YR 5/6) heavy loam grading to reddish-brown (5YR 4/4) in the lower part; many coarse, grayish mottles; weak, medium, subangular blocky structure; firm; few, patchy, thin clay films on ped faces; medium acid; abrupt, smooth boundary.

IIC1—32 to 40 inches, yellowish-red (5YR 4/6) silt loam; many gray (5YR 5/1) mottles; massive; friable; 5 percent pebbles; slightly acid; gradual, wavy boundary.

IIIC2—40 to 60 inches, grayish-brown (10YR 5/2) sandy loam; massive; friable; 5 percent pebbles; neutral.

The thickness of the solum ranges from 30 to 40 inches. Depth to bedrock is more than 10 feet. If present, coarse fragments make up as much as 5 percent of the A or B horizons and 20 percent of the C horizon. In unlimed areas reaction of the soils is very strongly acid at the surface and ranges to mildly alkaline in the substratum.

In the Ap horizon color ranges from dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/2). It has a value of 6 when the soil material is dry. Color in the upper part of the B horizon ranges mainly from dark gray (10YR 4/1) to pinkish gray (7.5YR 6/2). Mottles are common or many and range from yellowish brown to reddish brown. The lower part of the B horizon is strong brown (7.5YR 5/6) to reddish brown (5YR 4/4). Grayish mottles are present in places. Individual subhorizons within the B horizon range from heavy silt loam or loam to clay. Above a depth of 40 inches, the C horizon is generally loam or silt loam and has lamellae of contrasting textures. Below a depth of 40 inches is loamy sand or sandy loam.

Parsippany soils are near Whippany, Preakness, and Pompton soils. The Parsippany soils have matrix colors in the upper part of the subsoil that are lower in value than those in Whippany soils. Parsippany soils are finer textured than Preakness and Pompton soils.

Parsippany silt loam, sandy loam substratum (Pk).—This soil has the profile described as representative of the series. Slopes range from 0 to 3 percent. Included in mapping were areas of soils in the Whippany, Preakness, Ridgebury, Haledon, Haledon, wet variant, Carlisle, and Muck, shallow, series.

In many places the sandy substratum is at a depth of 26 to 40 inches. Limitations to development are mainly caused by the high water table and annual flooding. Poor drainage severely limits plant growth. Drainage outlets are difficult to establish in many places. Capability unit IVw—81; woodland group 4w.

Pits, Sand and Gravel

Pits, sand and gravel (Pt), are open excavations from which the soil and an underlying mixture of sand and gravel have been removed. The sides are steep in pits that have been recently excavated. The bottoms of some pits have been cut in steps, but most bottoms are sloping. In places bottoms are below the depth of the water table.

A hazard of ground-water pollution exists in areas that are used for disposal of liquid or solid wastes. Abandoned pits become eyesores if grading, erosion control, and revegetating are not part of the restoration process. The low available water capacity limits the growth of plants. The pits have potential for recreational, industrial, or commercial uses. Not assigned to a capability unit or woodland group.

Pompton Series

The Pompton series consists of deep, somewhat poorly drained, moderately coarse textured soils that have a loose gravelly and sandy substratum. These nearly level to gently sloping soils are on toe slopes in valleys. In most areas these soils are subject to annual flooding. The soils formed in glacial outwash derived mainly from granitic gneiss and lesser amounts of conglomerate basalt, sandstone, and shale.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam about 7 inches thick. The upper part of the subsoil is distinctly mottled, yellowish-brown fine sandy loam about 10 inches thick. The middle part is distinctly mottled, yellowish-brown sandy loam about 8 inches thick. The lower part of the subsoil is mottled, yellowish-brown, grayish-brown, and olive-gray gravelly sandy loam about 9 inches thick. The upper part of the substratum is yellowish-brown and light olive-brown stratified gravelly loamy sand about 14 inches thick. The lower part, between depths of 48 and 72 inches, is grayish-brown and light brownish-gray, stratified sand and gravel.

Permeability is moderate or moderately rapid in the surface layer and subsoil and rapid in the substratum. The available water capacity is moderate. The seasonal high water table is at a depth of 1/2 to 1 1/2 feet. These soils generally have moderate to severe limitations for community, recreational, and industrial development. Limitations are mainly caused by the seasonal high water table. A potential pollution hazard exists for onsite septic filter fields. These soils have been used as a source of sand and gravel, as housing sites, and for farming. In places areas are wooded.

Representative profile of Pompton fine sandy loam, 0 to 5 percent slopes, in an idle field in West Milford Township; 520 feet northeast of intersection of Cross Road and State Route No. 23:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; moderate, medium, granular structure; very friable; many roots; common fine pores; 3 percent pebbles; strongly acid; clear, smooth boundary.

B21—7 to 17 inches, yellowish-brown (10YR 5/4) fine sandy loam; common, fine, distinct, yellowish-brown (10YR 5/8) and strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; common roots; common fine pores; many clean sand grains; strongly acid; clear, wavy boundary.

B22—17 to 25 inches, yellowish-brown (10YR 5/4) sandy loam; common, fine, distinct, yellowish-brown (10YR 5/8), strong-brown (7.5YR 5/6), and light brownish-gray (2.5Y 6/2) mottles; weak, medium, subangular blocky structure; friable; common roots; common fine pores; many clean sand grains; strongly acid; clear, wavy boundary.

B3—25 to 34 inches, variegated yellowish-brown (10YR 5/6), grayish-brown (2.5Y 5/2), and olive-gray (5Y 5/2) gravelly sandy loam; common, fine and medium, distinct, strong-brown (7.5YR 5/6) and yellowish-red (5YR 4/8) mottles; weak, medium, subangular blocky structure; very friable; few roots; many fine pores; 30 percent pebbles and few cobblestones; strongly acid; gradual, wavy boundary.

IIC—34 to 48 inches, yellowish-brown (10YR 5/4) and light olive-brown (2.5Y 5/4) stratified gravelly loamy sand; single grained; loose; 45 percent pebbles and cobblestones; strongly acid; clear, wavy boundary.

IIIC—48 to 72 inches, grayish-brown (2.5Y 5/2) and light brownish-gray (10YR 6/2) stratified sand and gravel; single grained; loose; strongly acid.

The thickness of the solum ranges from 24 to 36 inches. Depth to bedrock is commonly more than 10 feet. Coarse fragments, mainly gravel and variable amounts of cobblestones, make up 0 to 15 percent of the A and B2 horizons, 5 to 35 percent of the B3 horizon, and as much as 65 percent of the C horizon. Coarse fragments are mainly granitic gneiss and lesser amounts of conglomerate sandstone, shale, and basalt. Reaction is strongly acid in unlimed areas.

The A1 horizon, if present, ranges from 1 to 5 inches in thickness. This horizon is commonly very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) to brown 10YR 4/3). The B horizon ranges from yellowish brown (10YR 5/6) to olive brown (2.5Y 4/4). Mottles are variable, ranging from strong brown to olive gray. Depth to low-chroma mottles ranges from 15 to 20 inches. The B1 and B2 horizons are fine sandy loam and sandy loam or the gravelly analogs of these textures. The B3 horizon ranges from sandy loam to loamy sand or the gravelly analogs of textures in this range. The C horizon is stratified. It ranges from loamy sand to sand. Cobblestones and gravel in varying proportions are present in this horizon in places.

Pompton soils are near Otisville, Riverhead, Preakness, Netcong, Rockaway, Hibernia, Boonton, Haledon, Whippany, Ridgebury, and Parsippany soils. The mottling in Pompton soils is lacking in Otisville, Riverhead, and Netcong soils. Pompton soils lack the firm lower part of the B horizon of Rockaway, Ridgebury, Haledon, Boonton, and Hibernia soils. They are coarser textured than Whippany and Parsippany soils. Pompton soils are not so gray in the upper part of the subsoil as Preakness soils.

Pompton fine sandy loam, 0 to 5 percent slopes (PvA).—The soil has the profile described as representative of the series. Included in mapping were small areas of Riverhead, Otisville, Preakness, Rockaway, Hibernia, Ridgebury, Boonton, Haledon, Haledon, wet variant, Whippany, and Parsippany soils.

These soils generally have moderate or severe limitations for most uses in community development. Limitations are mainly caused by the seasonal high water table. The high water table and the rapid percolation of the substratum cause a potential pollution hazard for onsite septic filter fields. Limitations for landscaping and lawn establishment are caused by inadequate drainage. Capability unit IIw-25; woodland group 3w.

Preakness Series

The Preakness series consists of deep, nearly level, poorly drained, loamy soils that have a water table at the surface late in winter and early in spring. In most places these soils are subject to annual flooding. They are in low positions on the landscape and receive much runoff from the surrounding higher areas. The soils formed in glacial outwash material derived mainly from granitic gneiss and lesser amounts of conglomerate, basalt, sandstone, and shale. Most areas of these soils are wooded. The trees in the wooded areas are mainly red maple, pin oak, ash, and white oak. Some areas have been cleared for farming, and some have been used for urban development.

In a representative profile the surface layer is very dark grayish brown silt loam about 9 inches thick. The upper part of the subsoil is mottled, grayish-brown sandy loam about 9 inches thick. The lower part is mottled, grayish-brown gravelly sandy loam about 9 inches thick. The upper part of the substratum is light browish-gray gravelly sandy loam about 13 inches thick. The lower part, between depths of 40 and 60 inches, is brownish-yellow gravelly sand.

Permeability is moderate in the surface layer, moderately rapid in the subsoil, and rapid in the substratum. Available water capacity is moderate.

Representative profile of Preakness silt loam, 0 to 3 percent slopes, in a wooded area in West Milford Township; 500 feet northwest of intersection of State Route 23 and Union Valley Road, 330 feet north of State Route 23:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, coarse, granular structure; very friable; dark-colored organic stains on sand grains; many clean sand grains; many roots; many fine pores; 10 percent pebbles; strongly acid; abrupt, smooth boundary.

B21g—9 to 18 inches, grayish-brown (10YR 5/2) sandy loam; common, medium, faint, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; few thin silt films on ped faces; many clean sand grains; few roots; many fine pores; 10 percent coarse fragments, dominantly pebbles but a few cobblestones; strongly acid; clear, smooth boundary.

B22g—18 to 27 inches, grayish-brown (2.5Y 5/2) gravelly sandy loam; common, fine and medium, faint, light olive-gray (5Y 6/2) and distinct, yellowish-brown (10YR 5/8) and brownish-yellow (10YR 6/8) mottles; weak, medium and coarse, subangular blocky structure; friable; few thin silt films on ped faces and pebble surfaces; many clean sand grains; few roots; common fine pores; 20 percent coarse fragments, dominantly pebbles and few cobblestones; strongly acid; clear, smooth boundary.

IIC1g—27 to 40 inches, light brownish-gray (10YR 6/2) gravelly sandy loam; common, fine and medium, distinct, grayish-brown (2.5Y 5/2), light olive-gray (5Y 6/2), and brownish-yellow (10YR 6/8) mottles; massive; friable; few silt caps on pebble surfaces; 35 percent coarse fragments, dominantly pebbles but a few cobblestones; strongly acid; abrupt, smooth boundary.

IIC2—40 to 60 inches, brownish-yellow (10YR 6/8) gravelly sand, single grained; loose; 40 percent coarse fragments, dominantly pebbles but a few cobblestones; strongly acid.

The thickness of the solum ranges from 20 to 36 inches. Depth to bedrock is commonly more than 10 feet. Coarse fragments make up less than 2 percent and up to 15 percent of the A horizon, 5 to 20 percent of the B horizon, and 10 to 50 percent of the C horizon. Coarse fragments are dominantly granitic gneiss and lesser amounts of conglomerate, sandstone, shale, and basalt. In unlimed areas reaction of the soils is strongly acid or very strongly acid.

The Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The B horizon ranges from dark grayish brown (2.5Y 4/2) to gray (10YR 5/1). Mottles are common to many, fine or medium, and faint to prominent. The C horizon ranges from gray (N 5/0) to brownish yellow (10YR 6/8). It is sandy loam, loamy sand, sand, or gravelly analogs of these textures.

Preakness soils are near Riverhead, Rockaway, Boonton, Haledon, Pompton, Ridgebury, Haledon, wet variant, Whippany, and Parsippany soils. The Preakness soils have low-chroma colors in the matrix of the subsoil that are lacking in Riverhead, Rockaway, Boonton, Haledon, and Pompton soils. They lack the very firm subsoil of Haledon, wet variant, and the Ridgebury soils. Preakness soils lack the high content of silt and clay commonly in the subsoil of Whippany and Parsippany soils.

Preakness silt loam (Px).—This soil has the profile described as representative of the series. It commonly has a surface layer of silt loam, but in some areas included in mapping this layer is fine sandy loam or sandy loam. Also included in mapping were areas of Riverhead, Pompton, Hibernia, Ridgebury, Haledon, Haledon, wet variant, Whippany, and Parsippany soils.

The high water table is a severe limitation for building foundations, onsite septic filter fields, and for several other uses in community development. The soil has potential for excavated ponds. The high water table limits landscape and lawn-establishment operations. Capability unit IVw-36; woodland group 4w.

Ridgebury Series

The Ridgebury series consists of deep, poorly drained, extremely stony soils that have a fragipan. These nearly level to gently sloping soils are in drainageways and depressions and on toe slopes of the rough, stony, and rocky Highlands in the northern part of the county. They receive much water from areas upslope. The soils formed in glacial till derived mainly from granitic gneiss and lesser amounts of conglomerate, sandstone, and shale. Most areas are wooded. Some are in idle fields. Large tracts of wooded areas are in State parks and municipal reservoir watersheds. The trees in the wooded areas are mainly red maple, ash, pin oak, and white oak.

In a representative profile the surface layer is very dark grayish-brown loam about 6 inches thick. It contains many stones. The upper part of the subsoil is mottled, dark grayish-brown gravelly loam about 8 inches thick. The lower part is dark-gray gravelly loam about 8 inches thick. The upper part of the substratum is a firm and brittle, olive, gravelly sandy loam fragipan about 18 inches thick. The lower part, between depths of 40 and 60 inches, is olive gravelly sandy loam.

Permeability is moderate in the surface layer and subsoil, slow in the fragipan, and moderate below the fragipan. Available water capacity is moderate. Late in winter and early in spring, the water table is at or near the surface. Ponding is likely during periods of high precipitation. The main soil features limiting use of this soil for community development are seasonal high water and stones. Many areas of these soils are surrounded by rough and rocky land, making accessibility for development costly or economically prohibitive.

Representative profile of Ridgebury loam, in a wooded area of Ridgebury extremely stony loam, 0 to 3 percent slopes, in West Milford Township; 700 feet north of the northeast corner of Greendale Drive:

O1—3 inches to 2, leaf litter, original vegetative form easily discernible.

O2—2 inches to 0, black (N 2/0) decayed vegetation of barely discernible origin, abrupt, smooth boundary.

A1—0 to 6 inches, very dark grayish-brown (2.5Y 3/2) loam; moderate, medium and coarse, granular structure; very friable; organic stains on sand grains; many uncoated sand grains; many roots; many fine pores; 20 percent stones, pebbles, and cobblestones; very strongly acid; clear, smooth boundary.

B21g—6 to 14 inches, dark grayish-brown (2.5Y 4/2) gravelly loam; common, medium, distinct, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/6) mottles; moderate, medium and coarse, subangular blocky structure; firm; few uncoated sand grains; common roots; few fine pores; 15 percent coarse fragments, dominantly pebbles but lesser amounts of cobblestones; medium acid; gradual, smooth boundary.

B22g—14 to 22 inches, dark-gray (10YR 4/1) gravelly loam; common, fine and medium, distinct, light yellowish-brown (2.5Y 6/4) and olive-yellow (2.5Y 6/6) mottles; moderate, coarse, subangular blocky structure; firm; few roots; few fine pores; 25 percent coarse fragments, dominantly pebbles but lesser amounts of cobblestones; medium acid; clear, smooth boundary.

C1x—22 to 40 inches, olive (5Y 5/3) gravelly sandy loam; many, coarse, faint, gray mottles; massive; firm; brittle; few discontinuous pores; 30 percent coarse fragments, dominantly pebbles but lesser amounts of cobblestones; medium acid; clear, smooth boundary.

C2—40 to 60 inches, olive (5Y 5/3) gravelly sandy loam; massive; very friable; 30 percent coarse fragments, dominantly pebbles but lesser amounts of cobblestones; medium acid.

The thickness of the solum and the depth to the fragipan range from 18 to 25 inches. Depth to granitic bedrock is variable, but it generally ranges from 6 to 10 feet. Coarse fragments make up 5 to 20 percent of the A horizon and 10 to 35 percent of the layers below it. Stones and boulders are few to common. Coarse fragments are mainly granitic gneiss and lesser amounts of conglomerate, sandstone, and shale. In unlimed areas, reaction of the soils is very strongly acid to medium acid.

In the A1 horizon color ranges from very dark gray (N 3/0) to black (10YR 2/1) or very dark grayish brown (2.5Y 3/2). In the B horizon it ranges from gray (10YR 6/1) to dark grayish brown (2.5Y 4/2). Brownish and yellowish mottles are throughout the B horizon. The B horizon ranges from sandy loam to loam. In some profiles the fragipan is partly within the B horizon. In these profiles the fragipan is massive or has weak, very thick, platy or very coarse, prismatic structure. In the C horizon color ranges from gray (10YR 6/1) to very dark olive gray (5Y 3/2) or from light yellowish brown (10YR 6/4) to olive (5Y 5/3). Mottles of contrasting colors are common throughout the C horizon. Part of the C horizon is at a depth of 30 inches or less in all profiles. Dominant colors in this part have a chroma of 3 or more.

Ridgebury soils are near Rockaway, Hibernia, Riverhead, Pompton, Preakness, Whippany, and Parsippany soils. The low-chroma matrix colors in the subsoil of Ridgebury soils are lacking in Rockaway, Hibernia, Riverhead, and Pompton soils. Ridgebury soils have a firm subsoil that is lacking in Preakness soils. Ridgebury soils, unlike Whippany and Parsippany, lack fine textured or morderately fine textured material in the subsoil.

Ridgebury extremely stony loam, 0 to 3 percent slopes (RbA).—This soil has the profile described as representative of the series. The content of stones is commonly about 10 percent, and the stones generally range from 1 to 6 feet in diameter. Stones on the surface are 2 to 5 feet apart. Rock crops out in a few places. Included in mapping were areas of Rockaway, Hibernia, more sloping Ridgebury soils, and Muck, shallow. Also included were small areas of Parsippany, Preakness, and Pompton soils.

The main soil features that limit the use of this soil are the high water table and the high stone content. Landscape and lawn-establishment operations are severely limited. Accessibility is generally difficult because of the surrounding rough and rocky land. Capability unit VIIs-38; woodland group 4w.

Ridgebury extremely stony loam, 3 to 8 percent slopes (RbB).—This soil has a profile similar to the one described as representative for the series. The surface layer is commonly 10 percent stones. Stones generally range from 1 to 6 feet in diameter. Those on the surface are 2 to 5 feet apart. Bedrock crops out in a few places. Included in mapping were small areas of Rockaway, Hibernia, and less sloping Ridgebury soils. These inclusions make up less than 25 percent of the mapped areas. Also included were small areas of Parsippany, Preakness, and Pompton soils that have common boundaries with Ridgebury soils.

The main soil features that limit the use of this soil are the high water table and high stone content. Landscape and lawn-establishment operations are severely limited. Accessibility is generally difficult because of the surrounding rough and rocky land. Capability unit VIIs-38; woodland group 4w.

Riverhead Series

The Riverhead series consists of deep, well-drained, moderately coarse textured soils. These gently sloping to strongly sloping soils are in valleys adjacent to the rough, stony Highlands. They formed in glacial outwash material derived mainly from granitic gneiss and lesser amounts of conglomerate, sandstone, and shale.

In a representative profile the surface layer is dark-brown sandy loam about 10 inches thick. The upper part of the subsoil is strong-brown gravelly sandy loam about 16 inches thick. The lower part is yellowish-brown gravelly sandy loam about 10 inches thick. The substratum, between depths of 36 and 60 inches, is yellowish-brown and brown gravelly sand.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the substratum. Available water capacity is moderate. This soil is a good source of sand and gravel. Rapid permeability in the substratum is a pollution hazard where the soils are used for onsite septic effluent disposal systems. These soils generally have slight to moderate limitations for most uses in community development.

Representative profile of Riverhead sandy loam, 3 to 8 percent slopes, in an idle field in Ringwood Borough; 160 feet west of intersection of Stoutsburg and Carletondale Roads:

Ap—0 to 10 inches, dark-brown (10YR 4/3) sandy loam; weak fine, granular structure; very friable; dark organic stains on sand grains; many uncoated sand grains; many roots; many fine pores; 10 percent coarse fragments, dominantly pebbles but a few cobblestones; strongly acid; abrupt, smooth boundary.

B2—10 to 26 inches, strong-brown (7.5YR 5/6) gravelly sandy loam; weak, medium, subangular blocky structure; very friable; common roots; common fine pores; 15 percent coarse fragments near top of horizon and gradually increasing to 25 percent in lower part, dominantly pebbles but a few cobblestones; strongly acid; clear, wavy boundary.

B3—26 to 36 inches, yellowish-brown (10YR 5/6) gravelly sandy loam; very weak subangular blocky structure; very friable; few roots; common fine pores; 25 percent coarse fragments near top of horizon and gradually increasing to 35 percent in lower part, dominantly pebbles but a few cobblestones; strongly acid; gradual, wavy boundary.

C—36 to 60 inches, yellowish-brown (10YR 5/4) and brown (10YR 5/3) gravelly sand intermixed, grading with depth to light yellowish-brown (10YR 6/4) and brownish-yellow (10YR 6/6); single grained; loose; 35 percent coarse fragments near top of horizon and increasing with depth to 50 percent, dominantly pebbles but lesser amounts of cobblestones; strongly acid.

The thickness of the solum ranges from 24 to 36 inches. Depth to bedrock is commonly more than 10 feet. Coarse fragments make up 0 to 15 percent of the A horizon; 0 to 35 percent of the B horizon, generally increasing in the lower part; and 10 to 50 percent of the C horizon. These fragments are dominantly granitic gneiss and lesser amounts of conglomerate sandstone, shale, and basalt. In unlimed areas reaction of the soils is strongly acid.

In the Ap horizon color ranges from very dark grayish brown (10YR 3/2) to brown or dark brown (10YR 4/3). In the B horizon it ranges from brown (7.5YR 4/4) to yellowish brown (10YR 5/6). The B horizon is dominantly sandy loam or gravelly sandy loam and has thin subhorizons that are loam or loamy sand in places. The C horizon is dominantly yellowish brown (10YR 5/4) and brown (10YR 5/3) but in places has a hue of 2.5Y with similar value and chroma. The C horizon ranges from loamy sand to sand or the gravelly analogs of textures in this range.

Riverhead soils are near Otisville, Pompton, Preakness, Netcong, Rockaway, Hibernia, Ridgebury, Boonton, and

Whippany soils. Riverhead soils have a thicker solum and lack the high amount of coarse fragments commonly in Otisville soils. They lack the mottling commonly in Pompton, Preakness, Hibernia, Ridgebury, Boonton, and Whippany soils. Riverhead soils, unlike Netcong soils, have a stratified substratum.

Riverhead sandy loam, 3 to 8 percent slopes (RhB).—This soil has the profile described as representative of the series. Included in mapping were areas of Otisville, Pompton, Preakness, Rockaway, and Hibernia soils and areas of strongly sloping Riverhead soils.

This soil generally has slight limitations for most uses in community development. Limitations are caused mainly by rapid permeability in the substratum, which makes onsite filter fields for septic effluent a potential pollution hazard. This soil is suitable for most ornamental plants and grasses commonly grown in the area. Capability unit IIe-7; woodland group 3o.

Riverhead sandy loam, 8 to 15 percent slopes (RhC).—This soil has a profile similar to the one described as representative for the series. Included in mapping were areas of Otisville, Pompton, Rockaway, and Hibernia soils and areas of Riverhead sandy loam, 3 to 8 percent slopes.

This soil generally has moderate limitations for most uses in community development. Limitations are caused mainly by slope and by the rapid permeability in the substratum. The permeability in the substratum makes onsite filter fields for septic effluent a potential pollution hazard. This soil is suitable for most ornamental plants and grasses in the area. Capabilty unit IIIe-7; woodland group 3o.

Rockaway Series

The Rockaway series consists of gently sloping to very steep soils that have a fragipan in the lower part of the subsoil. These soils are dominantly moderately well drained but in places are well drained. They are on side slopes in the rough, stony, and rocky Highlands in the northern part of the county. The soils formed in glacial till derived mainly from granitic gneiss and from lesser amounts of conglomerate, sandstone, and shale. Most areas are wooded. Others are idle fields or sites for small housing developments. A few areas are farmed. Large tracts of these soils are in State forests, State parks, and reservoir watersheds. The trees in the wooded areas are upland oaks, hickory, ash, beech, and red maple.

In a representative profile the surface layer, about 4 inches thick, is very dark grayish-brown gravelly sandy loam that contains a few stones. The upper part of the subsoil is friable, yellowish-brown gravelly loam about 18 inches thick. The lower part of the subsoil, part of a fragipan that extends into the upper part of the substratum, is very firm, mottled, yellowish-brown gravelly sandy loam about 16 inches thick. The upper (fragipan) part of the substratum is firm, pale-brown, grayish-brown, and light olive-brown gravelly sandy loam about 18 inches thick. The lower part of the substratum, between depths of about 56 and 72 inches, is very friable, pale-brown, grayish-brown, and light olive-brown gravelly loamy sand.

Permeability is moderate above and moderately rapid below the fragipan. It is slow in the fragipan. Available water capacity is moderate. In excessively wet areas water above the fragipan moves laterally. A seasonal perched water table is at a depth of $1^1/_2$ to $2^1/_2$ feet for short periods. The slowly permeable fragipan and the perched water table limit the use of these soils for onsite septic filter fields. Slips are a concern on roadbanks and on other slopes where the soil has been scalped, stockpiled, and redeposited on the fragipan. Stones and boulders on the surface are concerns where construction and landscaping are performed. These soils are surrounded by rough and rocky areas that make accessibility for developments costly or economically prohibitive.

Representative profile of Rockaway gravelly sandy loam in an area of Rockaway very stony sandy loam, 3 to 8 percent slopes, in West Milford Township; 10 feet east of dirt road and 0.8 mile north of junction of dirt road and Stonetown Road, which is 425 feet west of intersection of Stonetown Road with Greenwood Lake Turnpike:

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) gravelly sandy loam; weak, medium, granular structure; very friable; many roots; common fine pores; very dark gray to black stains on most coarse fragments, grains, and surfaces of peds; 25 percent stones, cobblestones, and pebbles; very strongly acid; clear, wavy boundry.

B1t—4 to 9 inches, yellowish-brown (10YR 5/6) gravelly loam; weak, fine, subangular blocky structure; friable; common roots; common fine pores; stains on many grains; thin, patchy silt and clay coatings on ped faces and coarse fragments and discontinuous silt and very fine sand coatings in pores; 20 percent stones, cobblestones, and pebbles in equal proportions; strongly acid; gradual, wavy boundary.

B2t—9 to 22 inches, yellowish-brown (10YR 5/6) gravelly loam; moderate, medium, subangular blocky structure; friable; common fibrous roots and few coarse roots that decrease in number with depth; common fine pores; thin, discontinuous clay films and isolated, thick, patchy, reddish clay films on ped surfaces, in sand and gravel niches, and in pores; 20 percent pebbles and cobblestones and a few stones; strongly acid; abrupt, smooth boundary.

Bx—22 to 38 inches, yellowish-brown (10YR 5/4) gravelly sandy loam; common, fine and medium, faint, strong-brown (7.5YR 5/6), yellowish-brown (10YR 5/6), and a pale-brown (10YR 6/3) mottles; moderate, thick, platy structure; very firm; brittle; very few very fine pores; thin to thick patchy clay films on ped faces; 25 percent coarse fragments, mostly pebbles and cobblestones but a few stones; strongly acid; gradual, wavy boundary.

C1x—38 to 56 inches, pale-brown (10YR 6/3), grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) gravelly light sandy loam; faint olive-yellow (2.5Y 6/6) and yellowish-brown (10YR 5/4) variegation that fades into matrix colors; massive; firm; brittle; very few very fine pores; 25 percent coarse fragments, mostly pebbles and cobblestones but a few stones; strongly acid; clear, wavy boundary.

C2—56 to 72 inches, pale-brown (10YR 6/3), grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) gravelly loamy sand; massive; very friable; 40 percent coarse fragments, mostly pebbles and cobblestones but a few stones; strongly acid.

The thickness of the solum ranges form 30 to 50 inches. The depth to granitic gneiss bedrock is variable but generally ranges from 6 to 10 feet. The depth to the fragipan ranges from 18 to 30 inches. Coarse fragments of granitic gneiss, conglomerate, sandstone, and shale make up 10 to 35 percent of the solum and up to 50 percent of the C horizon. Gravel is dominant, but cobblestones are also present. Stones and boulders are few to common. They commonly decrease in number with depth. In unlimed areas reaction of the soils is strongly acid or very strongly acid.

In the A1 horizon color ranges from very dark gray (10YR 3/1) to dark brown (10YR 3/3). In the Ap horizon it ranges from dark brown (7.5YR 4/2) to dark yellowish brown (10YR 4/4). The B horizon ranges from gravelly loam to gravelly sandy loam. The B1 and B2 horizons are dark brown (7.5YR 4/4) to yellowish brown (10YR 5/8). In the Bx horizon color ranges from dark brown (7.5YR 4/4) to light olive brown (2.5Y 5/6). This horizon is mottled various shades of brown and olive brown. The C horizon is brownish or grayish. Mottles, where present, are yellowish brown, brown, or gray. The C horizon ranges from gravelly sandy loam to gravelly loamy sand.

Rockaway soils are near Otisville, Netcong, Riverhead, Pompton, Whippany, Swartswood, and Hibernia soils. Rockaway soils have a fragipan in the lower part of the B horizon that Otisville, Netcong, Riverhead, Pompton, and Whippany soils lack. Where mottling is present in Rockaway soils, it is at a greather depth than the mottling in Hibernia soils. Rockaway soils are made up largely of granitic material, and Swartswood soils are not.

Rockaway very stony sandy loam, 3 to 8 percent slopes (RmB).—This soil has the profile described as representative of the series. Stones on the surface are 5 to 30 feet apart. Included in mapping were areas of Netcong, Hibernia, and strongly sloping Rockaway soils and small areas of Riverhead, Swartswood, and Boonton soils.

Most areas of this soil have been farmed but are now idle fields that are reverting to wooded areas. The soil features that affect the use of this soil are slope; the firm, dense, slowly permeable subsoil; the seasonal perched water table; and the content of stones. The stones are the main limitation to landscaping and to the establishment of lawns. Capability unit VIs-19; woodland group 3o.

Rockaway very stony sandy loam, 8 to 15 percent slopes (RmC).—This soil has a profile similar to the one described as representative of the series. Stones on the surface are 5 to 30 feet apart. Some surface stones and boulders have been removed. Included in mapping were areas of Netcong, gently sloping Rockaway, and Hibernia soils and small areas of Riverhead, Swartswood, and Boonton soils.

Most areas of this soil are easily accessible idle pasture that is reverting to woods. The soil features affecting the use of this soil are slope; the firm, dense, slowly permeable fragipan; and the content of stones. The content of stones and the moderate hazard of erosion are limitations to landscaping and to the establishment of lawns. Capability unit VIs-19; woodland group 3o.

Rockaway extremely stony sandy loam, 3 to 15 percent slopes (RrC).—This soil has a profile similar to the one described as representative of the series, except that the soil material contains more stones. The stones are typically 2 to 4 feet in diameter. Stones on the surface are 2 to 5 feet apart. The content of stones decreases with depth. Rocks crop out in a few places. Included in mapping were areas of Netcong, Hibernia, and steep Rockaway soils. Also included were small areas of Riverhead, Swartswood, and Boonton soils.

Soil features that limit the use of this soil are content of stones, slopes, slow permeability, and the seasonal perched water table. Low-density housing that is carefully designed and installed is practical in some areas. In places the surrounding rough and rocky areas reduce accessibility. The high content of stones is the main limitation to the establishment of lawns and to landscaping. Capability unit VIIs-22; woodland group 3x.

Rockaway extremely stony sandy loam, 15 to 25 percent slopes (RrD).—This soil has a profile similar to the one described as representative of the series, except that the soil material contains more stones. The stones are typically 2 to 4 feet in diameter. Stones on the surface are 2 to 5 feet apart. The content of stones decreases with depth. Rocks crop out in a few places. Included in mapping were areas of Netcong soils; areas of gently sloping to strongly sloping Rockaway and Hibernia soils; and small areas of Riverhead, Swartswood, and Boonton soils.

This soil has severe limitations for most uses in community development. Limiting features are the high content of stones and boulders; slope; the firm, dense, slowly permeable fragipan; and the surrounding rough rocky areas that make accessibility difficult. The high content of stones and the severe hazard of erosion are limitations to landscaping and to the establishment of lawns. Capability unit VIIs-22; woodland group 3x.

Rockaway-Rock outcrop complex, 3 to 15 percent slopes (RsC).—This complex consists of very stony or extremely stony Rockaway soils and granitic gneiss bedrock outcrops. The outcrops make up 15 to 30 percent of each mapped area. The depth of the soil between outcrops ranges from 2 feet to tens of feet within short distances but is 6 to 10 feet in most areas. Commonly included in mapping were small areas of Netcong and Hibernia soils that make up as much as 20 percent of the mapped areas. Soils that are shallow to bedrock make up 10 percent of the mapped areas. In the northern part of the county, the included soils make up about 10 percent of each mapped area. Also included in the northern part of the county were areas of soils in which the fragipan is weakly developed or missing and in which the subsoil has less clay accumulation. Areas of soils in which the subsoil or substratum is less acid were also included in places in the northern part of the county. The included soils in this part of the county generally are enough like the Rockaway soils to respond similarly to the same management.

Most areas of this complex have been left in their natural condition. In a few places individual homesites have been built in areas where rock outcrops are prevalent.

The main features that limit the use of this complex are bedrock outcrops, areas of shallow soils, content of boulders and stones, the fragipan (in Rockaway soils), and slopes (fig. 6). The content of stones is a limitation to landscaping and to the establishment of lawns on the Rockaway soils. Capability unit VIIs-22; woodland group 4x.

Rock Outcrop

Rock outcrop is bedrock that crops out on the surface. Where the outcrops are numerous, they severely limit use of the area. Rock outcrop is

Figure 6.—Rock outcrops in an area of Rockaway-Rock outcrop complex, 3 to 15 percent slopes. These outcrops severely limit the use of this soil for residential, industrial, commercial, and farm purposes and for wooded areas and wildlife habitat.

mapped in complexes with soils, since it was not feasible, because of the scale of the map, to map it separately.

Rock outcrop-Holyoke complex, 15 to 35 percent slopes (RwE).—This complex consists of basalt bedrock outcrops and Holyoke soils. The outcrops make up 30 to 50 percent of each mapped area, and Holyoke soils make up 30 to 70 percent. Included in mapping were small areas of Boonton and Haledon soils and a soil that is similar to Holyoke soils except that depth to bedrock is more than 20 inches.

Most areas of this complex have been left in a nearly natural condition and are used as parks and recreation areas. Some areas in this condition are parts of low-density residential, industrial, or high-rise developments. The soil, in large parts of a few areas, has been altered by man in preparation of building sites. Bedrock outcrops, shallow stony soils, and steep slopes are the major limitations to use. Landscaping and lawn establishment on Holyoke soils are limited by the shallow depth to bedrock. Capability unit VIIs-22; woodland group 4x.

Rock outcrop-Rockaway complex, 15 to 35 percent slopes (RxE).—This complex consists of granitic gneiss bedrock outcrops and Rockaway soils. The outcrops make up 30 to 50 percent of each mapped area, and Rockaway soils make up 50 to 70 percent. The exposed part of the bedrock ranges from a few inches to several feet in height. The depth of the soil between outcrops is generally less than 6 feet but ranges to many feet. Stones or boulders cover about 10 percent of the surface. Toward the northern boundary of the county, the proportion of shallow soils increases, the fragipan is less definitely expressed, and the subsoil has less clay accumulation. Included in mapping were small areas of Netcong and Hibernia soils and a soil that is underlain by bedrock at a depth of less than 20 inches.

Most areas of this complex have been left in a nearly natural condition. Bedrock outcrops; shallow, stony, or bouldery soils; and steep slopes are the major limitations to use. Stones limit landscaping and lawn establishment on the Rockaway soil. Capability unit VIIs-22; woodland group 4x.

Rock outcrop-Swartswood complex, 15 to 45 percent slopes (RyE).—This complex consists of bedrock outcrops and Swartswood soils. The outcrops make up to 25 to 50 percent of each mapped area and Swartswood soils make up 50 to 70 percent. The bedrock is commonly hard conglomerate or sandstone, but in a small area it is hard, slaty shale. The exposed bedrock is in broad areas or is in many, small, closely spaced, sharp outcrops. Outcrops range from a few inches to several feet in height. Depth of the soil between the outcrops is commonly 3½ to 6 feet. Boulders and stones make up 5 to 15 percent of the soil material and the surface area. Included in mapping were areas of Wurtsboro and Norwich soils and a soil that is shallow to bedrock. Scattered within these areas were small depressions occupied by shallow muck (Muck, shallow) that ranges from 15 to 40 inches in thickness.

Most areas of this unit are wooded. The rock outcrops; the shallow, bouldery, and stony soils; and steepness are the major limitations. Stones limit landscaping and lawn establishment on the Swartswood soils. Capability unit VIIs-22; woodland group 4x.

Swartswood Series

The Swartswood series consists of well drained and moderately well drained soils that have a fragipan in the lower part of the subsoil. In this county most Swartswood soils are moderately well drained. The gently sloping to very steep soils are part of the landscape of the rough, stony and rocky Highlands in the northwestern part of the county. The soils formed in glacial till derived mainly from conglomerate, sandstone, shale, and lesser amounts of gneiss. Most areas are wooded. Others are in abandoned farms, individual homesites, and housing developments. A few active farms are in areas of these soils. Large tracts of the wooded areas and abandoned farms are part of State forests and reservoir watersheds.

In a representative profile the surface layer is very dark grayish-brown gravelly fine sandy loam about 2 inches thick. The subsurface layer is brown cobbly fine sandy loam about 2 inches thick. The upper part of the subsoil is about 19 inches thick. The upper 4 inches is strong-brown gravelly fine sandy loam, the next 11 inches is yellowish-brown gravelly loam, and the lower 4 inches is brown gravelly sandy loam. The lower part of the subsoil is a fragipan. It is very firm and brittle, mottled, dark-brown gravelly sandy loam to a depth of about 33 inches. Below this, to a depth of 60 inches, is firm, brittle, mottled, yellowish-brown gravelly sandy loam.

Permeability is moderate above the fragipan and slow in the fragipan. Available water capacity is moderate. As the soil approaches saturation, water moves laterally above the fragipan. The slowly permeable fragipan severely limits the use of the soils for septic effluent fields. Slips are likely in roadbanks and other slopes where the soil is scalped, stockpiled, and then redeposited on the fragipan. Stones and boulders on the surface and throughout the profile cause limitations to building and landscaping. Many areas of these soils are surrounded by rough and rocky land, making accessibility for developments costly or economically prohibitive.

Representative profile of Swartswood gravelly fine sandy loam in an area of Swartswood extremely stony fine sandy loam, 8 to 15 percent slopes, in West Milford Township; 10 feet from the east side of Gould Road and 500 feet east of the intersection of Gould and Union Valley Roads:

O1—3 inches to 2, leaf litter; original form easily discernible.

O2—2 inches to 0, black (5YR 2/1) decayed vegetation; origin barely discernible; extremely acid; abrupt, smooth boundary.

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) gravelly fine sandy loam; weak, fine, granular structure; very friable; black (10YR 2/1) stains on sand grains; few uncoated sand grains; many roots; common fine pores; 20 percent stones, cobblestones, and pebbles; extremely acid; abrupt, irregular boundary.

A2—2 to 4 inches, brown (10YR 5/3) cobbly fine sandy loam; weak, fine, granular structure; many uncoated sand grains; many taproots and common fibrous roots; common fine pores; 15 percent cobblestones and pebbles; very strongly acid; abrupt, irregular boundary.

B21—4 to 8 inches, strong-brown (7.5YR 5/6) gravelly fine sandy loam; moderate, medium, granular structure; few uncoated sand grains; common roots; common fine pores; 25 percent pebbles and cobblestones; very strongly acid; clear, wavy boundary.

B22—8 to 19 inches, yellowish-brown (10YR 5/4) gravelly loam; moderate, fine and medium, subangular blocky structure; few clean sand grains; common roots; common fine pores; 25 percent pebbles and cobblestones; very strongly acid; clear, wavy boundary.

B23—19 to 23 inches, brown (7.5YR 5/4) gravelly sandy loam; weak, fine and medium, subangular blocky structure; few clean sand grains; common fine pores; few roots; 30 percent pebbles and cobblestones; very strongly acid; clear, wavy boundary.

Bx1—23 to 33 inches, dark-brown (7.5YR 4/4) gravelly sandy loam; few, fine, distinct, pale-brown (10YR 6/3), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/6) mottles; moderate, thick, platy structure; very firm; brittle; few, thin, patchy clay films on ped faces; few, fine, discontinuous pores; 30 percent pebbles and cobblestones; very strongly acid; clear, wavy boundary.

Bx2—33 to 60 inches, yellowish-brown (10YR 5/4) gravelly sandy loam; common, faint, light brownish-gray (2.5Y 6/2), pale-brown (10YR 6/3), and yellowish-brown (10YR 5/6) mottles that gradually decrease with depth; massive; firm; brittle; few, fine, discontinuous pores; 35 percent pebbles and cobblestones; very strongly acid.

The thickness of the solum ranges from 40 to 70 inches. Depth to bedrock is variable but commonly ranges from 6 to 10 feet. The depth to fragipan ranges from 18 to 24 inches. Coarse fragments make up 10 to 35 percent of the profile. Boulders and stones are few to common on the surface and in the soil. Coarse fragments are mainly conglomerate, sandstone, shale, and gneiss. Reaction of the soils is extremely acid or very strongly acid in unlimed areas.

In the A1 horizon color ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). The Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3), and the B2 horizon is dark yellowish brown (10YR 4/4) to strong brown (7.5YR 5/6). The B2 horizon ranges from sandy loam to loam or the gravelly analogs of textures in this range. Mottles in the Bx horizon are few to common and are yellowish brown, strong brown, or grayish. The Bx horizon is sandy loam, loam, or the gravelly analogs of these textures. The Bx horizon ranges from yellowish brown (10YR 5/4) to reddish brown (5YR 4/3). Mottles are yellowish, brownish, grayish, or reddish brown.

Swartswood soils are near Wurtsboro, Norwich, Rockaway, Hibernia, Chenango, and Braceville soils. In Swartswood soils low-chroma matrix colors and low-chroma mottling is not so close to the surface as it is in Wurtsboro, Norwich, and Hibernia soils. Swartswood soils are largely materials derived from dark-covered sandstone or conglomerates, which distinguishes them from Rockaway soils. They lack the stratified substratum of Chenango and Braceville soils.

Swartswood very stony fine sandy loam, 3 to 8 percent slopes (SdB).—This soil contains less stones, but the profile is otherwise similar to the one described as representative for the series. Also, the stones in this soil are typically less than 2 feet in diameter. Stones on the surface are 5 to 30 feet apart. Depth to bedrock is generally 6 to 10 feet. Included in mapping were areas of Wurtsboro soils, strongly sloping areas of Swartswood soils, and small areas of Chenango, Braceville, and Rockaway soils.

Most of this soil is easily accessible idle farmland that is reverting to wooded areas. This soil has moderate limitations for most uses in community development. Limitations are caused mainly by the firm, dense, slowly permeable fragipan and by stones. Stones limit landscaping and lawn establishment. Capability unit VIs-19; woodland group 3o.

Swartswood very stony fine sandy loam, 8 to 15 percent slopes (SdC).—This soil contains fewer stones, but the profile is otherwise similar to the one described as representative of the series. Also, the stones in this soil are generally less than 2 feet in diameter. Stones on the surface are 5 to 30 feet apart. Depth to bedrock is generally 6 to 10 feet. Included in mapping were areas of a soil similar to Swartswood soils that does not have mottling at a depth of less than 36 inches and has a fragipan at a greater depth. Also included are Wurtsboro soils and small areas of Rockaway and Chenango soils.

Most of this soil is easily accessible idle farmland that is reverting to wooded areas. This soil has limitations for community and recreational development. Limitations are mainly caused by slope; the firm, dense, slowly permeable fragipan; and stones. Stones and a moderate hazard of erosion limit landscaping and lawn establishment. Capability unit VIs-19; woodland group 3o.

Swartswood extremely stony fine sandy loam, 3 to 8 percent slopes (SeB).—This soil has a profile similar to the one described as representative of the series. Stones commonly make up more than 10 percent of the soil material. Stones on the surface are commonly 5 or more feet in diameter. They are 2 to 5 feet apart. Rock crops out in a few places. Included in mapping were areas of Wurtsboro soils,

Figure 7.—An area of extremely stony Swartswood soil.

strongly sloping Swartswood soils, and small areas of Chenango and Rockaway soils.

Severe limitations to residential, commercial, and industrial development are caused mainly by boulders and stones (fig. 7), slow permeability in the fragipan, and seepage above the fragipan. Accessibility is difficult because of the surrounding rough and rocky land. This soil is commonly used to grow trees and to provide watershed protection. The high stone content severely limits landscaping and lawn establishment. Capability unit VIIs-19; woodland group 3x.

Swartswood extremely stony fine sandy loam, 8 to 15 percent slopes (SeC).—This soil has the profile described as representative of the series. Stones commonly make up 10 percent of the material in the soil profile. Stones larger than 5 feet in diameter are throughout the soil material. Stones on the surface are 2 to 5 feet apart. Rock crops out in places. Included in mapping were areas of Wurtsboro soils, gently sloping and steep areas of Swartswood soils, and small areas of Rockaway and Chenango soils.

This soil generally has severe limitations for high-density community development, industrial sites, recreation areas, or other uses that require intensive land smoothing and grading. Limitations are caused mainly by boulders and stones, slope, and the fragipan. Accessibility is difficult because of the surrounding steep slopes and rock outcrops. High stone content and a moderate hazard of erosion severely limit landscaping and lawn establishment. Capability unit VIIs-19; woodland group 3x.

Swartswood extremely stony fine sandy loam, 15 to 25 percent slopes (SeD).—This soil has a profile similar to the one described as representative of the series. Stones commonly make up more than 10 percent of the soil material in the profile. Stones larger than 5 feet in diameter are throughout. Stones on the surface are 2 to 5 feet apart. Depth to bedrock is generally 3½ to 6 feet. Rock crops out in a few places. Included in mapping were areas of a soil similar to Swartswood soil but that lacks mottling at a depth of less than 36 inches and has a fragipan at a greater depth. Also included were areas of Wurtsboro and Rockaway soils.

This soil generally has severe limitations for high-density community development, industrial sites, and recreation areas. Limitations are caused mainly by boulders and stones and by slope. Accessibility is difficult because of the surrounding rough and rocky land. High stone content and a severe hazard of erosion severely limit landscaping and lawn establishment. Capability unit VIIs-19; woodland group 3x.

Swartswood-Rock outcrop complex, 3 to 15 percent slopes (SrC).—This complex consists of Swartswood soils and hard conglomerate or sandstone bedrock outcrops. The Swartswood soil has a profile similar to the one described as representative of the Swartswood series. The outcrops make up 15 to 30 percent of each mapped area. The exposed bedrock is in broad areas or small, sharp, closely spaced outcrops. Outcrops are a few inches to several feet high. Depth of the soil between outcrops is commonly 3½ to 6 feet. Boulders and stones cover 5 to 10 percent of the surface. Included in mapping were areas of Wurtsboro or Norwich soils or a soil that is shallow to bedrock. Also included were numerous small depressions occupied by shallow muck (Muck, shallow), 15 to 40 inches thick.

Most areas of this complex are wooded. Depth to bedrock and presence of rock outcrops are the major limitations. Stones limit landscaping and lawn establishment on Swartswood soils. Capability unit VIIs-19; woodland group 4x.

Urban Land

Urban land consists of areas that have been developed for residential, commercial, or industrial use. During development these areas were leveled or cut and filled to such an extent that 40 to 80 percent of the original soil has been altered.

Urban land-Boonton complex, gently sloping (UbB).—This complex consists of areas where man has altered the soil, areas of Boonton soils, and small inclusions of Holyoke or Haledon soils. Urban land makes up 40 to 80 percent of each mapped area, and Boonton soils make up 20 to 60 percent. Extensive areas are under paving or under structures. Slopes are dominantly 3 to 8 percent, but some areas have been leveled by man or are steep edges of cuts or fills.

The soil materials and the Boonton soils are mostly stony and gravelly glacial deposits derived from shale, sandstone, basalt, and granitic materials. Depth to shale, sandstone, or basalt bedrock ranges from 3 to 10 feet but is generally more than 6 feet. Stones, cobblestones, and gravel are common throughout the materials, and boulders are common in some areas. Not assigned to a capability unit or woodland group.

Urban land-Boonton complex, sloping (UbC).—This complex consists of areas where man has altered the soil, areas of Boonton soils, and small inclusions of Holyoke soils and bedrock outcrops.

Urban land makes up 40 to 80 percent of each mapped area, and Boonton soils make up 20 to 60 percent. Slopes are dominantly 8 to 15 percent. In some tracts extensive areas are under paving or structures. In preparing building sites, developers have made extensive cuts and fills. Such sites generally have steep, shallow cuts or fills at the edges. The soil materials consist of stony and gravelly fine sandy loam glacial deposits composed mostly of red sandstone and shale, basalt, and granitic gneiss. Depth to shale, sandstone, or basalt bedrock ranges from 3 to more than 10 feet but is generally 6 to 10 feet. Where bedrock is at a depth of 3 to 6 feet, the sandstone and shale in most places are rippable to a depth of at least 6 feet. Not assigned to a capability unit or woodland group.

Urban land-Riverhead complex, gently sloping (UrB).—This unit consists of areas where man has altered the soil, areas of Riverhead soils, and small inclusions of Otisville and Pompton soils. Urban land makes up 40 to 80 percent of each mapped area, and Riverhead soils make up 20 to 60 percent. Slopes are dominantly 3 to 8 percent. Extensive areas are under paving or structures. The soil materials are stratified and sorted, cobbly or gravelly, coarse-textured glacial outwash materials composed mostly of granitic gneiss, sandstone, or shale materials. Depth to bedrock in most areas is more than 10 feet. Not assigned to a capability unit or woodland group.

Urban land-Rockaway complex (Ux).—This unit consists of areas where man has altered the soil, areas of Rockaway soils, and small inclusions of Hibernia and Netcong soils. Urban land makes up 40 to 80 percent of each mapped area and Rockaway soils make up 20 to 60 percent. Slopes are dominantly 3 to 15 percent. Extensive areas are under paving or structures. The soil materials are very stony and gravelly sandy loam glacial deposits derived mainly from granitic gneiss materials. Depth to granitic gneiss bedrock ranges from 3 feet to many feet but is mostly 6 to 10 feet. Not assigned to a capability unit or woodland group.

Whippany Series

The Whippany series consists of somewhat poorly drained soils that have a moderately fine textured or fine textured subsoil underlain by coarser textured material. These nearly level to gently sloping soils are adjacent to the glacial lake bottoms. The soils formed in lacustrine deposits composed of silty and clayey material underlain by sandy material of glacial outwash origin. These soils have been used for farming and, more recently, for housing and industrial development. Some areas are still wooded. The areas adjacent to large streams are subject to flooding.

In a representative profile the surface layer is very dark brown silt loam about 3 inches thick. The subsoil is about 29 inches thick. The upper 6 inches is brown silt loam, the next 6 inches is yellowish-brown silty clay loam, and the next 8 inches is mottled, dark-brown clay loam. The lower 9 inches of the subsoil is also mottled, dark-brown clay loam but contains less clay than the layer above it. The upper part of the substratum is dark-brown loam about 8 inches thick. The lower part, between depths of 40 and 60 inches, is yellowish-brown sandy loam.

Permeability is slow in the subsoil and moderately rapid in the substratum. Available water capacity is high. The seasonal high water table is at a depth of ½ to 1½ feet. Limitations for community, recreational, and industrial development are caused mainly by the seasonal high water table. Most Whippany soils do not flood frequently, but some areas in the lowest positions are subject to flooding.

Representative profile of Whippany silt loam, sandy loam substratum, 0 to 5 percent slopes, in a wooded area in Wayne Township; 830 feet southeast of intersection of Parrish Drive and Dey Road, 100 feet north of Dey Road:

A1—0 to 3 inches, very dark brown (10YR 2/2) heavy silt loam; moderate, medium, granular structure; very friable; dark-colored stains on sand grains; few uncoated sand grains; many roots; many fine pores; medium acid; gradual, smooth boundary.

B1—3 to 9 inches, brown (10YR 4/3) silt loam; weak, medium, subangular blocky structure; friable; dark-colored stains on some sand grains; common uncoated sand grains; many roots; many fine pores; medium acid; abrupt, smooth boundary.

B21t—9 to 15 inches, yellowish-brown (10YR 5/6) heavy silty clay loam; many grayish-brown (10YR 5/2) mottles; moderate, medium, subangular blocky structure; firm; plastic and sticky; few patchy clay films on ped faces; common roots; few fine pores; fine rust-colored stains in few root channels; medium acid; gradual, wavy boundary.

B22t—15 to 23 inches, dark-brown (7.5YR 4/4) heavy clay loam; many, fine and medium, distinct, pale-brown (10YR 6/3) and common, medium, prominent, grayish-brown (10YR 5/2) mottles; strong, medium, subangular blocky structure; firm; sticky and plastic; few patchy clay films on ped faces; common roots; slightly acid; clear, wavy boundary.

B3—23 to 32 inches, dark-brown (7.5YR 4/4) clay loam; common, medium, faint, strong-brown (7.5YR 5/6) and gray (N 5/0) mottles; strong, medium, subangular blocky structure; firm; few clay films lining pores; common roots; neutral; abrupt, smooth boundary.

IIC1—32 to 40 inches, dark-brown (7.5YR 4/4) loam; massive; friable; many uncoated sand grains; few roots; neutral; abrupt, smooth boundary.

IIIC2—40 to 60 inches, yellowish-brown (10YR 5/6) sandy loam; massive; friable; many uncoated sand grains; few roots; 5 percent pebbles; neutral.

The thickness of the solum ranges from 30 to 40 inches. Depth to bedrock ranges from 6 to 10 feet or more. Coarse fragments make up 0 to 5 percent of the solum and as much as 20 percent of the soil material below a depth of 40 inches. The content of coarse fragments in the substratum is variable depending on the sequence of strata. Coarse fragments are mainly granitic gneiss and lesser amounts of conglomerate, sandstone, shale, and traprock. Reaction of the soils in unlimed areas is medium acid in the surface layer and neutral in the substratum.

In the A1 horizon color ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The Ap horizon is dark grayish brown (10YR 4/2) to dark yellowish brown (10YR 4/4). In the B horizon color ranges from yellowish brown (10YR 5/6) in the upper part to dark brown (7.5YR 4/4) or yellowish red (5YR 5/6) in the lower part. Texture is dominantly heavy silty clay loam or heavy clay loam, but in individual subhorizons it ranges from heavy silt loam to clay. High- and low-chroma mottles are throughout the B horizon. The C horizon is variable in both color and texture. The dominant colors are dark reddish brown (5YR 3/4) to dark brown (7.5YR 4/4). Grayish mottles range from few to many.

Texture above a depth of 40 inches is loam or silt loam. Below a depth of 40 inches it ranges from gravelly loamy sand to sandy loam.

Whippany soils are near Parsippany, Pompton, Preakness, Ridgebury, Riverhead, and Rockaway soils. In Whippany soils the low-chroma matrix colors and mottling are not so near the surface as in Parsippany and Ridgebury soils. Whippany soils have a finer textured subsoil than Riverhead, Pompton, Rockaway, and Preakness soils.

Whippany silt loam, sandy loam substratum, 0 to 5 percent slopes (WIA).—This soil has the profile described as representative of the series. Included in mapping were areas of Riverhead, Preakness, Parsippany, Hibernia, Ridgebury, Haledon, and Haledon, wet variant, soils.

This soil is in idle farmland, housing developments, industrial developments, and trees. Limitations to development are mainly caused by the moderately high water table, low position, and in some areas, the flood hazard. Landscaping and lawn establishment are limited by the somewhat poor drainage. In places, drainage outlets are difficult to obtain. Capability unit IIw-70; woodland group 3w.

Wurtsboro Series

The Wurtsboro series consists of moderately well drained and somewhat poorly drained soils that have a fragipan in the lower part of the subsoil and in the substratum. In this county most Wurtsboro soils are somewhat poorly drained. These gently sloping to strongly sloping soils are on toe slopes in the rough, stony, bouldery, and rocky Highlands in the northwestern part of the county. The soils formed in glacial till derived mainly from conglomerate, sandstone, shale, and lesser amounts of granitic gneiss. Most areas are wooded. Large tracts of the wooded areas and abandoned farms are part of the State forests and reservoir watersheds. The main trees in wooded areas are upland oaks, pin oak, red maple, and ash.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. It contains many stones. The upper part of the subsoil is yellowish-brown gravelly silt loam about 7 inches thick. The next layer is mottled, pale-brown gravelly loam 7 inches thick. The lower part of the subsoil is a brown, mottled, very firm gravelly sandy loam fragipan 20 inches thick. The upper part of the substratum is also a very firm fragipan. It is mottled, yellowish-brown, very firm gravelly sandy loam between depths of 42 and 60 inches.

Permeability is moderate above the fragipan and slow in the fragipan. Available water capacity is moderate. The perched water table is at a depth of ½ to 1½ feet late in winter and early in spring. Limitations for most uses in community development are caused by the seasonal perched high water table, the fragipan, and stones and boulders. Many areas of these soils are surrounded by rough and rocky land, making accessibility for development costly.

Representative profile of Wurtsboro silt loam, in an area of Wurtsboro extremely stony silt loam, 8 to 15 percent slopes, in a wooded area in West Milford Township; 330 feet east of Conklin Road, 2,300 feet northeast of the intersection of Conklin and Union Valley Roads:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, coarse, granular structure; very friable; dark-colored organic stains on sand grains; many uncoated sand grains; many fine and medium roots; many fine pores; 10 percent coarse fragments, dominantly stones, pebbles, and cobblestones; very strongly acid; clear, smooth boundary.

B21—8 to 15 inches, yellowish-brown (10YR 5/4) gravelly silt loam; moderate, medium, subangular blocky structure; friable; few silt films on ped faces and gravel surfaces; many fine and medium roots; few fine pores; 25 percent coarse fragments, dominantly gravel and lesser amounts of cobblestones; very strongly acid; gradual, wavy boundary.

B22—15 to 22 inches, pale-brown (10YR 6/3) intermixed with yellowish-brown (10YR 5/4) gravelly loam; common, fine and medium, faint, yellowish-brown (10YR 5/6) and few, fine, distinct, strong-brown (7.5YR 5/6) and light brownish-gray (10YR 6/2) mottles; moderate, coarse, subangular blocky structure; friable; few, thin, silt and clay films on ped faces and pebble surfaces; common medium and fine roots; few fine pores; 25 percent coarse fragments, dominantly pebbles and lesser amounts of cobblestones; very strongly acid; abrupt, smooth boundary.

Bx—22 to 42 inches, brown (7.5YR 5/4) gravelly sandy loam; common, fine and medium, faint, yellowish-brown (10YR 5/4) and common, fine and medium, distinct, gray (10YR 5/1) mottles; light-gray (5Y 6/1) bleached fracture plane that extends into upper part of the Cx horizon; moderate, thick, platy structure; very firm; brittle; few uncoated sand grains; few, thin, patchy clay films on ped faces; few, fine, discontinuous pores; 20 percent coarse fragments, dominantly gravel and lesser amounts of cobblestones; very strongly acid; clear, wavy boundary.

Cx—42 to 60 inches, yellowish-brown (10YR 5/4) gravelly sandy loam; few, fine and medium, faint, yellowish-brown (10YR 5/6) and few, distinct, grayish-brown (10YR 5/2) mottles, decreasing in number with depth; weak, very thick, platy structure in upper part of horizon fading with depth to massive; very firm; brittle; few uncoated sand grains; 20 percent coarse fragments, dominantly gravel and lesser amounts of cobblestones; very strongly acid.

The thickness of the solum ranges from 32 to 60 inches. Depth to bedrock is variable but commonly ranges from 6 to 10 feet. Depth to the fragipan ranges from 18 to 24 inches. Coarse fragments up to cobblestone size make up 10 to 35 percent of the material in the soil profile. Boulders and stones are few to common throughout. Coarse fragments are mainly conglomerate, sandstone, shale, and gneiss. In unlimed areas of these soils reaction is extremely acid or very strongly acid.

In the A1 horizon color ranges from dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/2). The Ap horizon is commonly dark yellowish brown (10YR 4/4). In the B21 horizon color ranges from brown (7.5YR 4/4) and strong brown (7.5YR 5/6) to yellowish brown (10YR 5/4). The B21 horizon ranges from silt loam to loam or the gravelly analogs of textures in this range. In the B22 horizon color is generally a combination of two of the following: pale brown (10YR 6/3), yellowish-brown (10YR 5/4), or brown (10YR 5/3). High-chroma mottles are dominant, but low-chroma mottles are also present. The B22 horizon ranges from sandy loam to loam or the gravelly analogs of textures in this range. In the Bx horizon color ranges from dark yellowish brown (10YR 4/4) to dark brown (7.5YR 4/4), strong brown (7.5YR 5/6), and grayish brown (2.5Y 5/2). The Bx horizon ranges from sandy loam to loam or the gravelly analogs of textures in this range. The Cx horizon varies 1 or 2 in hue, chroma, and value from the normal yellowish brown (10YR 5/4).

Wurtsboro soils are near Swartswood, Norwich, Chenango, and Braceville soils. Wurtsboro soils have low-chroma mottles nearer to the surface than Swartswood soils and lack the low-chroma matrix colors commonly in Norwich soils. Wurtsboro soils lack the loose, stratified substratum that is common in Chenango and Braceville soils.

Wurtsboro extremely stony silt loam, 3 to 8 percent slopes (WvB).—This soil has a profile similar to the one described as representative of the series. Stones range from 1 foot to more than 5 feet in diameter. Stones larger than 2 feet in diameter are common. The stones on the surface are 2 to 5 feet apart. Included in mapping were areas of Swartswood and Norwich soils, strongly sloping Wurtsboro soils, and small areas of Chenango and Braceville soils.

Some areas have been cleared and used for farmland, individual homesites, and housing developments. Limitations for community, recreational, and industrial development are caused mainly by the perched water table, the fragipan, and the stones and boulders. Many areas of these soils are surrounded by rough stony land, making accessibility for development costly or economically prohibitive. The high stone content severely limits this soil for lawn establishment and landscaping. Capability unit VIIs-34; woodland group 3x.

Wurtsboro extremely stony silt loam, 8 to 15 percent slopes (WvC).—This soil has the profile described as representative of the series. Stones range from 1 foot to more than 5 feet in diameter, and stones larger than 2 feet are common. Stones on the surface are 2 to 5 feet apart. Rock crops out in a few places. Included in mapping were areas of Swartswood and Norwich soils, gently sloping Wurtsboro soils, and small areas of Chenango and Braceville soils.

Some areas have been cleared and used for farmland, individual homesites, and housing developments. Late in winter and in spring, seepage spots are numerous on the surface. Limitations for community, recreational, and industrial development are caused mainly by the seasonal perched water table, the fragipan, the stones and boulders, and slope. Many areas are surrounded by rough, stony land, making accessibility for development costly or economically prohibitive. High stone content severely limits this soil for lawn establishment and landscaping. Capability unit VIIs-34; woodland group 3x.

Use and Management of the Soils

This section is designed to help the landowner understand how soils behave and how they can be used. In the first part engineering uses and engineering properties are discussed. In the next section community development uses of soils are described. The remaining part deals with woodland, wildlife, and capability groups.

Engineering Uses of the Soils[2]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built to predict performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 2, 3, and 4, which show, respectively, several estimated soil properties significant to engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map, soil descriptions, and other parts of this publication, can be used to make interpretations in addition to those given in tables 3 and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works. Inspection of sites is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meanings to soil scientists that differ from those used by engineers. The Glossary defines many of these terms commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*14*) used by the SCS engineers, Department of Defense, and others, and the AASHO system (*2*) adopted by the American Association of State Highway Officials.

[2] JAMES W. STINGEL, engineer, Soil Conservation Service, assisted in the preparation of this section.

TABLE 2.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more soils. The soils in such mapping series that appear in the first column of this table. The symbol > means more than; the sym-

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface of typical profile	Classification: USDA texture [1]	Classification: Unified	Classification: AASHO
	Feet	*Feet*	*Inches*			
Alluvial land: Ae	>5	½–3½				
Boonton: BrB, BrC, BsD	6–10	1½–4	0–8	Silt loam	ML, CL	A–4
			8–30	Fine sandy loam, gravelly fine sandy loam, and gravelly loam.	SM, SC, ML, CL	A–2, A–4
			30–60	Gravelly sandy loam	SM, SC	A–2, A–4
Braceville: BtA	>10	1½–3	0–24	Gravelly silt loam and gravelly loam.	ML, CL, SM	A–4
			24–38	Gravelly loam	ML, CL, SM	A–2, A–4
			38–60	Gravelly loamy sand	SP, SP–SM, GP, GP–GM	A–1, A–2
Carlisle: Ca	>10	0	0–60	Muck	Pt	------------
Chenango: CkB, CkC	>10	>6	0–8	Silt loam	ML, CL	A–4
			8–26	Gravelly silt loam	ML, CL, SM, SC, GM	A–2, A–4
			26–60	Very gravelly sand	GP–GM, GP	A–1
Haledon: HcB, HcC	6–10	½–1½	0–8	Cobbly loam	ML, CL	A–4
			8–30	Cobbly loam	ML, CL, SM, SC	A–4, A–2
			30–45	Gravelly sandy loam	SM, SC, ML, CL	A–2, A–4
			45–72	Gravelly sandy loam	SM, SC	A–2
Haledon, wet variant: HdA, HdB	6–10	0–1	0–14	Silt loam and loam	ML, CL	A–4
			14–24	Sandy clay loam	ML, CL, SM, SC	A–2, A–7
			24–42	Gravelly sandy loam	SM, SC, ML, CL	A–2, A–4
			42–72	Gravelly loam	ML, SM, SC, CL	A–4
Hibernia: HpC	6–10	½–1½	0–5	Cobbly loam	ML, CL, SM, SC	A–4
			5–25	Cobbly sandy loam	SM, SC, ML, CL	A–2, A–4
			25–62	Gravelly sandy loam	SM	A–2
			62–72	Gravelly loamy sand	SM	A–2
*Holyoke: HrC. Rock outcrop part too variable to be rated.	1–1½	[4] >6	0–16	Silt loam and gravelly silt loam	ML, CL	A–4
			16	Bedrock.		
Made land, sanitary land fill: Ma. Too variable to be rated.						
Muck, shallow: Ms	>10	0				
Netcong: NkC, NkD	6–10	>6	0–5	Gravelly loam	ML, CL, SM, SC	A–4
			5–36	Gravelly sandy loam	SM, SC	A–2, A–4
			36–60	Cobbly loamy sand	SM	A–1, A–2
Norwich: NpA, NpB	6–10	0–1	0–18	Gravelly loam	ML, CL, SM, SC	A–2, A–4
			18–45	Gravelly sandy loam	SM, SC, ML, CL	A–2, A–4
			45–60	Gravelly sandy loam	SM	A–2

See footnotes at end of table.

significant to engineering

units may have different properties and limitations, and for this reason the reader should follow carefully the instructions for referring to other bol < means less than. Absence of data indicates that the soil is too variable to be rated]

Coarse fraction greater than 3 inches	Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permea-bility	Available water capacity	Reaction	Shrink-swell potential
Percent					*Inches per hour*	*Inches per inch of depth*	*pH value*	
5–10	90–95	85–95	75–95	50–85	0.6–2.0	[2] 0.19–0.23	4.5–5.0	Low.
0–10	75–100	75–95	50–95	30–70	0.6–2.0	0.12–0.21	4.5–5.5	Low.
0–10	80–95	65–95	45–65	25–40	<0.2	0.06–0.10	5.1–6.5	Low.
0–2	70–85	65–80	45–75	40–60	0.6–2.0	[2] 0.10–0.15	4.5–5.0	Low.
0–2	70–85	70–80	40–75	30–60	<0.2	0.08–0.15	5.1–5.5	Low.
0–5	40–70	35–55	30–45	0–10	>6.0	0.01–0.06	5.6–6.0	Low.
					>6.0	[2] 0.35–0.45	5.6–7.8	Low. [3]
0–2	85–100	85–95	80–95	65–75	0.6–2.0	0.20–0.23	4.5–5.5	Low.
0–5	50–80	50–70	40–65	20–55	0.6–2.0	0.10–0.18	4.5–5.5	Low.
0–5	30–40	20–30	10–25	0–10	>6.0	0.01–0.06	4.5–5.5	Low.
0–5	80–95	75–80	65–80	50–70	0.6–2.0	[2] 0.16–0.19	5.6–6.0	Low.
0–10	85–95	75–90	50–80	30–75	0.6–2.0	0.14–0.19	5.6–6.0	Low.
0–5	80–100	75–95	45–80	30–60	<0.2	0.06–0.10	5.6–6.0	Low.
0–5	75–85	70–80	40–65	20–35	<0.6	0.06–0.10	6.1–6.5	Low.
0–5	85–95	85–95	70–95	60–85	0.6–2.0	[2] 0.18–0.23	4.5–5.5	Low.
0–5	90–95	85–95	60–90	30–80	0.2–0.6	0.10–0.18	5.1–6.5	Moderate.
0–5	80–95	80–95	45–65	20–60	<0.2	0.06–0.10	5.1–6.5	Low.
0–5	80–95	80–95	65–90	45–70	0.6–2.0	0.14–0.18	6.6–7.3	Low.
5–15	75–95	70–80	55–70	35–60	0.6–2.0	[2] 0.14–0.20	4.5–5.5	Low.
5–15	75–95	65–80	40–70	30–60	2.0–6.0	0.10–0.16	4.5–5.5	Low.
0–5	75–95	65–80	40–55	20–35	<0.2	0.06–0.10	4.5–5.5	Low.
0–10	65–90	60–80	40–70	15–25	>6.0	0.06–0.09	4.5–5.5	Low.
0–5	80–100	70–80	50–80	50–70	0.6–2.0	0.15–0.21	4.5–5.5	Low.
15–25	75–95	65–80	65–75	40–65	0.6–2.0	0.13–0.17	4.5–5.0	Low
5–25	75–90	65–90	40–75	30–50	0.6–6.0	0.10–0.17	5.1–5.5	Low
5–25	70–90	65–90	30–65	15–30	>6.0	0.05–0.10	5.1–5.5	Low.
10–20	70–95	65–95	40–85	20–70	0.6–2.0	[2] 0.10–0.17	5.1–5.5	Low.
10–20	70–95	55–85	40–70	20–60	<0.2	0.06–0.10	5.1–6.0	Low.
10–20	70–95	55–85	35–60	15–30	2.0–6.0	0.06–0.10	5.1–6.0	Low

TABLE 2.—*Estimated soil properties*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface of typical profile	Classification: USDA texture [1]	Classification: Unified	Classification: AASHO
	Feet	*Feet*	*Inches*			
Otisville: OrC, OsD	>10	>6	0–15	Sandy loam and gravelly sandy loam.	SM	A–2
			15–60	Gravelly loamy sand and very gravelly sand.	GP–GM, GM, SP–SM, SM	A–1, A–2
Parsippany: Pk	>10	0–1	0–7	Silt loam	ML, CL	A–4
			7–40	Silty clay loam, clay, loam, and silt loam.	ML, CL	A–6, A–7
			40–60	Silt loam and sandy loam	SM, SC, ML, CL	A–2, A–4
Pits, sand and gravel: Pt. Too variable to be rated.						
Pompton: PvA	>10	½–1½	0–17	Fine sandy loam	SC, SM	A–2, A–4
			17–34	Sandy loam and gravelly sandy loam.	SM, SC	A–2
			34–72	Gravelly loamy sand and very gravelly sand.	SP–SM, SM, GW–GM, GM	A–1, A–2, A–3
Preakness: Px	>10	0	0–9	Silt loam	ML, CL	A–4
			9–40	Sandy loam and gravelly sandy loam.	SM, SC	A–2, A–4
			40–60	Gravelly sand	SP–SM, SP, SM	A–1, A–2, A–3
Ridgebury: RbA, RbB	6–10	0–1	0–6	Loam	ML, CL	A–4
			6–22	Gravelly loam	SM, ML, CL, SC	A–2, A–4
			22–40	Gravelly sandy loam	SM, SC	A–2, A–4
			40–60	Gravelly sandy loam	SM, SC	A–2, A–4
Riverhead: RhB, RhC	>10	>6	0–10	Sandy loam	SM, SC	A–2, A–4
			10–36	Gravelly sandy loam	SM, SC	A–2, A–4
			36–60	Gravelly sand	SP–SM, SM	A–1, A–2, A–3, A–4
*Rockaway: RmB, RmC, RrC, RrD, RsC. Rock outcrop part of RsC too variable to be rated.	6–10	1½–2½	0–9	Gravelly sandy loam and gravelly loam.	SM, SC, ML, CL	A–2, A–4
			9–22	Gravelly loam and gravelly sandy loam.	ML, CL, SM, SC	A–2, A–4
			22–56	Gravelly sandy loam	SM, SC	A–2, A–4
			56–72	Gravelly loamy sand	SM, SP–SM	A–2
*Rock outcrop: RwE, RxE, RyE. Rock outcrop parts are too variable to be rated. For Holyoke part of RwE, see Holyoke series. For Rockaway part of RxE, see Rockaway series. For Swartswood part of RyE, Swartswood series.						
*Swartswood: SdB, SdC, SeB, SeC, SeD, SrC. Rock outcrop part of SrC too variable to be rated.	6–10	1½–2	0–8	Gravelly fine sandy loam	SM, SC	A–4, A–2
			8–23	Gravelly loam and gravelly sandy loam.	ML, CL, SM, SC	A–2, A–4
			23–60	Gravelly sandy loam	SM, SC, ML, CL	A–2, A–4

See footnotes at end of table.

significant to engineering—Continued

Coarse fraction greater than 3 inches	Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permea-bility	Available water capacity	Reaction	Shrink-swell potential
Percent					*Inches per hour*	*Inches per inch of depth*	*pH value*	
0–5	90–100	75–95	40–60	20–35	2.0–6.0	0.09–0.12	4.5–5.5	Low.
5–15	40–70	35–65	20–35	5–15	>6.0	0.04–0.08	4.5–5.5	Low.
------------	90–100	90–100	80–100	65–90	0.6–2.0	[2] 0.22–0.24	4.5–5.5	Low.
------------	90–100	90–100	80–100	65–90	<0.2	0.12–0.18	5.1–6.5	Moderate.
<5	90–100	90–100	45–75	20–60	0.2–2.0	0.14–0.20	6.1–7.8	Low.
<5	90–100	80–100	55–85	30–50	0.2–6.0	[2] 0.10–0.16	5.1–5.5	Low.
<5	70–95	65–95	40–65	20–35	2.0–6.0	0.09–0.16	5.1–5.5	Low.
<5	55–95	20–90	20–70	5–25	>6.0	0.04–0.09	5.1–5.5	Low.
<5	90–100	85–95	75–85	60–80	0.6–2.0	[2] 0.20–0.24	4.5–5.5	Low.
0–5	80–95	80–95	40–70	25–50	2.0–6.0	0.10–0.15	4.5–5.5	Low.
0–5	55–95	50–90	25–60	2–15	>6.0	0.03–0.07	4.5–5.5	Low.
15–25	85–95	85–95	70–85	50–80	0.6–2.0	[2] 0.19–0.23	4.5–5.5	Low.
10–20	85–95	65–90	50–80	25–60	0.6–2.0	0.10–0.18	4.5–6.0	Low.
5–15	80–95	65–90	60–85	20–40	<0.2	0.06–0.10	4.5–6.0	Low.
10–30	75–95	65–90	40–65	20–40	2.0–6.0	0.06–0.10	4.5–6.0	Low.
0–2	90–100	85–95	60–85	12–40	2.0–6.0	0.13–0.15	5.1–5.5	Low.
0–2	70–95	65–90	40–65	15–40	2.0–6.0	0.10–0.15	5.1–5.5	Low.
0–5	70–95	45–90	35–75	5–40	>6.0	0.05–0.08	5.1–5.5	Low.
5–25	70–95	65–85	55–80	30–70	0.6–2.0	[2] 0.12–0.18	4.5–5.5	Low.
5–25	70–95	65–90	40–75	20–65	0.6–2.0	0.10–0.17	4.5–5.5	Low.
5–20	70–95	65–90	40–65	20–40	<0.2	0.06–0.10	4.5–5.5	Low.
5–20	65–90	65–90	25–65	10–35	2.0–6.0	0.06–0.10	4.5–5.5	Low.
10–25	80–90	65–90	55–85	25–45	0.6–2.0	[2] 0.11–0.17	<4.5–5.0	Low.
10–20	70–90	65–90	40–85	20–70	0.6–2.0	0.10–0.17	4.5–5.0	Low.
5–20	70–90	65–90	40–75	20–60	<0.2	0.06–0.10	4.5–5.0	Low.

TABLE 2.—*Estimated soil properties*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface of typical profile	Classification: USDA texture [1]	Classification: Unified	Classification: AASHO
	Feet	*Feet*	*Inches*			
*Urban land: UbB, UbC, UrB, Ux. Urban land parts are too variable to be rated. For Boonton parts of UbB, and UbC, see Boonton series. For Riverhead part of UrB see Riverhead series. For Rockaway part of Ux see Rockaway series.						
Whippany: WlA	6-10	½-1½	0-9	Silt loam	ML	A-4
			9-32	Silty clay loam and clay loam	ML, CL	A-4, A-6
			32-60	Loam and sandy loam	SM, SC	A-2, A-4
Wurtsboro: WvB, WvC	6-10	½-1½	0-15	Silt loam and gravelly silt loam	ML, CL, SM	A-4, A-2
			15-22	Gravelly loam and gravelly sandy loam.	ML, CL, SM, SC	A-2, A-4
			22-60	Gravelly sandy loam and gravelly loam.	SM, SC, ML, CL	A-2, A-4

[1] Textures listed for the horizons are those of the representative profile. (See section "Descriptions of the Soils.") The full range of textures in the horizons common to the series in this county is listed following the description of the representative profile.
[2] Additional water available seasonally from ground water in places.

significant to engineering—Continued

Coarse fraction greater than 3 inches	Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
Percent					*Inches per hour*	*Inches per inch of depth*	*pH value*	
0–2	95–100	95–100	85–100	65–90	0.6–2.0	[2] 0.21–0.24	5.6–6.0	Low.
0–2	90–100	90–100	85–100	65–90	<0.2	0.18–0.22	5.6–7.3	Moderate.
0–5	90–100	80–100	45–75	15–50	2.0–6.0	0.06–0.16	6.6–7.3	Low.
15–25	80–95	70–90	50–85	25–80	0.6–2.0	[2] 0.14–0.22	<4.5–5.0	Low.
10–20	75–95	70–90	40–80	25–65	0.6–2.0	0.10–0.18	4.5–5.0	Low.
10–30	75–90	70–90	40–70	30–60	<0.2	0.06–0.10	4.5–5.0	Low.

[3] High shrinkage upon drying.
[4] Seepage over bedrock.

TABLE 3.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such to other series that appear in the

Soil series and map symbols	Suitability as source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Road location	Reservoirs: Reservoir area
Alluvial land: Ae	Fair	Unsuitable	Fair: moderate frost-action potential; variable material.	Seasonal high water table at depth of ½ to 3½ feet; subject to flooding.	Seasonal high water table at depth of ½ to 3½ feet; pervious in substratum.
Boonton: BrB, BrC, BsD	Fair: BrB and BrC stony. Poor: BsD very stony.	Unsuitable: excessive fines.	Fair: ML, CL, SM, SC material; high frost-action potential; BsD stony.	Seasonal high water table at depth of 1½ to 4 feet; high frost-action potential; BsD steep.	Slow permeability in fragipan; stony in places.
Braceville: BtA	Poor: high content of gravel and cobblestones.	Good below depth of 3 feet.	Fair: ML, CL, or SM material to depth of 38 inches; SP, SP–SM, GP, or GP–SM below depth of 38 inches; seasonal high water table at depth of 1½ to 3 feet; high frost-action potential.	Seasonal high water table at depth of 1½ to 3 feet; high frost-action potential.	Rapid permeability in substratum; seasonal high water table at depth of 1½ to 3 feet.
Carlisle: Ca	Poor: seasonal water table at surface; highly organic material.	Unsuitable: none present.	Unsuitable: unstable, highly organic material.	Seasonal water table at surface; unstable; highly organic material.	Seasonal water table at surface; highly organic material; rapid permeability.
Chenango: CkB, CkC	Fair: moderate content of gravel.	Good below depth of 2 feet.	Good: SM, SC, GM, GP material.	Good: moderate frost-action potential; substratum unstable in cut slopes.	Rapid permeability in substratum; excessive seepage losses.
Haledon: HcB, HcC	Poor: high content of stones.	Unsuitable: excessive fines.	Fair: ML, CL, SM, SC material; seasonal high water table at depth of ½ to 1½ feet.	Moderate frost-action potential; seasonal high water table at depth of ½ to 1½ feet; seepage above fragipan, slips in steep cuts.	High content of stones; diabase, shale, or sandstone at depth of 6 to 10 feet; slow permeability in fragipan.
Haledon, wet variant: HdA, HdB	Poor: high content of stones.	Unsuitable: excessive fines.	Fair: ML, CL, SM, SC material; seasonal high water table at depth of 0 to 1 foot.	Seasonal high water table at depth of 0 to 1 foot; high frost-action potential.	Seasonal high water table at depth of 0 to 1 foot; slow permeability in fragipan; high content of stones.

engineering properties of the soils

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring first column of this table]

Soil features affecting—						
Reservoirs: Embankment materials	Drainage	Irrigation	Terraces and diversions	Grassed waterways	Winter grading	Shallow excavations
Good to poor stability.	Seasonal high water table at depth of ½ to 3½ feet; subject to flooding.	Seasonal high water table at depth of ½ to 3½ feet.	Not needed	Not needed	Seasonal high water table at depth of ½ to 3½ feet.	Seasonal high water table at depth of ½ to 3½ feet; subject to flooding.
Fair to good stability and compaction; BsD excessively stony.	Slow permeability in fragipan; seasonal high perched water table at depth of 1½ to 4 feet.	Moderate intake rate; slow permeability in fragipan; BsD excessively stony.	Seasonal high perched water table at depth of 1½ to 4 feet; BsD excessively stony.	Seasonal high perched water table at depth of 1½ to 4 feet; BsD excessively stony.	Seasonal high perched water table at depth of 1½ to 4 feet; BsD excessively stony.	Seasonal high water table at depth of 1½ to 4 feet; lateral seepage above fragipan.
Fair stability and compaction; moderate permeability where compacted.	Seasonal high water table at depth of 1½ to 3 feet; slow permeability in fragipan.	Moderate intake rate; seasonal high water table at depth of 1½ to 3 feet; drainage needed.	Seasonal high water table at depth of 1½ to 3 feet; seepage above fragipan; rapid permeability in substratum.	Seasonal high water table at depth of 1½ to 3 feet; lateral seepage above fragipan.	Seasonal high water table at depth of 1½ to 3 feet; lateral seepage above fragipan.	Seasonal high water table at depth of 1½ to 3 feet; unstable trench walls.
Unsuitable: highly organic material.	Seasonal water table at surface, subsidence problems; limited outlets; rapid permeability.	Rapid intake rate; high available water capacity; drainage needed.	Not needed	Not needed	Seasonal high water table at surface; highly organic material.	Seasonal high water at surface; low bearing capacity in highly organic material.
Fair to good stability and compaction; moderate permeability where compacted.	Not needed	Moderate available water capacity; moderate intake rate.	All features favorable.	Moderate permeability; moderate available water capacity.	All features favorable.	Unstable trench walls.
High content of stones; good to poor stability; requires careful compaction.	Seasonal high water table at depth of ½ to 1½ feet; slow permeability in fragipan.	Moderate intake rate; moderate available water capacity; drainage needed; high content of stones.	High content of stones; seasonal high water table at depth of ½ to 1½ feet.	High content of stones; seasonal high water table at depth of ½ to 1½ feet.	Seasonal high water table at depth of ½ to 1½ feet; poor surface drainage.	High content of stones; shale or diabase bedrock below depth of 6 feet; seasonal high water table at depth of ½ to 1½ feet; unstable trench walls.
Good to poor stability; requires careful compaction; high content of stones.	Seasonal high water table at depth of 0 to 1 foot; slow permeability in fragipan; high content of stones.	Seasonal high water table at depth of 0 to 1 foot; moderate intake rate; drainage needed; high content of stones.	Seasonal high water table at depth of 0 to 1 foot; high content of stones.	Seasonal high water table at depth of 0 to 1 foot; high content of stones.	Seasonal high water table at depth of 0 to 1 foot; poor surface drainage; high content of stones.	High content of stones; shale or diabase bedrock below depth of 6 feet; seasonal high water table at depth of 0 to 1 foot; unstable trench walls.

TABLE 3.—*Interpretations of*

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road fill	Soil features affecting— Road location	Reservoirs: Reservoir area
Hibernia: HpC	Poor: high content of boulders and stones.	Poor: excessive fines; high content of stones.	Fair: ML, CL, SM, or SC material to depth of 25 inches; SM below depth of 25 inches; seasonal high perched water table at depth of ½ to 1½ feet; high content of boulders and stones.	Seasonal high perched water table at depth of ½ to 1½ feet; lateral seepage above fragipan; high content of boulders and stones; moderate frost-action potential.	Seasonal high perched water table at depth of ½ to 1½ feet; high content of boulders and stones.
*Holyoke: HrC. For Rock outcrop part, see Rock outcrop.	Poor: high content of gravel.	Unsuitable: excessive fines; shallow to bedrock.	Poor: limited supply; shallow to bedrock.	Hard bedrock at depth of less than 1½ feet; high content of stones.	Hard impervious bedrock at depth of less than 1½ feet.
Made land, sanitary land fill: Ma	Poor: variable material.	Unsuitable: excessive fines; variable material.	Poor: variable material.	Variable material; uneven settling.	Variable material; refuse and soil material; pollution hazard.
Muck, shallow: Ms	Poor: water table at surface; highly organic material.	Unsuitable: none available.	Unsuitable: highly organic material; low bearing capacity.	Unstable: highly organic material; water table at surface most of year.	Water table at surface most of of year.
Netcong: NkC, NkD	Poor: high content of boulders and stones.	Poor: high content of boulders and stones.	Fair: high content of boulders and and stones; SM, SC, ML, CL material.	High content of boulders and stones; steep in NkD.	Pervious material; seepage losses likely.
Norwich: NpA, NpB	Poor: high content of boulders and stones; seasonal high water table at depth of 0 to 1 foot.	Unsuitable: none present.	Poor: ML, CL, SM, or SC material; high content of boulders and stones; seasonal high water table at depth of 0 to 1 foot.	Seasonal high water table at depth of 0 to 1 foot; high content of boulders and stones; high frost-action potential.	Pervious material in substratum; seasonal high water table at depth of 0 to 1 foot.
Otisville: OrC, OsD	Poor to fair: moderate to high content of gravel.	Good: sand and gravel below depth of 2 feet.	Good: SM, GM, GP material.	Cut slopes unstable and erodible; loose sand and gravel in substratum.	Rapid permeability in subsoil and substratum; seepage losses likely.
Parsippany: Pk	Poor: seasonal high water table at depth of 0 to 1 foot.	Unsuitable: none present.	Poor: ML, CL material; seasonal high water table at depth of 0 to 1 foot; areas near streams subject to flooding.	Seasonal high water table at depth of 0 to 1 foot; high frost-action potential; areas near streams subject to flooding.	Seasonal high water table at depth of 0 to 1 foot; slow permeability in subsoil; areas near streams subject to flooding.

engineering properties of the soils—Continued

Soil features affecting—						
Reservoirs: Embankment materials	Drainage	Irrigation	Terraces and diversions	Grassed waterways	Winter grading	Shallow excavations
Fair to poor stability and compaction; high content of boulders and stones.	Seasonal high perched water table at depth of ½ to 1½ feet; fragipan and stone content hinder drainage.	Moderate intake rate; slow permeability in fragipan; high content of boulders and stones; seasonal high perched water table at depth of ½ to 1½ feet.	High content of boulders and stones; seasonal high perched water table at depth of ½ to 1½ feet.	High content of boulders and stones; seasonal high perched water table at depth of ½ to 1½ feet.	Seasonal high perched water table at depth of ½ to 1½ feet; lateral seepage above fragipan; high content of stones.	Seasonal high perched water table at depth of ½ to 1½ feet; high content of boulders and stones.
Hard bedrock at depth of less than 1½ feet, limited supply.	Not needed	Hard bedrock at depth of less than 1½ feet.	Hard bedrock at depth of less than 1½ feet.	Hard bedrock at depth of less than 1½ feet.	Hard bedrock at depth of less than 1½ feet; high content of stones.	Hard bedrock at depth of less than 1½ feet.
Variable material; refuse and soil material.	Not needed	Not needed	Not needed	Not needed	Not needed	Variable material; refuse and soil material.
Unsuitable: poor stability; unstable, highly organic material.	Water table at surface most of year.	Rapid intake rate; high available water capacity; drainage needed.	Not needed	Not needed	Water table at surface most of year.	Water table at surface most of year; unstable ditchbanks.
Good stability; high content of boulders and stones.	Not needed	Moderate available water capacity; slope ranges to 25 percent; high content of boulders and stones.	High content of boulders and stones.	High content of boulders and stones; moderate available water capacity.	All conditions favorable.	High content of boulders and stones.
Fair stability and compaction; high content of boulders and stones.	Seasonal high water table at depth of 0 to 1 foot; slow permeability in subsoil; extremely stony.	Seasonal high water table at depth of 0 to 1 foot; high content of boulders and stones; drainage needed.	High content of boulders and stones.	High content of boulders and stones.	Seasonal high water table at depth of 0 to 1 foot; poor surface drainage; high content of boulders and stones.	Seasonal high water table at depth of 0 to 1 foot; high content of boulders and stones.
Good stability and compaction; moderate to high permeability where compacted; piping hazard.	Not needed	Rapid intake rate; low available water capacity.	Gravelly and sandy substratum; low available water capacity.	Low available water capacity.	All features favorable.	Sandy and gravelly substratum; unstable trench walls.
Good to poor stability; piping hazard.	Slow permeability; seasonal high water table at depth of 0 to 1 foot; outlets limited; areas near streams subject to flooding.	Moderate intake rate; seasonal high water table at depth of 0 to 1 foot; drainage needed; areas near streams subject to flooding.	Not needed	Not needed	Seasonal high water table at depth of 0 to 1 foot; poor trafficability.	Seasonal high water table at depth of 0 to 1 foot; plastic subsoil; areas near streams subject to flooding.

TABLE 3.—*Interpretations of*

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road fill	Soil features affecting— Road location	Reservoirs: Reservoir area
Pits, sand and gravel: Pt. Too variable for valid interpretations.					
Pompton: PvA	Fair: seasonal high water table at depth of ½ to 1½ feet; moderate content of gravel.	Fair to good below depth of 3 feet; seasonal high water table at depth lf ½ to 1½ feet.	Good: SM, GM material.	Seasonal high water table at depth of ½ to 1½ feet; high frost-action potential.	Seasonal high water table at depth of ½ to 1½ feet; rapid permeability in substratum; seepage losses likely.
Preakness: Px	Poor: seasonal high water table at depth of 0 to 1 foot.	Fair: sand and gravel below depth of 3½ feet; seasonal high water table at depth of 0 to 1 foot.	Poor: seasonal high water table at depth of 0 to 1 foot; ML, CL, SM material.	Seasonal high water table at surface; high frost-action potential.	Seasonal high water table at depth of 0 to 1 foot; moderately rapid permeability in subsoil.
Ridgebury: RbA, RbB	Poor: high content of boulders and stones; seasonal high water table at depth of 0 to 1 foot.	Unsuitable: excessive fines, stones, and boulders.	Poor: ML, CL, SM, or SC material to depth of 22 inches; SM or SC below depth of 22 inches; excessive content of boulders and stones; seasonal high water table at depth of 0 to 1 foot.	Seasonal high water table at depth of 0 to 1 foot; high content of boulders and stones; high frost-action potential.	Seasonal high water table at depth of 0 to 1 foot; slow permeability in subsoil; high content of boulders and stones.
Riverhead: RhB, RhC	Fair: moderate content of gravel and cobblestones.	Good: sand and gravel below depth of 3 feet.	Good: SM, SC material.	Erosion hazard in RhC.	Excessive seepage losses; rapid permeability in substratum.
*Rockaway: RmB, RmC, RrC, RrD, RsC. For Rock outcrop part of RsC, see Rock outcrop.	Poor: excessive content of boulders, stones, and gravel.	Poor: excessive content of fines, stones, and boulders.	Fair: ML, CL, SM, or SC material to depth of 22 inches; SM, or SC below depth of 22 inches; excessive content of boulders and stones.	Excessive content of boulders and stones; excessive slope in RrD and RxE.	Excessive content of boulders and stones; slow permeability in fragipan, moderately rapid below fragipan.
*Rock outcrop: RwE, RxE, RyE. For Holyoke part of RwE, see Holyoke series. For Rockaway part of RxE, see Rockaway series. For Swartswood part of RyE, see Swartswood series.	Unsuitable: bedrock at surface.	Unsuitable: none present.	Unsuitable; bedrock at surface.	Bedrock at surface.	Bedrock at surface.
*Swartswood: SdB, SdC, SeB, SeC, SeD, SrC. For Rock outcrop part of SrC, see Rock outcrop.	Poor: excessive content of gravel and stones.	Unsuitable: none present.	Fair: high frost-action potential; ML, CL, SM, SC material; high content of boulders and stones.	Lateral seepage above fragipan; bedrock at depth of 6 feet or more; high frost-action potential; slippage in cuts.	Slow permeability in subsoil; excessive content of stones; pervious layers in substratum.

engineering properties of the soils—Continued

Soil features affecting—						
Reservoirs: Embankment materials	Drainage	Irrigation	Terraces and diversions	Grassed waterways	Winter grading	Shallow excavations
Fair stability; moderate permeability where compacted; fair resistance to piping.	Seasonal high water table at depth of ½ to 1½ feet; moderately rapid permeability.	Moderately rapid permeability; seasonal high water table at depth of ½ to 1½ feet; drainage needed.	Seasonal high water table at depth of ½ to 1½ feet.	Seasonal high water table at depth of ½ to 1½ feet.	Seasonal high water table at depth of ½ to 1½ feet.	Seasonal high water table at depth of ½ to 1½ feet; unstable trench walls.
Fair stability and compaction; piping hazard.	Seasonal high water table at depth of 0 to 1 foot.	Moderate intake rate; seasonal high water table at depth of 0 to 1 foot; drainage needed.	Not needed	Not needed	Seasonal high water table at depth of 0 to 1 foot; poor surface drainage.	Seasonal high water table at depth of 0 to 1 foot; unstable trench walls.
Good stability; low permeability where compacted; excessive content of boulders and stones.	Seasonal high water table at depth of 0 to 1 foot; slow permeability in fragipan	Seasonal high water table at depth of 0 to 1 foot; excessive content of boulders and stones; moderate intake rate; slow permeability.	Excessive content of boulders and stones.	Excessive content of boulders and stones; seasonal high water table at depth of 0 to 1 foot.	Seasonal high water table at depth of 0 to 1 foot.	Seasonal high water table at depth of 0 to 1 foot; excessive content of boulders and stones.
Good stability; fair compaction; pervious material.	Not needed	Moderately rapid intake rate; moderate available water capacity.	All features favorable.	All features favorable.	All features favorable.	Unstable trench walls.
Excessive content of boulders and stones; good stability.	Not needed	Moderate intake rate; low to moderate water holding capacity; slow permeability in fragipan.	Excessive content of boulders and stones; excessive slope in RrD and RxE.	Excessive content of boulders and stones; excessive slope in RrD and RxE.	All features favorable.	Excessive content of boulders and stones.
Bedrock at surface.	Bedrock at surface.	Bedrock at surface.	Bedrock at surface.	Bedrock at surface.	Bedrock at surface.	Bedrock at surface.
Good stability and compaction; piping hazard; excessive content of boulders and stones.	Not needed	Moderate intake rate; moderate available water capacity; excessive content of boulders and stones.	Excessive content of boulders and stones.	Excessive content of boulders and stones.	All features favorable.	Bedrock at depth of 6 feet or more; excessive content of boulders and stones.

TABLE 3.—*Interpretations of*

Soil series and map symbols	Suitability as source of— Topsoil	Suitability as source of— Sand and gravel	Suitability as source of— Road fill	Soil features affecting— Road location	Soil features affecting— Reservoirs: Reservoir area
*Urban land: UbB, UbC, Urb, Ux. Urban land parts are in residential, commercial, or industrial use and are too variable for valid interpretation. For Boonton parts of UbB and UbC, see Boonton series. For Riverhead part of UrB, see Riverhead series. For Rockaway part of Ux, see Rockaway series.					
Whippany: WIA	Fair: seasonal high water table at depth of ½ to 1½ feet.	Unsuitable: none present.	Poor: ML, CL material; high frost-action potential; areas near streams subject to occasional flooding.	Seasonal high water table at depth of ½ to 1½ feet; high frost-action potential; areas near streams subject to occasional flooding.	Seasonal high water table at depth of ½ to 1½ feet; little seepage losses; rapid recharge rate for dug ponds; areas near streams subject to occasional flooding.
Wurtsboro: WvB, WvC	Poor: high content of boulders and stones.	Unsuitable: none present; excessive fines.	Fair: ML, CL, SM, SC material; seasonal high water table at depth of ½ to 1½ feet; excessive content of stones.	High content of boulders and stones; high frost-action potential.	Seasonal high water table at depth of ½ to 1½ feet; high content of boulders and stones.

engineering properties of the soils—Continued

Soil features affecting—						
Reservoirs: Embankment materials	Drainage	Irrigation	Terraces and diversions	Grassed waterways	Winter grading	Shallow excavations
Poor to fair stability and compaction; piping hazard.	Seasonal high water table at depth of ½ to 1½ feet; slow permeability; areas near streams subject to occasional flooding.	Moderate intake rate; slow permeability; seasonal high water table at depth of ½ to 1½ feet; drainage needed; areas near streams subject to occasional flooding.	Not needed	Not needed	Seasonal high water table at depth of ½ to 1½ feet.	Seasonal high water table at depth of ½ to 1½ feet; highly plastic subsoil; areas near streams subject to occasional flooding.
Fair stability and compaction; high content of boulders and stones.	Seasonal high water table at depth of ½ to 1½ feet; slow permeability in fragipan; high content of boulders and stones.	Moderate intake rate; moderate available water capacity; high content of boulders and stones.	Seasonal high water table at depth of ½ to 1½ feet; high content of boulders and stones.	Seasonal high water table at depth of ½ to 1½ feet; high content of boulders and stones.	Seasonal high water table at depth of ½ to 1½ feet; high content of boulders and stones.	Seasonal high water table at depth of ½ to 1½ feet; high content of boulders and stones.

TABLE 4.—*Engineering*

[Tests performed by College of Engineering, Rutgers University, in accordance with the standard procedures of the American Association

Soil series	Sampling site—			Test results		
	Site number	Latitude	Longitude	Depth	Sieve analysis: Cumulative percentage passing sieve— ¾ inch	Sieve analysis: Cumulative percentage passing sieve— No. 4 (4.7 mm.)
				Inches		
Boonton (Finer material than in modal.)	36	40° 54′ 40″	74° 13′ 40″	0–8	94	92
				8–18	99	99
				18–30	81	76
Riverhead (Finer material between depths of 24 and 36 inches than in modal.)	17	40° 55′ 52″	74° 13′ 55″	0–6	100	97
				6–24	94	89
				24–36	99	96
Riverhead (A horizon coarser material than in modal, solum thinner than in modal.)	4	40° 56′ 50″	74° 12′ 45″	0–8	99	95
				8–19	100	96
				19–36	96	82
Rockaway (Coarser material than in modal.)	31	41° 03′ 48″	74° 21′ 55″	0–10	89	82
				10–19	94	88
				19–40	94	77
Wurtsboro (Coarser material than in modal.)	25	41° 08′ 25″	74° 19′ 50″	0–9	83	82
				9–14	94	79
				14–30	85	75
Wurtsboro (Coarser material than in modal.)	29	41° 05′ 00″	74° 23′ 15″	0–10	95	87
				10–17	95	82
				17–24	90	82

[1] AASHO Designation: T–88.
[2] AASHO Designation: T–89.
[3] AASHO Designation: T–90 and T–91.
[4] AASHO Designation: T–99.

test data

State of Highway Officials (AASHO)(*2*). Absence of data indicates no determination was made or information does not apply]

Test results									Classification	
Sieve analysis: Cumulative percentage passing sieve—			Hydrometer analysis [1]		Liquid limit [2]	Plasticity index [3]	Moisture density data [4]		AASHO [5]	Unified [6]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05–0.005 mm.	0.005 mm.			Maximum dry density	Optimum moisture content		
			Percent	*Percent*	*Percent*	*Percent*	*Pounds per cubic foot*	*Percent*		
91	82	50			26	4			A-4(3)	ML-CL
97	89	56			20	3			A-4(4)	ML
74	62	32	15	11	24	6			A-2-4(0)	SM-SC
96	75	33			24	4			A-2-4(0)	SM-SC
84	65	28			20	2	119	12	A-2-4(0)	SM
92	73	38			21	4	122	11	A-4(1)	SM-SC
89	62	13			19	[7] NP			A-2-4(0)	SM
90	61	26			16	[7] NP	125	11	A-2-4(0)	SM
66	36	7			20	2	120	12	A-1-b(0)	SP-SM
77	60	31			25	4			A-2-4	SM-SC
83	57	23			19	4	121	11	A-2-4(0)	SM-SC
70	51	28			20	4	122	11	A-2-4(0)	SM-SC
76	53	24			40	9			A-2-4(0)	SM
70	57	39	19	17	28	7			A-4(1)	SM-SC
70	56	35			19	4			A-2-4(0)	SM-SC
81	63	34			34	9			A-2-4(0)	SM
77	57	26			28	6			A-2-4 0)	SM-SC
76	59	35	19	12	24	7			A-2-4 0)	SM-SC

[5] AASHO Designation: M145-49.
[6] ASTM Designation: D2487-66T.
[7] Nonplastic.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. In this system there are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML-CL.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils, with group index numbers in parentheses, is shown in table 4; the estimated classification, without group index numbers, is given in table 2 for all soils mapped in the county.

Soil properties significant to engineering

Several estimated soil properties significant to engineering are given in table 2. These estimates are made for typical soil profiles in which layers are sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. In the following paragraphs are explanations of some of the columns in table 2.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water is the distance from the surface of the soil to the highest level that ground water or water over a fragipan reaches in the soil in most years.

USDA texture in table 2 is in the standard terms used by the U.S. Department of Agriculture. Textures listed for the horizons are those of the representative profile. The full range of textures in the horizons common in this county is listed following the representative profile in the section "Descriptions of the Soils." These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 2 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants (*5*).

Reaction is the degree of acidity or alkalinity of an untreated soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Engineering interpretations

The estimated interpretations in table 3 are based on the engineering properties of soils shown in table 2, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Passaic County. In table 3 ratings are used to summarize suitability of the soils as sources of topsoil, sand and gravel, and road fill. For other uses table 3 lists those soil features not to be overlooked in planning, installation, and maintenance.

Topsoil (table 3) is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 3 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and they do not indicate quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Road location. Soil properties that most affect highway and road location are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to permeability and depth to fractured or permeable bedrock or other permeable material.

Embankment materials need to be resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in the soil are among factors that are unfavorable.

Drainage is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to the water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff and seepage so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Layout and construction of grassed waterways are affected by such soil properties as texture, depth, and erodibility of the soil; presence of stones or rock outcrops; and the steepness of slopes. Other factors affecting waterways are seepage, natural soil drainage, available water capacity, susceptibility to siltation, and the ease of establishing and maintaining vegetation.

Winter grading is affected chiefly by soil features that are relevant to moving, mixing, and compacting soil in roadbuilding when temperatures are below freezing.

Shallow excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries are those that generally require digging or trenching to a depth of less than 6 feet. Desirable soil properties are good workability and moderate resistance to sloughing.

Engineering test data

All engineering test data in this survey are from sampling and testing performed by the College of Engineering, Rutgers University (*7, 8*).

Table 4 contains engineering test data for some of the major soil series in Passaic County. These tests were made to help evaluate the soils for engineering uses. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction, or moisture-density, data are important in earthwork. If a soil material is compacted at a successively higher content of moisture, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material.

Town and Country Planning

This section is mainly for land planners (*11*), municipal officials, developers, and owners or users of land who are responsible for the evaluation of land areas for community planning and development. The limitations of the soils for several uses in community developments are given in table 5. The table lists, for each mapping unit, the degree of limitation and the critical soil features likely to affect each proposed use. This information does not eliminate the need for further investigations at sites being considered for community developments.

A rating of *slight* means that soil properties are generally favorable for the rated use or that limitations are minor and easily overcome.

A rating of *moderate* means that some soil properties are unfavorable but can be overcome by careful planning, design, and good management.

A rating of *severe* means that soil properties are so unfavorable and so difficult to correct or overcome that soil reclamation, special designs, or intensive maintenance are required. Some properties are so unfavorable for a particular use that overcoming the limitations is difficult, costly, and commonly not practical for the rated use (fig. 8). Many soils that have severe limitations can be improved at considerable cost, however, and used for building sites.

In table 5 the ratings for *foundations for dwellings* are for houses not more than three stories high that are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to its

TABLE 5.—*Properties and limitations of soils*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such map- series that appear in

Soil series and map symbols	Limitations of soil for— Foundations for dwellings— With basements	Foundations for dwellings— Without basements	Septic tank absorption fields	Sanitary landfill
Alluvial land: Ae	Severe: subject to frequent flooding; seasonal water table at depth of ½ to 3½ feet.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding; hazard of stream pollution.	Severe: subject to frequent flooding; hazard of stream pollution.
Boonton:				
BrB	Moderate: seasonal high perched water table at depth of 1½ to 4 feet; lateral seepage above fragipan.	Slight	Moderate: seasonal high perched water table above fragipan; slow permeability; special design needed for deep trenches.	Moderate: seasonal high perched water table above fragipan; bedrock at depth of 6 feet or more.
BrC	Moderate: seasonal high perched water table at depth of 1½ to 4 feet; lateral seepage above fragipan.	Slight	Moderate: seasonal high perched water table above fragipan; slow permeability in fragipan; special design needed for deep ditches.	Moderate: seasonal high perched water table above fragipan; bedrock at depth of 6 feet or more.
BsD	Severe: steep slopes	Severe: steep slopes	Severe: steep slopes	Moderate: seasonal high perched water table above fragipan; bedrock at depth of 6 feet or more; steep slopes.
Braceville: BtA	Moderate: seasonal high water table at depth of 1½ to 3 feet.	Slight: seasonal high water table at depth of 1½ to 3 feet.	Moderate: seasonal high water table at depth of 1½ to 3 feet; special design needed for deep trenches; hazard of ground-water polution.	Severe: seasonal high water table at depth of 1½ to 3 feet; hazard of ground-water pollution.
Carlisle: Ca	Severe: seasonal water table at surface; subject to frequent flooding; low bearing strength; severe subsidence.	Severe: seasonal water table at surface; subject to frequent flooding; low bearing strength; severe subsidence.	Severe: seasonal water table at surface; subject to frequent flooding; hazard of ground-water pollution.	Severe: seasonal water table at surface; subject to frequent flooding; hazard of ground-water pollution.
Chenango:				
CkB	Slight	Slight	Slight: rapid permeability in substratum; hazard of ground-water pollution.	Severe: rapid permeability in substratum; hazard of ground-water pollution.
CkC	Moderate: strong slopes.	Moderate: strong slopes.	Moderate: strong slopes; rapid permeability in substratum causes a hazard of ground-water pollution.	Severe: rapid permeability in substratum causes hazard of ground-water pollution.
Haledon: HcB, HcC	Severe: seasonal high perched water table at depth of ½ to 1½ feet.	Moderate: seasonal high perched water table at depth of ½ to 1½ feet.	Severe: seasonal high perched water table at depth of ½ to 1½ feet.	Severe: seasonal high perched water table at depth of ½ to 1½ feet.

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ping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other the first column of this table.]

Limitations of soil for—					
Local roads and streets	Lawns, landscaping, and golf fairways	Athletic fields	Picnic and play areas	Campsites for trailers and tents	Paths and trails
Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Moderate: subject to flooding 1 or 2 times for short periods during season of use.	Severe: subject to frequent flooding.	Moderate: subject to frequent flooding; water table above depth of 20 inches for short periods during season of use.
Severe: seasonal high water table at depth of 1½ to 4 feet; high frost-action potential.	Slight	Moderate: stony and gravelly; gentle slopes.	Slight	Moderate: stony	Slight.
Severe: seasonal high water table at depth of 1½ to 4 feet; high frost-action potential.	Moderate: strong slopes.	Severe: strong slopes.	Moderate: strong slopes.	Moderate: stony; strong slopes.	Slight.
Severe: seasonal high water table at depth of 1½ to 4 feet; high frost-action potential; steep slopes.	Severe: very stony; steep slopes.	Severe: very stony; steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Moderate: very stony; steep slopes.
Moderate: seasonal high water table at depth of 1½ to 3 feet; high frost-action potential.	Moderate: gravelly	Moderate: gravelly	Slight	Slight	Slight.
Severe: seasonal water table at surface; subject to frequent flooding.	Severe: seasonal water table at surface; subject to frequent flooding.	Severe: seasonal water table at surface; subject to frequent flooding.	Severe: water table above depth of 20 inches for month or more during season of of use.	Severe: subject to frequent flooding; water table above depth of 20 inches for month or more during season of of use.	Severe: subject to frequent flooding; seasonal water table at surface.
Slight	Slight	Moderate: gentle slopes.	Slight	Slight	Slight.
Moderate: strong slopes.	Moderate: strong slopes.	Severe: strong slopes.	Moderate: strong slopes.	Moderate: strong slopes.	Slight.
Severe: seasonal high perched water table at depth of ½ to 1½ feet; high frost-action potential.	Moderate: very stony.	Severe: water table above depth of 20 inches during season of use; strong slopes in HcC.	Moderate: water table above depth of 20 inches for short periods during season of use.	Severe: water table above depth of 20 inches during season of use.	Moderate: water table may be above depth of 20 inches during season of use.

TABLE 5.—*Properties and limitations of soils*

Soil series and map symbols	Limitations of soil for— Foundations for dwellings— With basements	Without basements	Septic tank absorption fields	Sanitary landfill
Haledon, wet variant: HdA, HdB	Severe: seasonal high perched water table at depth of 0 to 1 foot.	Severe: seasonal high perched water table at depth of 0 to 1 foot.	Severe: seasonal high perched water table at depth of 0 to 1 foot; hazard of ground-water pollution.	Severe: seasonal high perched water table at depth of 0 to 1 foot; hazard of ground-water pollution.
Hibernia: HpC	Severe: seasonal high perched water table at depth of ½ to 1½ feet; extremely stony.	Severe: seasonal high perched water table at depth of ½ to 1½ feet; extremely stony.	Severe: seasonal high perched water table at depth of ½ to 1½ feet; hazard of ground-water pollution.	Severe seasonal high perched water table at depth of ½ to 1½ feet; hazard of ground-water pollution.
*Holyoke: HrC. For Rock outcrop part, see Rock outcrop.	Severe: hard bedrock at depth of less than 1½ feet.	Severe: hard bedrock at depth of less than 1½ feet.	Severe: hard bedrock at depth of less than 1½ feet.	Severe: hard bedrock at depth of less than 1½ feet.
Made land, sanitary land fill: Ma	Severe: uneven settling; subject to gas formation.	Moderate: uneven settling.	Severe: variable material at moderate depths.	Severe: variable material at moderate depths.
Muck, shallow: Ms	Severe: seasonal water table at surface; subject to frequent flooding; low bearing strength; severe subsidence.	Severe: seasonal water table at surface; subject to frequent flooding; low bearing strength; severe subsidence.	Severe: seasonal water table at surface; subject to frequent flooding.	Severe: seasonal water table at surface; subject to frequent flooding.
Netcong:				
NkC	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony; hazard of ground-water pollution.	Severe: extremely stony; hazard of ground-water pollution.
NkD	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.
Norwich: NpA, NpB	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.
Otisville:				
OrC (3 to 8 percent slopes)	Slight	Slight	Slight: rapid permeability in subsoil and substratum; hazard of ground-water pollution.	Severe: rapid permeability in subsoil and substratum; hazard of ground-water pollution.
OrC (8 to 15 percent slopes)	Moderate: strong slopes.	Moderate: strong slopes.	Moderate: strong slopes; rapid permeability in subsoil and substratum; hazard of ground-water pollution.	Severe: rapid permeability in subsoil and substratum; hazard of ground-water pollution.
OsD	Severe: steep or very steep slopes.	Severe: steep or very steep slopes.	Severe: steep or very steep slopes; rapid permeability in subsoil and substratum; hazard of ground-water pollution.	Severe: rapid permeability in subsoil and substratum; hazard of ground-water pollution; very steep slopes in places.

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Limitations of soil for—					
Local roads and streets	Lawns, landscaping, and golf fairways	Athletic fields	Picnic and play areas	Campsites for trailers and tents	Paths and trails
Severe: seasonal high perched water table at depth of 0 to 1 foot.	Severe: seasonal high perched water table at depth of 0 to 1 foot.	Severe: very stony.	Severe: water table above depth of 20 inches or more during season of use.	Severe: water table above depth of 20 inches or more during season of use.	Severe: seasonal high perched water table at depth of 0 to 1 foot.
Severe: seasonal high perched water table at depth of ½ to 1½ feet.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.
Severe: hard bedrock at depth of less than 1½ feet.	Severe: hard bedrock at depth of less than 1½ feet.	Severe: hard bedrock at depth of less than 1½ feet.	Moderate: strong slopes in places.	Moderate: strong slopes in places.	Slight.
Moderate: uneven settling.	Moderate: medium rooting depth likely, only moderately deep; variable in texture.	Moderate: variable in texture, number of coarse fragments, and thickness of soil covering; uneven settling.	Slight	Slight	Slight.
Severe: seasonal water table at surface; subject to frequent flooding.	Severe: seasonal water table at surface; subject to frequent flooding.	Severe: seasonal water table at surface; subject to frequent flooding.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: subject to frequent flooding; water table above depth of 20 inches for month or more during season of use.	Severe: subject to frequent flooding; seasonal water table at surface.
Moderate: strong slopes; extremely stony.	Severe: extremely stony.	Severe: extremely stony; strong slopes.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.
Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.
Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: seasonal high water table at surface; extremely stony.
Slight	Slight	Moderate: gentle slopes; gravelly.	Slight	Slight	Slight.
Moderate: strong slopes.	Moderate: strong slopes.	Severe: strong slopes.	Moderate: strong slopes.	Moderate: strong slopes.	Slight.
Severe: steep or very steep slopes.	Severe: steep or very steep slopes.	Severe: steep or very steep slopes.	Severe: steep or very steep slopes.	Severe: steep or very steep slopes.	Moderate: steep or very steep slopes.

TABLE 5.—*Properties and limitations of soils*

Soil series and map symbols	Limitations of soil for— Foundations for dwellings— With basements	Foundations for dwellings— Without basements	Septic tank absorption fields	Sanitary landfill
Parsippany: Pk	Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot.	Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot.	Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot; hazard of ground-water pollution.	Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot; hazard of ground-water pollution.
Pits, sand and gravel: Pt. Too variable to be rated.				
Pompton: PvA	Severe: seasonal high water table at depth of ½ to 1½ feet.	Moderate: seasonal water table at depth of ½ to 1½ feet.	Severe: seasonal high water table at depth of ½ to 1½ feet; hazard of ground-water pollution.	Severe: seasonal high water table at depth of ½ to 1½ feet; hazard of ground-water pollution.
Preakness: Px	Severe: seasonal high water table at depth of 0 to 1 foot.	Severe: seasonal high water table at depth of 0 to 1 foot.	Severe: seasonal high water table at depth of 0 to 1 foot; hazard of ground-water pollution.	Severe: seasonal high water table at depth of 0 to 1 foot; hazard of ground-water pollution.
Ridgebury: RbA, RbB	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot.
Riverhead:				
RhB	Slight	Slight	Slight: rapid permeability in subsoil; hazard of ground-water pollution.	Severe: rapid permeability in subsoil; hazard of ground-water pollution.
RhC	Moderate: strong slopes.	Moderate: strong slopes.	Moderate: strong slopes; rapid permeability in subsoil; hazard of ground-water pollution.	Severe: rapid permeability in subsoil; hazard of ground-water pollution.
*Rockaway:				
RmB	Moderate: very stony; perched water table above fragipan for short periods.	Moderate: very stony.	Moderate: slow permeability; deep ditches needed in places, lateral seepage above fragipan; very stony.	Moderate: seasonal high water table at depth of 1½ to 2½ feet for short periods.
RmC	Moderate: very stony.	Moderate: very stony.	Moderate: slow permeability; deep ditches needed; very stony.	Moderate: seasonal high water table at depth of 1½ to 2½ feet for short period.
RrC, RrD	Severe: extremely stony; steep slopes in RrD.	Severe: extremely stony; steep slopes in RrD.	Severe: extremely stony; RrD has steep slopes.	Severe: extremely stony.

for use in town and country planning—Continued

Limitations of soil for—					
Local roads and streets	Lawns, landscaping, and golf fairways	Athletic fields	Picnic and play areas	Campsites for trailers and tents	Paths and trails
Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot.	Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot.	Severe: subject to frequent flooding; seasonal high perched water table at depth of 0 to 1 foot.	Severe: water table above depth of 20 inches during season of use.	Severe: subject to frequent flooding; water table above depth of 20 inches during season of use.	Severe: water table above depth of 20 inches during season of use.
Severe: seasonal high water table at depth of ½ to 1½ feet; high frost-action potential.	Moderate: seasonal high water table at depth of ½ to 1½ feet.	Severe: seasonal high water table at depth of ½ to 1½ feet.	Moderate: water table below depth of 20 inches during season of use.	Moderate: water table below depth of 20 inches during season of use.	Moderate: water table above depth of 20 inches for short periods during season of use.
Severe: seasonal high water table at depth of 0 to 1 foot.	Severe: seasonal high water table at depth of 0 to 1 foot.	Severe: seasonal high water table at depth of 0 to 1 foot.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: water table above depth of 20 inches for month or more during season of use.
Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: seasonal high water table at depth of 0 to 1 foot; extremely stony.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: water table above depth of 20 inches for month or more during season of use.	Severe: water table above depth of 20 inches for month or more during season of use.
Slight	Slight	Moderate: gentle slopes; gravelly.	Slight	Slight	Slight.
Moderate: strong slopes; hazard of erosion.	Moderate: strong slopes; hazard of erosion.	Severe: strong slopes.	Moderate: strong slopes.	Moderate: strong slopes.	Slight.
Moderate: perched water table above fragipan; moderate frost-action potential.	Moderate: very stony.	Severe: very stony.	Moderate: very stony.	Moderate: very stony.	Moderate: very stony.
Moderate: perched water table above fragipan; moderate frost-action potential.	Moderate: very stony.	Severe: very stony.	Moderate: very stony; strong slopes.	Moderate: very stony.	Moderate: very stony.
Moderate for RrC: perched water table above fragipan; moderate frost-action potential; extremely stony. Severe for RrD: steep slopes.	Severe: extremely stony; RrD has steep slopes.	Severe: extremely stony; strong slopes in places; RrD has steep slopes.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.

TABLE 5.—*Properties and limitations of soils*

Soil series and map symbols	Limitations of soil for— Foundations for dwellings— With basements	Foundations for dwellings— Without basements	Septic tank absorption fields	Sanitary landfill
RsC. For Rock outcrop part, see Rock outcrop.	Moderate where very stony. Severe where extremely stony	Moderate where very stony. Severe where extremely stony.	Moderate where very stony; slow permeability; deep ditches needed. Severe where extremely stony.	Severe: seasonal high water table at depth of 1½ to 2½ feet.
*Rock outcrop: RwE, RxE, RyE. For Holyoke part of RwE, see Holyoke series. For Rockaway part of RxE, see Rockaway series, unit RrD. Swartswood soils in RyE have the same limitations as Rock outcrop.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.
*Swartswood:				
SdB, SdC	Moderate: very stony.	Moderate: very stony.	Severe: slow permeability; strong slopes in SdC.	Moderate: very stony.
SeB, SeC	Severe: extremely stony.	Severe: extremely stony.	Severe: slow permeability; strong slopes in SeC.	Severe: extremely stony.
SeD	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: slow permeability; steep slopes; extremely stony.	Severe: extremely stony.
SrC. For Rock outcrop part, see Rock outcrop.	Severe: extremely stony.	Severe: extremely stony.	Severe: slow permeability; steep slopes.	Severe: extremely stony.
*Urban land: UbB, UbC, UrB, Ux. Urban land parts of these mapping units are mostly in residential, commercial, or industrial use and are too variable to be rated. For Boonton parts of UbB and UbC, see Boonton series, units BrB and BrC, respectively. For Riverhead part of UrB, see Riverhead series, unit RhB. For Rockaway part of Ux, see Rockaway series, unit RrC.				
Whippany: WlA	Severe: seasonal high water table at depth of ½ to 1½ feet; subject to occasional flooding in areas near large streams.	Severe: seasonal high water table at depth of ½ to 1½ feet; subject to occasional flooding in areas near large streams.	Severe: seasonal high water table at depth of ½ to 1½ feet; subject to occasional flooding in areas near large streams.	Severe: seasonal high water table at depth of ½ to 1½ feet; subject to occasional flooding in areas near large streams.
Wurtsboro: WvB, WvC	Severe: seasonal high water table at depth of ½ to 1½ feet; extremely stony.	Severe: extremely stony.	Severe: seasonal high water table at depth of ½ to 1½ feet.	Severe: seasonal high water table at depth of ½ to 1½ feet.

for use in town and country planning—Continued

Limitations of soil for—					
Local roads and streets	Lawns, landscaping, and golf fairways	Athletic fields	Picnic and play areas	Campsites for trailers and tents	Paths and trails
Moderate: perched water table above fragipan; moderate frost-action potential.	Moderate where very stony. Severe where extremely stony.	Severe: very or extremely stony.	Moderate where very stony. Severe where extremely stony	Moderate where very stony. Severe where extremely stony.	Moderate where very stony. Severe where extremely stony.
Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.	Severe: rock outcrops; very steep slopes.
Slight for SdB. Moderate for SdC: strong slopes.	Moderate: very stony.	Severe: very stony; excessive gravel.	Moderate: very stony.	Moderate: very stony.	Moderate: very stony.
Moderate: extremely stony; strong slopes in SeC.	Severe: extremely stony.	Severe: extremely stony; strong slopes in SeC.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.
Severe: steep slopes.	Severe: extremely stony.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony; steep slopes.	Severe: extremely stony.
Moderate: strong slopes.	Severe: extremely stony.	Severe: extremely stony; strong slopes.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.
Severe: seasonal high water table at depth of ½ to 1½ feet; subject to occasional flooding in areas near large streams.	Moderate: seasonal high water table at depth of ½ to 1½ feet.	Severe: seasonal high water table at depth of ½ to 1½ feet.	Moderate: water table above depth of 20 inches for short periods during season of use.	Moderate: subject to flooding during season of use; water table above depth of 20 inches during season of use.	Moderate: water table above depth of 20 inches for short periods during season of use.
Severe: seasonal high water table at depth of ½ to 1½ feet; high frost-action potential.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.

Figure 8.—Recreation lake in the process of being filled in to provide area for building sites.

capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding (*6*). Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sanitary landfill results from the disposal of refuse. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 5 apply only to a depth of about 5 feet, and therefore limitation ratings of *slight* or *moderate* are not valid in places if trenches are to be much deeper than that. Reliable predictions can be made to a depth of 10 or 15 feet for some soils; but regardless of that, every site should be investigated.

Local roads and streets, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Ratings for *lawns, landscaping, and golf fairways* are based on those properties that affect plant production, such as natural fertility, available water capacity, slope, natural drainage, and the hazard of stream overflow.

Athletic fields are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use must be able to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Picnic and play areas are attractive natural or landscaped tracts used for preparing meals and eating outdoors and for recreational activities. These areas are subject to heavy foot traffic. Most of the vehicular traffic is confined to access roads. The best soils are firm when wet but not dusty when dry; do not flood during the season of use; and do not have characteristics of slope or stoniness that would greatly increase cost of leveling or building of access roads.

Campsites for trailers and tents are used intensively for tents, small camp trailers, and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Paths and trails are used for local and cross-country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Woodland

Passaic County, like most of the northern part of New Jersey, was cleared of forests for use as farmland where physical conditions permitted. By 1849 approximately 96,000 acres were classified as farmland. A higher percentage was cleared in the southern part of the county because slopes were more favorable to farming. Even where the land was not cleared for cultivation, other factors contributed to the decline of quality and quantity of the woodland. Large quantities of wood were needed for fuel. Forges and foundries consumed charcoal for smelting, and thousands of acres of woodland were cut to make the charcoal. Woodland was cut over fre-

Figure 9.—Area of Holyoke soils. Shallow soils such as these support slowly growing plants and weak root systems and are subject to moderate windthrow.

quently, every twenty to twenty-five years, as soon as trees reached cordwood size. Disease and insects recently have also contributed to reduce the quality of the trees. About 56,000 acres in the county is wooded. Much of this acreage is protection for reservoirs. Some wooded areas are in parks, and some are parts of residential areas.

Woodland groups

The soils of the county have been placed, according to suitability, in woodland groups. This grouping can be used to assist owners in planning the use of soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees, that need about the same management where the vegetation on them is similar, and that have the same potential production.

Each woodland group is identified by a two-part symbol, such as 3o, 4w, or 4x. The potential productivity of the soils in the group is indicated by the first number in the symbol: 3 indicates moderately high, 4 indicates moderate, and 5 indicates low. These ratings are based on field determination of average site index. Site index of a soil is the height, in feet, that the dominant and codominant trees of upland oak species reach in a natural, essentially unmanaged stand in 50 years. Upland oaks include red, white, black, and scarlet oaks. Site index was converted into approximate yield per acre in board feet for timber stands at age fifty. For Passaic County, conversions of average site index into volumetric growths and yield are based on International Rule measurements as follows: moderately high site index, 65 to 75 feet at 50 years, is 9,750 board feet; moderately low site index, 55 to 65 feet, is 6,300 board feet; and low site index, below 55 feet, is 4,775 board feet or less (*9*).

The second part of the symbol identifying a woodland group is a lowercase letter. In this county o, w, and x are used. Except for o, the lowercase letter indicates an important soil property that imposes a hazard or limitation in managing the soils of the group for trees. The letter o shows that the soils have few limitations that restrict their use for trees. The letter w means excessive wetness, either seasonal or all year. The soils have restricted drainage, have a high water table, or are subject to flooding. The letter x indicates stoniness or rockiness. Stones and rocks are so numerous that they reduce the stand density and also cause a limitation to harvest operations. In addition, some soils have shallow depths to bedrock that restrict root development (fig. 9).

In table 6 each woodland group in the county is rated for various management hazards or limitations. These ratings are *slight*, *moderate*, or *severe*, and they are described in the following paragraphs. The following land types and complexes were too variable to be assigned to a group and to be rated, and onsite investigation is required to determine species suitable for planting: Made land, sanitary land fill; Pits, sand and gravel; Urban land-Boonton complex, gently sloping; Urban land-Boonton complex, sloping; Urban land-Riverhead complex, gently sloping; and Urban land-Rockaway complex.

Suitable species are the kinds of native trees that should be favored in management and the kind of trees that are suitable for planting.

Seedling mortality refers to the loss of naturally occurring or planted seedlings, as influenced by kinds of soil or topographic conditions where plant competition is not a limiting factor. Seedling mortality is slight if 0 to 25 percent of the seedlings are expected to die and is moderate if this percentage is between 25 and 50 percent. If more than 50 percent of the seedlings are expected to die, seedling mortality is severe.

Site index information for this county consists of estimates based on data on similar soils in adjoining states.

Plant competition refers to the rate at which brush, grass, and undesirable trees are likely to invade. Plant competition is slight if unwanted plants do not prevent adequate natural regeneration and early growth or do not interfere with the growth of planted seedlings. It is moderate if competing plants delay but do not prevent establishment of a normal, fully-stocked stand by natural regeneration or from planted seedlings. Competition is severe where natural or artificial regeneration is not adequate unless there is intensive site preparation and maintenance, including weeding.

Equipment limitations include steep slopes, stones, and excess water that limit the use of ordinary equipment in thinning or harvesting operations. The rating is slight if there are very few limitations on the type of equipment or the time of year that the equipment can be used. It is moderate if

TABLE 6.—*Woodland groups, productivity, suitable species, and management concerns*

[Land types Ma and Pt and complexes UbB, UbC, Urb, and Ux are too variable to be assigned to a woodland group and require onsite investigation to determine species suitable for planting. The symbol < means less than]

Woodland group, soil series, and map symbol	Productivity		Suitable species—		Management concerns				
	Commercial trees	Estimated site index	To favor in existing stands	For planting	Erosion hazard	Equipment limitations	Seedling mortality	Plant competition	Windthrow hazard
Group 3o: Deep, well-drained and moderately well drained soils having moderate available water capacity; slopes are mostly less than 15 percent. Boonton: BrB, BrC, BsD. Braceville: BtA. Chenango: CkB, CkC. Otisville: OrC, OsD. Riverhead: RhB, RhC. Rockaway: RmB, RmC. Swartswood: SdB, SdC.	Upland oaks.	65–75	Upland oaks, yellow-poplar, and white ash.	White pine, larch, Austrian pine, and Norway spruce.	Moderate for BsD and OsD; slight for all others.	Slight	Slight	Slight	Slight.
Group 3w: Deep soils having moderately high seasonal water tables. Haledon: HcB, HcC. Pompton: PvA Whippany: WlA.	Upland oaks	65–75	Pin oak, white ash, and white oak.	Pin oak	Slight	Moderate	Moderate	Moderate	Moderate.
Group 3x: Extremely stony, gently sloping to moderately steep soils. Hibernia: HpC. Netcong: NkC, NkD. Rockaway: RrC, RrD. Swartswood: SeB, SeC, SeD. Wurtsboro: WvB, WvC.	Upland oaks.	65–75	Upland oaks and white ash.	White pine.	Slight	Severe	Slight	Slight	Slight.
Group 4w: Deep soils having a high seasonal water table; Ridgebury soils are extremely stony. Alluvial land: Ae. Haledon, wet variant: HdA, HdB. Parsippany: Pk. Preakness: Px. Ridgebury: RbA, RbB.	Upland oaks.	55–65	Pin oak, white oak, white ash, and red maple.	Pin oak	Slight	Severe	Severe	Severe	Severe.
Group 4x: Deep and shallow soils between moderate to extensive rock outcrops. Holyoke-Rock outcrop complex: HrC. Rockaway-Rock outcrop complex: RsC. Rock outcrop-Holyoke complex: RwE. Rock outcrop-Rockaway complex: RxE. Rock outcrop-Swartswood complex: RyE. Swartswood-Rock outcrop complex: SrC.	Upland oaks	55–65	Upland oaks and white ash.	White pine	Slight	Severe	Slight	Slight	Slight for RsC, RxE, RyE, and SrC; moderate for HrC, and RwE.
Group 5w: Organic and mineral soils having a high water table; Norwich soils are extremely stony. Carlisle: Ca. Muck, shallow: Ms. Norwich: NpA, NpB.	Northern hardwoods.	<52	White ash and red maple.	Generally not feasible.	Slight	Severe	Severe	Severe	Severe.

slopes are moderately steep, if heavy equipment is restricted by wetness during the wettest periods, or if the equipment damages the roots. Equipment limitations are severe if many types of equipment cannot be used, if the equipment cannot be used for more than 3 months a year, or if the use of the equipment severely damages tree roots and the structure of the soils.

Erosion hazard is rated according to the risk of erosion on well-managed woodland that is not protected by special practices. It is slight where only a small loss of soil is expected, even when trees are harvested. The erosion hazard is moderate where a moderate loss of soil is expected if runoff is not controlled and vegetative cover is not adequate for protection. Where erosion hazard is moderate, some practices are needed on skid trails and logging roads immediately after trees are harvested. The erosion hazard is severe where steep slopes, rapid runoff, and slow infiltration and permeability make the soil susceptible to severe erosion. In these areas harvesting and other operations should be done across the slope as much as possible. It is advisable to lay out skid trails and logging roads on mild slopes so that excess water is disposed of safely during logging. Immediately after logging, practices to control erosion are needed on the logging roads and the skid trails.

Windthrow hazard is rated on the basis of characteristics that affect the development of roots and firmness so that the roots anchor the trees and the trees resist the force of the wind. The windthrow hazard is slight if no trees are expected to be blown down by the wind. It is moderate if roots hold the tree firmly, except when the soil is excessively wet and the velocity of the wind is high. The hazard is severe if rooting is not deep enough to give stability. Under this circumstance many trees are expected to be blown down when the soil is very wet or the wind is high, and individual trees are likely to be blown down if all surrounding trees have been removed.

Wildlife

The welfare of a wildlife species depends largely on the amount and distribution of food, shelter, and water (*1*). If any of these elements is missing, inadequate, or inaccessible, the species is absent or scarce. The kinds of wildlife that live in a given area and the number of each kind are closely related to land use, to the resulting kinds and patterns of vegetation, and to the supply and distribution of water. These, in turn, are generally related to the kinds of soils.

Habitat for wildlife normally can be created or improved by planting suitable vegetation, by properly managing the existing plant cover, by fostering the natural establishment of desirable plants, or by using a combination of these measures.

In this section the soils of Passaic County are rated according to their suitability for eight elements of wildlife habitat and three kinds of wildlife, and the elements, classes of wildlife, and ratings are explained.

The suitability ratings in this section can be used as an aid in:

1. Planning the broad use of parks, refuges, nature-study areas, and other recreational developments for wildlife.
2. Selecting the better soils for creating, improving, or maintaining specific kinds of wildlife habitat elements.
3. Determining the relative intensity of management needed for individual habitat elements.
4. Eliminating sites that would be difficult or not feasible to manage for specific kinds of wildlife.
5. Determining areas that are suitable for acquisition for use by wildlife.

Elements of wildlife habitat

Each soil is rated in table 7 according to its suitability for various kinds of plants and other elements that make up wildlife habitat. The eight elements considered important are as follows:

Grain and seed crops.—These crops include such seed-producing annuals as corn, sorghum, wheat, barley, oats, millet, buckwheat, cowpeas, and other plants commonly grown for grain or for seed. The major soil properties affecting this habitat element are effective rooting depth, available water capacity, natural drainage, slope, surface stoniness, hazard of flooding, and texture of the surface layer and subsoil.

Domestic grasses and legumes.—Making up this group are domestic perennial grasses and herbaceous legumes that are established by planting and that furnish wildlife cover and food. Among the plants are bluegrass, fescue, brome, timothy, orchardgrass, reed canarygrass, clover, and alfalfa. The major soil properties affecting this habitat element are effective rooting depth, available water capacity, natural drainage, slope, surface stoniness, hazard of flooding, and texture of the surface layer and subsoil.

Wild herbaceous plants.—In this group are native or introduced perennial grasses and weeds that generally are established naturally. They include bluestem, quackgrass, panicgrass, goldenrod, wild carrot, nightshade, and dandelion. They provide food and cover principally to upland forms of wildlife. The major soil properties affecting this habitat element are effective rooting depth, available water capacity, natural drainage, surface stoniness, hazard of flooding or ponding, and texture of the surface layer and subsoil.

Hardwood plants.—These plants are nonconiferous trees, shrubs, and woody vines that produce nuts, fruits, buds, catkins, twigs, or foliage eaten by wildlife. They are generally established naturally but can be planted. Examples of native species are oak, cherry, maple, poplar, apple, hawthorn, dogwood, persimmon, sumac, sassafras, hazelnut, black walnut, hickory, sweetgum, bayberry, blueberry, huckleberry, blackhaw, viburnum, grape, and briers. The major soil properties affecting this habitat element are effective rooting depth, available

TABLE 7.—*Suitability of the soils for wildlife habitats and kinds of wildlife*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more soils. The soils in such mapping units may have different properties and limitations, and for this reason the reader should follow carefully the instructions for referring to other series in the first column of this table. Soils rated 1 are good; 2, fair; 3, poor; and 4, very poor]

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hard wood plants	Wetland plants	Shallow-water areas	Open-land	Wood-land	Wet-land
Alluvial land: Ae	3	2	2	1	2	2	2	2	2
Boonton: BrB BrC, BsD	3	2	1	1	4	4	2	1	4
Braceville: BtA	2	1	1	1	3	3	1	1	3
Carlisle: Ca	4	3	3	3	1	1	3	3	1
Chenango: CkB, CkC	2	1	1	1	4	4	1	1	4
Haledon: HcB, HcC	4	3	1	1	4	4	3	2	4
Haledon, wet variant:									
HdA	4	3	2	2	1	3	3	2	2
HdB	4	3	2	2	3	4	3	2	4
Hibernia: HpC	4	4	1	2	3	4	3	2	4
*Holyoke: HrC	3	2	2	3	4	4	2	3	4
For Rock outcrop part of HrC, see Rock outcrop.									
Made land, sanitary land fill: Ma. Too variable to be rated.									
Muck, shallow: Ms	4	3	3	3	1	1	3	3	1
Netcong: NkC, NkD	4	4	1	1	4	4	3	2	4
Norwich:									
NpA	4	4	2	2	1	3	3	2	2
NpB	4	4	2	2	3	4	3	2	4
Otisville: OrC, OsD	3	3	2	3	4	4	3	3	4
Parsippany: Pk	3	2	2	2	1	1	2	2	1
Pits, sand and gravel: Pt. Too variable to be rated.									
Pompton: PvA	2	1	1	1	2	3	1	1	3
Preakness: Px	3	2	2	2	1	2	2	2	2
Ridgebury:									
RbA	4	4	2	3	1	3	3	3	2
RbB	4	4	2	3	3	4	3	3	4
Riverhead:									
RhB	1	1	1	1	4	4	1	1	4
RhC	2	1	1	1	4	4	1	1	4
*Rockaway:									
RmB, RmC, RsC	4	3	2	3	4	4	3	3	4
For Rock outcrop part of RsC, see Rock outcrop.									
RrC, RrD	4	4	2	3	4	4	4	3	4
*Rock outcrop: RwE, RxE, RyE	4	4	4	4	4	4	4	4	4
For Holyoke part of RwE, see Holyoke series. For Rockaway part of RxE, see Rockaway series, unit RsC. For Swartswood part of RyE, see Swartswood series.									

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood plants	Wetland plants	Shallow-water areas	Openland	Woodland	Wetland
*Swartswood: SdB, SdC, SeB, SeC, SeD, SrC. For Rock outcrop part of SrC, see Rock outcrop.	4	4	2	3	4	4	3	3	4
*Urban land: UbB, UbC, UrB, Ux. Urban land parts are too variable to be rated. For Boonton parts of UbB and UbC, see Boonton series. For Riverhead part of UrB, see Riverhead series, unit RhB. For Rockaway part of Ux, see Rockaway series, units RmB, RmC, and RsC.									
Whippany: WlA	2	1	1	1	2	3	1	1	3
Wurtsboro: WvB, WvC	4	4	2	3	4	4	3	3	4

water capacity, natural drainage, and surface stoniness or rockiness.

Also in this group are several varieties of fruiting shrubs that are raised commercially for planting. Autumn-olive, Amur honeysuckle, Tatarian honeysuckle, crabapple, multiflora rose, highbush cranberry, and silky cornel dogwood are some of the shrubs that are generally available and can be planted on soils that are well suited. Hardwoods that are not available commercially can commonly be transplanted successfully.

Wetland plants.—Making up this group are wild, herbaceous, annual and perennial plants that grow on moist-to-wet sites exclusive of submerged or floating aquatics. They produce food and cover extensively used mainly by wetland forms of wildlife. They include smartweed, wild millet, bulrush, sedges, barnyardgrass, pondweed, duckweed, duckmillet, arrow-arum, pickeralweed, waterwillow, wetland grasses, wildrice, and cattails. The major soil properties affecting this habitat element are natural drainage, surface stoniness, frequency of flooding or ponding, slope, and texture of the surface layer and subsoil.

Shallow water areas.—These are areas of surface water, generally not exceeding five feet in depth, near food and cover for wetland wildlife. Examples of such areas are shallow dugouts, level ditches, blasted potholes, and devices that keep the water 6 to 24 inches deep in marshes. The major soil properties affecting this habitat element are depth to bedrock, natural drainage, slope, hazard of flooding, and surface stoniness.

Excavated ponds are not considered in this habitat element; however, they can be important for fishing and other recreational activities and as a source of water for wildlife. If stocked with fish, such impoundments should be at least 6 feet deep over a large part of the area.

Kinds of wildlife

In table 7 the soils are rated according to their suitability for three kinds of wildlife in the county—openland, woodland, and wetland.

Openland wildlife.—Examples of openland wildlife are quail, pheasants, meadowlarks, field sparrows, doves, cottontail rabbits, red foxes, and woodchucks. These birds and mammals normally make their home in areas of cropland, pasture, meadow, lawns, and areas overgrown with grasses, herbs, and shrubs.

Woodland wildlife.—Among the birds and mammals that prefer woodland are ruffed grouse, woodcocks, thrushes, vireos scarlet tanagers, gray and red squirrels, gray foxes, white-tailed deer, and raccoons. They obtain food and cover in stands of hardwoods, coniferous trees, shrubs, or a mixture of these plants.

Wetland wildlife.—Ducks, geese, rails, herons, shore birds, and muskrats are typical examples of birds and mammals that generally make their homes in wet areas, such as ponds, marshes, and swamps.

Each rating under "Kinds of wildlife" in table 7 is based on the ratings listed for the habitat elements in the first part of the table. For openland wildlife the rating is based on the ratings shown for grain and seed crops, domestic grasses and legumes, wild herbaceous plants, and hardwood plants. The rating for woodland wildlife is based on the ratings listed for domestic grasses and legumes, wild herbaceous plants, and hardwood trees. For wetland wildlife, the rating is based on the ratings shown for wetland plants and shallow-water areas.

On soils rated *good*, habitat is generally easily created, improved, or maintained. Satisfactory habitat is almost a certainty in these soils, and there are few or no soil limitations to habitat management.

On soils rated *fair*, habitat generally can be created, improved, or maintained; but the soils have moderate limitations that affect the creation, improvement, or maintenance of the habitat. A moderate intensity of management and fairly frequent attention are required to assure satisfactory results.

On soils rated *poor*, habitat can usually be created, improved, or maintained; but there are severe soil limitations. Habitat management may be difficult and expensive and may require intensive effort. Satisfactory results are questionable.

On soils rated *very poor*, it is impractical to create, improve, or maintain habitat because of the very severe soil limitations. Unsatisfactory results are probable.

Not considered in the ratings are present land use, the location of a soil in relation to other soils, and the mobility of wildlife.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.
- Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife.
- Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.
- Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to use for esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-5 or IIIe-5. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Capability unit numbers are generally assigned locally but are part of a statewide system. Not all of the units in the system are represented by the soils of Passaic County; therefore the numbers are not consecutive.

The capability unit of each soil in the county is given in the mapping unit description and in the Guide to Mapping Units.

Formation, Morphology, and Classification of the Soils

The factors and processes of soil formation and their effect on the soils of Passaic County are discussed in the first part of this section. Soil morphology is then discussed, and the current system of soil classification is explained.

Formation of Soils

All soils form through the interaction of five major factors. These factors are parent material, climate, plant and animal life, topography, and time. The relative influence of each factor varies from place to place. The differences among the soils of Passaic County are largely due to differences in parent material, topography, and time.

Parent material

Parent material is the unconsolidated geologic material from which soils form. In Passaic County most parent materials are glacial till or outwash. Small areas of lacustrine sediment, recent stream alluvium, and accumulations of organic material are also present.

During the glacial period the glacier picked up and transported unconsolidated material and rock fragments. It ground them together and added fragments of local bedrock to the mass. The parent material of Rockaway soils is glacial till composed mainly of granitic gneiss. Boonton soils formed in till composed mainly of basalt and shale, and Swartzwood soils formed in till that has a high content of quartzite.

As the glacier melted, it yielded large amounts of sediment-laden water. Extensive areas of outwash were deposited in low areas. Riverhead, Pompton, and Preakness soils are examples of soils that formed in stratified, sandy glacial outwash.

During and following the glacial period there were large and small water impoundments throughout the county. Lake Passaic, in the southern part of the county, was the largest of these (*4*). During the existence of this lake, large amounts of sediment washed into it. The finer textured material was deposited in its basin. Parsippany and Whippany are examples of soils that formed in these lacustrine deposits.

Many of the lakes and ponds formed during the glacial period have been gradually filling in with accumulating plant residue. This resdue has resulted in muck deposits. Muck, shallow, and Carlisle soils are examples of soils formed in these muck deposits.

Along streams, in low positions subject to flooding, sediment eroded from nearby uplands is being deposited. This sediment is so variable in texture and composition that it has not been given a name. Alluvial land is in such areas.

Climate

Climate is important in the formation of soils, because temperature and rainfall are responsible for variations in plant and animal life and affect rates of rock weathering and mineral decomposition.

The climate of Passaic County is characteristic of a humid, continental type that is marked by extreme seasonal temperature changes. It has an annual precipitation of about 48 inches and a mean annual air temperature of about 53° F. For more detailed information on climate, see the "Climate" section.

Plant and animal life

All living organisms that live on or in the soil are important in soil formation. This includes higher forms of plants and animals as well as lower forms, such as bacteria and fungi. These organisms add organic matter to soils and produce acids that accelerate mineral weathering and leaching. Some plants have the ability to take nitrogen out of the air and assimilate it into plant tissue and eventually to the soil in plant residue. Earthworms and other animals are continually stirring or mixing the upper layers of the soil. In Passaic County native forests have strongly influenced soil formation. Also, in recent time man has played a major role in altering the course of soil development. Men have cleared the land of natural vegetation and drained it, added nutrients in the form of manures and other fertilizer, and mixed soil horizons during plowing or construction.

Topography

Passaic County falls into subdivisions of two major physiographic provinces (*3*). The Highland subdivision of the New England Upland Province encompasses the area from Pompton Lakes northward. The Triassic subdivision of the Piedmont Province encompasses the area south of Pompton Lakes.

Most of the bedrock in the Highlands is composed of granitic gneiss. The western part of West Milford Township near Bearfort Mountain consists of sandstone, shale, and conglomerate. Combined geologic forces, including folding of the earth's crust, erosion, and a period of glacial advances ending about 10,000 to 15,000 years ago, resulted in rough, bouldery land. The glacial movements left many areas at higher elevations devoid of soil material, while in the valleys and on side slopes, the depth of glacial deposits ranges from a few feet to many. Slopes are generally narrow and are as much as 40 percent or more. Abrupt drops in elevation are not uncommon. The highest point in the Highland area, near Bearfort Mountain, is 1,490 feet above sea level. The lowest points in the area, 400 feet above sea level, are in the narrow valleys.

The bedrock in the Piedmont area consists of sandstone, shale, and three areas of basalt known as the Watchung Mountains. Erosion and subsequent glaciation of these bedrock formations are the prime factors in the shaping of the topography as we know it today. Glacial and postglacial lacustrine deposits range from a few feet to many feet thick. Exposed bedrock increases with elevation in the basalt areas. Slopes are generally long and gently sloping in the sandstone and shale bedrock areas. Slopes in the basalt areas are generally narrow and range from gently sloping to slopes exceeding 40 percent. Elevation in the Piedmont area ranges from 10 feet above sea level near Passaic River to 600 feet above sea level in the basalt areas of the Passaic County and Bergen County boundary.

The shape of the land surface, commonly called the "lay of the land," the slope, and the position in relation to the water table have had great influence on the formation of soils in the county. Soils that formed in sloping areas, where runoff is moderate to rapid, generally are well drained, and have a bright-colored, unmottled subsoil. In most areas these soils are leached to greater depths than wetter soils in the same general area. In more gently sloping areas, where runoff is slower, the soils generally exhibit some evidence of wetness, such as mottling in the subsoil, for short periods of time. In level areas or slight depressions where the water table is at or near the surface for long periods, the soils show evidence of wetness to a marked degree. They have a dark-colored, thick, organic surface layer and a strongly mottled or grayish subsoil. Some soils, however, are wet because of a high water table or because of their position. Also, the permeability of the soil material, as well as the length, steepness, and configuration of the slopes, influence the kind of soil that is formed from place to place. Local differences in soils are largely the results of differences in parent material and topography.

Time

The formation of soils requires time for changes to take place. Millions of years are generally needed for development of a soil from freshly exposed bedrock. Climatic factors such as freezing and thawing, heating and cooling, and wetting and drying weaken the rock structure. Minerals within the rock react, setting up stresses and strains that further weaken the rock. Eventually the rock is broken into smaller pieces. Other forces, such as chemical reactions, add to the rock breakdown. Thus, the resulting mixture of particles is considered the parent material.

In Passaic County the grinding action of glacial activity and the subsequent meltwaters and impoundments were a prime factor in the formation of parent material. One can probably say, therefore, that the formation of the present mixture of parent material can be measured in tens of thousands of years rather than in millions of years.

Processes of Soil Formation

Many processes are involved in the formation of soil horizons in the soils of Passaic County. Among these are the formation and accumulation of organic matter, the solution and the leaching of soluble salts, the reduction and translocation of iron, the formation of soil structure, and to some degree, the transformation and loss of clay, minerals, aluminum, silica, and iron. These processes are continually taking place, generally at the same time throughout the profile. They have been active for thousands of years in most soils in Passaic County.

The accumulation of organic matter takes place with the decomposition of plant residue. This process darkens the surface layer and helps form the A1 horizon.

Soils in Passaic County generally have a distinct subsoil horizon. It is believed that some of the lime and other soluble salts go into solution and are leached before translocation of iron and clay takes place. Many factors affect this leaching, such as the kinds of salts originally present, the depth to which the soil solution percolates, and the texture of the soil material.

Well drained and moderately well drained soils in Passaic County have a yellowish-brown to strong-brown subsoil. These colors are mainly caused by thin coatings of iron oxides on sand and silt grains. Substratum colors are variable and in some soils reflect colors of the mineral.

The wetter, more poorly drained soils are grayish or have grayish mottling, reflecting the reduction of iron. This process of iron reduction is called "gleying." In soils that have intense reduction, the horizons are given the special suffix designation "g." Examples of poorly drained soils having horizons with the suffix "g" are those of the Norwich and Preakness series.

Many of the soils in Passaic County have a firm, dense, slowly permeable fragipan in the subsoil. Genesis of these horizons is not fully understood. Studies show that swelling and shrinking takes place in alternating wet and dry periods. This may account for the tight packing of soil particles and for the polygonal pattern of cracks in the fragipan.

Another factor that may have influenced the fragipan characteristics is the tremendous vertical pressure of the glacier coinciding with lateral movement of material.

Morphology of Soils

The results of the soil-forming factors can be distinguished by the different layers, or soil horizons, seen in a soil profile. The soil profile extends from the surface downward to materials that are little altered by the soil-forming processes.

Most soils contain three major horizons—A, B, and C (*12*). These major horizons may be further subdivided by the use of subscripts and letters to indicate changes within one horizon. An example would be the B2t horizon that represents a layer within the B horizon of maximum clay accumulation.

The A horizon is the surface layer. It has the largest accumulation of organic matter in a layer called the A1 horizon. The A horizon is also the layer of maximum leaching of relatively soluble components or eluviation of clay. When considerable leaching has taken place, an A2 horizon is formed.

The B horizon is underneath the A horizon and is commonly called the subsoil. It is the horizon of maximum accumulation, or illuviation, of clay, iron, aluminum, or other compounds. In some soils the B horizon is formed by alteration in place rather than by illuviation. The alteration may be caused by oxidation and reduction of iron or the weathering of clay minerals. The B horizon is generally firmer than the A horizon and has blocky or prismatic

TABLE 8.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Boonton	Coarse-loamy, mixed, mesic	Typic Fragiudalfs	Alfisols.
Braceville	Coarse-loamy, mixed, mesic	Typic Fragiochrepts	Inceptisols.
Carlisle	Euic, mesic	Typic Medisaprists	Histosols.
Chenango	Loamy-skeletal, mixed, mesic	Typic Dystrochrepts	Inceptisols.
Haledon	Coarse-loamy, mixed, mesic	Aquic Fragiudalfs	Alfisols.
Haledon, wet variant	Fine-loamy, mixed, mesic	Aeric Fragiaquepts	Inceptisols.
Hibernia	Coarse-loamy, mixed, mesic	Aquic Fragiudults	Ultisols.
Holyoke	Loamy, mixed, mesic	Lithic Dystrochrepts	Inceptisols.
Netcong	Coarse-loamy, mixed, mesic	Ruptic Ultic Dystrochrepts	Inceptisols.
Norwich	Fine-loamy, mixed, mesic	Typic Fragiaquepts	Inceptisols.
Otisville	Sandy-skeletal, mixed, mesic	Typic Udorthents	Entisols.
Parsippany	Fine, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Pompton	Coarse-loamy, mixed, mesic	Aquic Dystrochrepts	Inceptisols.
Preakness	Coarse-loamy, mixed, acid, mesic	Typic Humaquepts	Inceptisols.
Ridgebury	Coarse-loamy, mixed, mesic	Aeric Fragiaquepts	Inceptisols.
Riverhead	Coarse-loamy, mixed, mesic	Typic Dystrochrepts	Inceptisols.
Rockaway	Coarse-loamy, mixed, mesic	Typic Fragiudults	Ultisols.
Swartswood	Coarse-loamy, mixed, mesic	Typic Fragiochrepts	Inceptisols.
Whippany	Fine, mixed, mesic	Aquic Hapludalfs	Alfisols.
Wurtsboro	Coarse-loamy, mixed, mesic	Typic Fragiochrepts	Inceptisols.

structure and more clay. It is generally lighter colored than the A1 horizon, but darker than the C horizon. Most young soils have not developed a B horizon.

The C horizon is below the A and B horizons. It consists of material that is little altered by the soil-forming processes but that may be modified by weathering.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*10*, *13*). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8 the soil series of Passaic County are placed in 4 categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols that occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect the presence or absence of waterlogging or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquent* (*Aqu*, meaning water or wet, and *ent*, from Entisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquents (*Hapl*, meaning simple horizons, *aqu* for wetness or water, and *ent*, from Entisols).

TABLE 9.—*Relationship of parent material to drainage class*

Parent material	Soils in drainage class			
	Excessively drained and well drained	Moderately well drained	Somewhat poorly drained	Poorly drained and very poorly drained
1. Glacial till:				
Very stony or extremely stony sandy loams or loam; slightly weathered to a depth of 30 to 40 inches; dominantly granitic gneiss	Rockaway	Rockaway	Hibernia	Ridgebury.
Extremely stony loams; weathered, dominantly granitic gneiss	Netcong		Hibernia	Ridgebury.
Very stony or extremely stony loams or silt loams; dominantly basalt, red shale, and granitic gneiss	Boonton	Boonton	Haledon	Haledon, wet variant.
Shallow silt loams above rock; dominantly basalt	Holyoke			
Very stony or extremely stony fine sandy loams or silt loams; conglomerates, sandstone, or shale; contains small amounts of granitic gneiss	Swartswood	Swartswood; Wurtsboro.	Wurtsboro	Norwich.
2. Glacial Outwash:				
Gravelly silt loams or silt loams; gravelly or very gravelly and sandy substratum; conglomerate, sandstone, and shale; contains small amounts of granitic gneiss	Chenango	Braceville		
Sandy loams, fine sandy loams, or silt loams; gravelly sand or loamy sand substratum; dominantly granitic gneiss	Riverhead		Pompton	Preakness.
Sandy loams: gravelly loamy sand subsoil; gravelly, cobbly, or very gravelly sand substratum	Otisville [1]			
3. Muck soils:				
Organic material 16 to 50 inches deep over sedimentary deposits				Muck, shallow [2].
Organic material more than 50 inches deep				Carlisle [2]
4. Loamy, alluvium of mixed composition			Alluvial land	Alluvial land.
5. Glacial lake sediment; dominantly silts and clays of mixed composition			Whippany	Parsippany.

[1] Excessively drained. [2] Very poorly drained.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquents (a typical Haplaquent).

FAMILY. Soil families are separated within a subgroup mainly on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and other characteristics that are used as family differentiae. An example is the coarse-loamy, siliceous, acid, thermic family of Typic Haplaquents.

SERIES. The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile. They are given the name of a town or other geographic feature near the place where that soil was first observed and mapped. An example of a series established in Passaic County is Hibernia. In table 8 each soil series in Passaic County is placed in its family, subgroup, and order of the current classification system. In table 9 the relationship between parent material and drainage class is shown for soil series and land types of the county.

Climate[3]

Passaic County is humid and temperate, but it has a continental climate that is influenced very little by the Atlantic Ocean. The data in table 10 are from the cooperative weather stations at Paterson and Charlotteburg. Those in table 11 are from the Charlotteburg weather station.

Temperatures in summer seldom exceed 100° F., but temperatures in the middle or upper 90's occur frequently. Temperatures in winter are generally

[3] By DONALD V. DUNLAP, climatologist for New Jersey, U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

not below 10° F. for long periods, but drainage tiles must be placed below a depth of 30 inches for protection against freezing.

The average annual precipitation ranges from about 47 to 54 inches in the county. The monthly averages indicate that precipitation is well distributed throughout the year. Nearly every year, however, there are periods when rainfall is not sufficient for high-value crops. Rainfall is heaviest during July and August. Much of the rainfall in the summer months occurs during thunderstorms, and about 33 thunderstorms occur annually. In August 1955 between 13 and 17 inches of rain fell in the county in connection with the passage of two hurricanes and some thunderstorms.

The average length of the growing season in the county is about 131 days. The average date of the last killing freeze in the spring is May 17th, and that of the first in the fall is September 25th. Probabilities for the last damaging cold temperatures in spring and the first in fall are listed in table 11.

Sometimes temperatures are not low enough to keep the ground frozen throughout the winter. At times during winter, rainfall warms the soils enough to thaw the soil material. Partly thawed soils, however, tend to be very erodible during periods of heavy rainfall. Hail does not occur frequently but has been proven to be destructive to high-value crops.

TABLE 10.—*Temperature and precipitation data*

[Snow data from Charlotteburg. All other data from Paterson]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with— Maximum temperature higher than—	Two years in 10 will have at least 4 days with— Minimum temperature lower than—	Average monthly total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Number of days having snow cover of 1 inch or more	Average depth of snow on days having snow cover
	°F	*°F*	*°F*	*°F*	*In*	*In*	*In*		*In*
January	39	22	54	5	3.2	1.5	6.4	15	5
February	40	23	55	8	3.2	1.9	5.9	14	8
March	49	30	67	18	4.5	2.6	6.7	11	6
April	62	41	81	31	3.9	1.6	7.0	1	3
May	73	50	88	41	4.4	1.5	7.0	0	0
June	82	60	94	50	3.6	1.0	6.8	0	0
July	87	65	96	56	4.5	1.3	8.3	0	0
August	84	63	94	53	4.9	1.8	8.5	0	0
September	78	55	91	43	4.0	1.4	6.9	0	0
October	68	45	83	34	3.4	1.0	7.5	([1])	1
November	55	36	68	25	4.4	2.2	7.3	1	2
December	42	26	58	10	4.1	1.5	7.0	9	3
Year	63	43	[2] 99	[3] 2	48.1	36.1	56.4	51	5

[1] Less than 0.5 day. [2] Average annual highest temperature. [3] Average annual lowest temperature.

TABLE 11.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data from Charlotteburg]

Season and probability	Dates for given probability and temperature of— 16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	Apr. 7	Apr. 15	Apr. 30	May 15	May 31
2 years in 10 later than	Mar. 30	Apr. 9	Apr. 24	May 9	May 25
5 years in 10 later than	Mar. 19	Mar. 29	Apr. 15	Apr. 30	May 17
Fall:					
1 year in 10 earlier than	Nov. 2	Oct. 13	Oct. 2	Sept. 24	Sept. 12
2 years in 10 earlier than	Nov. 10	Oct. 22	Oct. 11	Sept. 30	Sept. 18
5 years in 10 earlier than	Nov. 23	Nov. 6	Oct. 25	Oct. 9	Sept. 25

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Basalt (Trap Blue rock): hard, heavy, dark volcanic rock.

Boulder. Any large rock worn and rounded by weather or water.

Coarse fragments. Mineral or rock particles more than 2 millimeters in diameter.

Cobblestone. A rounded or partly rounded fragment of rock, 3 to 10 inches in diameter.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres, to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Fragipan. A loamy, brittle, subsurface horizon that is very low in organic-matter content and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

Friability. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Granitic gneiss. A coarse-grained, metamorphic rock resembling granite.

Gravelly soil material. From 15 to 50 percent of material, by volume, consists of rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Highland area. A region higher than adjacent land and containing many hills or mountains.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Illuviation. The accumulation of material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial horizon.

Lacustrine deposit (geology). Material deposited in lake water and exposed by lowering of the water level or elevation of the land.

Leached soil. A soil from which most of the soluble materials have been removed from the entire profile or have been removed from one part of the profile and have accumulated in another part.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these; *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below 6 to 16 inches, and in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Shale. A sedimentary rock formed by the hardening of clay deposits.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Traprock. Dark-colored igneous rock located within other rock in steplike formations.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Water table, perched. The upper surface of a body of free ground water that is separated from an underlying body of ground water by unsaturated material.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. For information on capability units, read the section "Capability Grouping" beginning on page 62. Other information is given in tables as follows:

Acreage and extent, table 1, page 6.
Engineering uses of soils, tables 2, 3, and 4, pages 30 through 45.
Soil properties and limitations affecting town and country planning, table 5, page 48.
Suitability of soils for woodland, table 6, page 58.
Suitability of soils for wildlife, table 7, page 60.

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Woodland suitability group Symbol
Ae	Alluvial land	5	VIw-46	4w
BrB	Boonton stony silt loam, 3 to 8 percent slopes	7	IIe-5	3o
BrC	Boonton stony silt loam, 8 to 15 percent slopes	7	IIIe-5	3o
BsD	Boonton very stony silt loam, 15 to 30 percent slopes	7	VIs-19	3o
BtA	Braceville gravelly silt loam, 0 to 5 percent slopes	8	IIw-24	3o
Ca	Carlisle muck	9	IIIw-41	5w
CkB	Chenango silt loam, 3 to 8 percent slopes	10	IIe-7	3o
CkC	Chenango silt loam, 8 to 15 percent slopes	10	IIIe-7	3o
HcB	Haledon very stony loam, 3 to 8 percent slopes	11	VIs-19	3w
HcC	Haledon very stony loam, 8 to 15 percent slopes	11	VIs-19	3w
HdA	Haledon very stony silt loam, wet variant, 0 to 3 percent slopes	12	VIs-19	4w
HdB	Haledon very stony silt loam, wet variant, 3 to 8 percent slopes	12	VIs-19	4w
HpC	Hibernia extremely stony loam, 3 to 15 percent slopes	13	VIIs-34	3x
HrC	Holyoke-Rock outcrop complex, 3 to 15 percent slopes	14	VIIs-22	4x
Ma	Made land, sanitary land fill	14	-------	------
Ms	Muck, shallow	14	VIIw-41	5w
NkC	Netcong extremely stony loam, 3 to 15 percent slopes	15	VIIs-22	3x
NkD	Netcong extremely stony loam, 15 to 25 percent slopes	15	VIIs-22	3x
NpA	Norwich extremely stony silt loam, 0 to 3 percent slopes	16	VIIs-45	5w
NpB	Norwich extremely stony silt loam, 3 to 8 percent slopes	16	VIIs-45	5w
OrC	Otisville sandy loam, 3 to 15 percent slopes	17	IVs-12	3o
OsD	Otisville gravelly sandy loam, 15 to 30 percent slopes	17	VIs-12	3o
Pk	Parsippany silt loam, sandy loam substratum	18	IVw-81	4w
Pt	Pits, sand and gravel	18	-------	------
PvA	Pompton fine sandy loam, 0 to 5 percent slopes	19	IIw-25	3w
Px	Preakness silt loam	20	IVw-36	4w
RbA	Ridgebury extremely stony loam, 0 to 3 percent slopes	21	VIIs-38	4w
RbB	Ridgebury extremely stony loam, 3 to 8 percent slopes	21	VIIs-38	4w
RhB	Riverhead sandy loam, 3 to 8 percent slopes	22	IIe-7	3o
RhC	Riverhead sandy loam, 8 to 15 percent slopes	22	IIIe-7	3o
RmB	Rockaway very stony sandy loam, 3 to 8 percent slopes	23	VIs-19	3o
RmC	Rockaway very stony sandy loam, 8 to 15 percent slopes	23	VIs-19	3o
RrC	Rockaway extremely stony sandy loam, 3 to 15 percent slopes	23	VIIs-22	3x
RrD	Rockaway extremely stony sandy loam, 15 to 25 percent slopes	23	VIIs-22	3x
RsC	Rockaway-Rock outcrop complex, 3 to 15 percent slopes	23	VIIs-22	4x
RwE	Rock outcrop-Holyoke complex, 15 to 35 percent slopes	24	VIIs-22	4x
RxE	Rock outcrop-Rockaway complex, 15 to 35 percent slopes	24	VIIs-22	4x
RyE	Rock outcrop-Swartswood complex, 15 to 45 percent slopes	24	VIIs-22	4x
SdB	Swartswood very stony fine sandy loam, 3 to 8 percent slopes	25	VIs-19	3o
SdC	Swartswood very stony fine sandy loam, 8 to 15 percent slopes	25	VIs-19	3o
SeB	Swartswood extremely stony fine sandy loam, 3 to 8 percent slopes	25	VIIs-19	3x
SeC	Swartswood extremely stony fine sandy loam, 8 to 15 percent slopes	26	VIIs-19	3x
SeD	Swartswood extremely stony fine sandy loam, 15 to 25 percent slopes	26	VIIs-19	3x
SrC	Swartswood-Rock outcrop complex, 3 to 15 percent slopes	26	VIIs-19	4x
UbB	Urban land-Boonton complex, gently sloping	26	-------	------
UbC	Urban land-Boonton complex, sloping	26	-------	------
UrB	Urban land-Riverhead complex, gently sloping	27	-------	------
Ux	Urban land-Rockaway complex	27	-------	------
WlA	Whippany silt loam, sandy loam, substratum, 0 to 5 percent slopes	28	IIw-70	3w
WvB	Wurtsboro extremely stony silt loam, 3 to 8 percent slopes	29	VIIs-34	3x
WvC	Wurtsboro extremely stony silt loam, 8 to 15 percent slopes	29	VIIs-34	3x

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