SOIL SURVEY OF

Crawford County, Pennsylvania

United States Department of Agriculture
Soil Conservation Service
In cooperation with
The Pennsylvania State University
College of Agriculture
and
The Pennsylvania Department of
Environmental Resources
State Conservation Commission

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 1962–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service; The Pennsylvania State University, College of Agriculture; and the Pennsylvania Department of Environmental Resources, State Conservation Commission. It is part of the technical assistance furnished to the Crawford County 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 Crawford 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.

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 with a moderate limitation can be colored yellow, and those with 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, the explanation of the capability classification system, the yield table, and the woodland interpretations.

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

Wildlife managers and others can find information about soils and wildlife in the section "Use of the Soils for 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 sections "Use of the Soils for Town and Country Planning" and "Use of the Soils for Recreation Development."

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 and how they are classified in the section "Formation, Morphology, and Classification of the Soils."

Newcomers in Crawford 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 in the section "Environmental Factors Affecting Soil Use."

Cover: Tamarack Lake is used for flood protection, recreation, and wildlife habitat. It was constructed in an area of Carlisle and Holly soils and is surrounded by Venango and Cambridge soils.

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SOIL SURVEY OF CRAWFORD COUNTY, PENNSYLVANIA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE PENNSYLVANIA STATE UNIVERSITY, COLLEGE OF AGRICULTURE, AND THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES, STATE CONSERVATION COMMISSION

CRAWFORD COUNTY is in the northwestern part of Pennsylvania (fig. 1) and within short distance of surrounding cities, including Cleveland and Youngstown, Ohio, and Erie, Pittsburgh, Sharon, New Castle, and Butler, Pennsylvania. The land area is about 1,012 square miles, or 647,616 acres. The population in 1970, according to the U.S. Census of that year, was 81,342. Meadville, the county seat, has a population of 16,573.

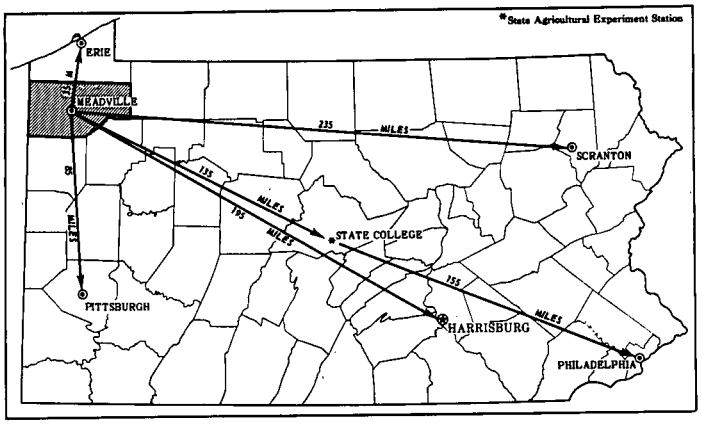

Figure 1.—Location of Crawford County in Pennsylvania.

The economy of Crawford County depends on industry, farming, lumbering, recreation, and services in utilities and communications, construction, real estate, and other enterprises.

About 40 percent of Crawford County is used for farming, and about 46 percent is in commercial woodland. The rest is being developed for urban use or for recreation or is reverting back to woodland. Dairying is the major type of farming, and Crawford County ranks among the top 10 counties in the state in milk production. The principal crops grown are corn, wheat, oats, and hay. Cabbage, cucumbers, and beans are grown in the Springboro area for canning. Lumber, pulpwood, maple syrup, and Christmas trees are sources of income from woodland.

Among the many industries in the county, gas and oil production are the major industries. Other industries include the manufacture of glass, zippers, tools, plastic, acetate, construction materials, and metal products.

The county lies entirely within the glaciated part of the Allegheny Plateau, and the topographic features vary greatly from east to west. The eastern part has the most irregular terrain, having deeper valleys and steeper slopes. Like most of the county, it drains into the Allegheny River system. A part of the northwestern area of the county is flat and drains toward Lake Erie. A large percentage of the soils in the northwestern part are poorly drained. Soils in the southeastern part of the county are leached or weathered to a greater depth than those in the northwestern part. Nearly three-fourths of the soils of the county are very poorly drained to somewhat poorly drained because of slow permeability in the subsoil and the relief.

About 65 percent of the land area needs some artificial drainage before it can be used intensively for farming. About 10 percent is well suited for farming and needs no special management. About 20 percent is either too steep, stony, or swampy for intensive use. About 5 percent consists of soils that are droughty.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Crawford County, where they are located, and how they can be used. The soil scientists went into 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 (*9*).[1]

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. Most soil series are named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Valois and Cambridge, 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, Venango silt loam, 0 to 3 percent slopes, is one of several phases within the Venango 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 other 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 shown on the soil map of Crawford County is a soil complex.

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. Cambridge-Venango silt loams, 3 to 8 percent slopes, is an example.

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 as a growing place 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 its 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 consultation. 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 Crawford 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 soil 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, recreation 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 other structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Some of the names and some of the boundaries indicated on the general soil map of Crawford County do not match those in surveys of adjoining counties published at a different date. Differences are a result of changes in the concept of some series, differences in soil patterns observed between adjacent survey areas, and correlations that have combined some soils into other associations.

The Canfield soils in Mercer County appear to be transitional between typical Canfield soils, which have a horizon of clay accumulation above the fragipan, and Cambridge soils, which do not. The Cambridge soils were mapped in Crawford County; the Canfield soils in Mercer County. The common boundary between the two counties serves as the line separating the two series.

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

[1] Italic numbers in parenthesis refer to literature cited, page 71.

1. *Venango-Frenchtown-Cambridge association*

Deep, moderately well drained to poorly drained, nearly level to moderately steep soils that formed in materials weathered from glacial till; on uplands

This soil association is in broad upland areas (fig. 2). The landscape is characterized by hills, mounds, knobs, depressions, nearly level areas, and side slopes of valleys.

This association makes up about 60 percent of the county. About 46 percent of the association is Venango soils, 18 percent is Frenchtown soils, 15 percent is Cambridge soils, and 21 percent is minor soils.

Venango soils are somewhat poorly drained. These soils are mostly gently sloping, but some are nearly level and a few are sloping. They are very slowly permeable and have moderate available water capacity.

Frenchtown soils are poorly drained. More than two-thirds of these soils are nearly level, and the rest are gently sloping. They are slowly permeable and have moderate available water capacity.

Cambridge soils are moderately well drained. These soils are mostly gently sloping to sloping, but some are nearly level. They are very slowly permeable and have moderate available water capacity.

Valois, Holly, and Alden soils are the most extensive minor soils. Valois soils are on steeper hillsides and knobs, and Alden soils are in depressions and in level areas. Holly soils are on narrow flood plains.

Most of the acreage of these soils is used to support dairy farming. Some nearly level, poorly drained soils are in trees, pasture, or brush or are idle. The more sloping soils are used for general farming. In cultivated areas, artificial drainage and practices to control erosion are needed. The steeper soils and hillsides are used for pasture, wildlife, or recreation. The main limitations for town and country development are restricted permeability and a high water table.

2. *Holly-Red Hook-Chenango association*

Deep, very poorly drained to somewhat excessively drained, nearly level to sloping soils that formed in materials weathered from stream deposits and glacial outwash; on flood plains and terraces

This soil association is on broad flood plains along major streams, on narrow flood plains along smaller streams, and on undulating, rolling, and some smooth

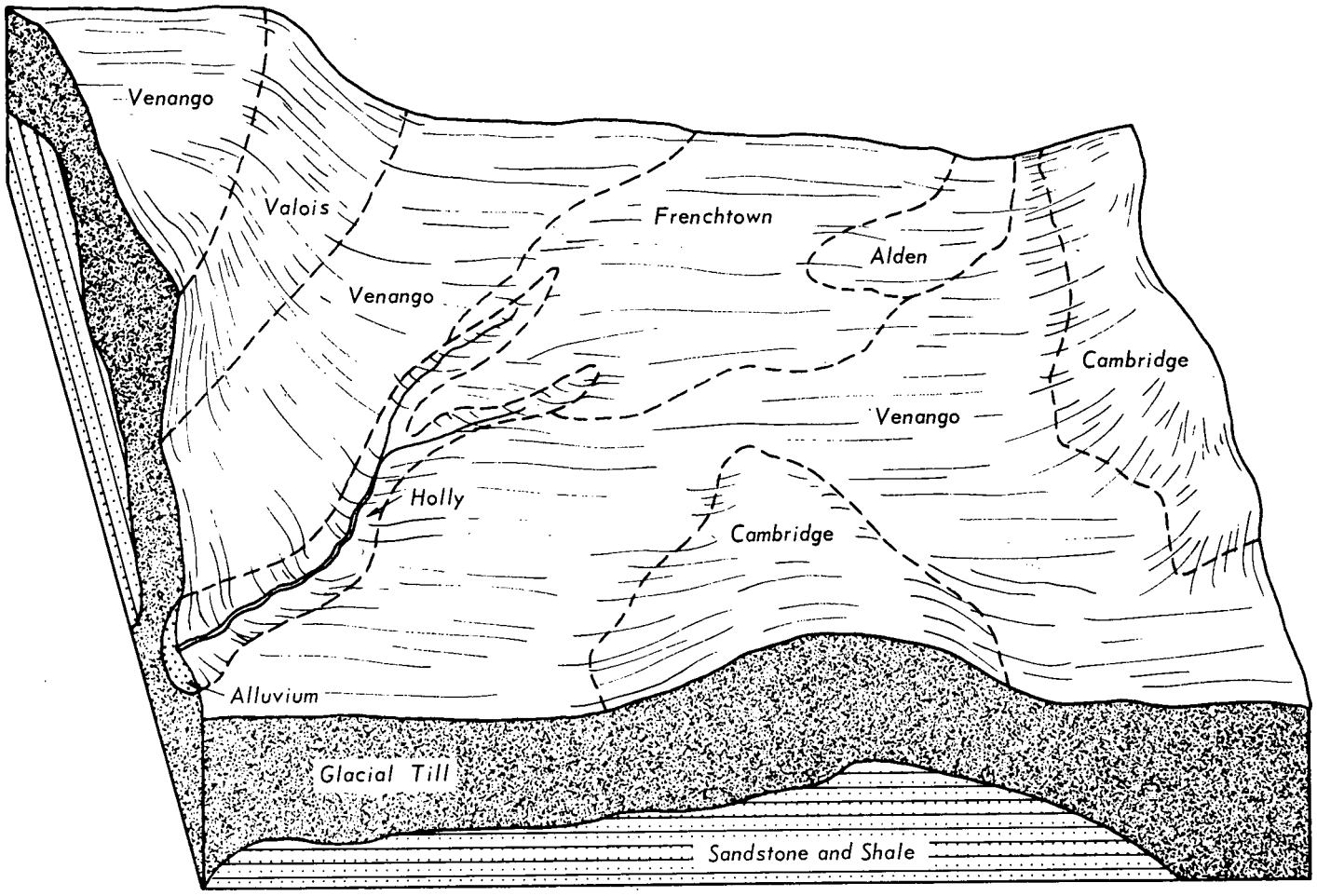

Figure 2.—**Underlying material and pattern of the soils in the Venango-Frenchtown-Cambridge association.**

stream terraces between the flood plains and the uplands.

This association makes up about 22 percent of the county. About 31 percent of the association is Holly soils, 15 percent is Red Hook soils, 9 percent is Chenango soils, and 45 percent is minor soils.

Holly soils are very poorly drained and poorly drained soils on flood plains. They are moderately permeable to moderately slowly permeable and have moderate to high available water capacity.

Red Hook soils are somewhat poorly drained soils on terraces. About half of these soils are nearly level, and the rest are gently sloping. They are moderately permeable and have moderate to high available water capacity.

Chenango soils are well drained to somewhat excessively drained soils on outwash plains and terraces. These soils are mostly gently sloping, but some are nearly level or sloping. They are moderately permeable to moderately rapidly permeable and have low available water capacity.

Wyoming, Carlisle, Haven, Pope, Philo, and Halsey soils are the most extensive minor soils. Wyoming, Haven, and Halsey soils are on outwash terraces, and Carlisle, Pope, and Philo soils are on flood plains.

Dairying is the most common type of farming on the more poorly drained soils in this association. Some large areas of nearly level soils that are difficult to drain are in trees and pasture. Cash crops are cultivated on the well-drained and somewhat excessively drained soils in this association. Large areas of nearly level and sloping soils are used for corn, potatoes, wheat, and oats. In dry seasons, the somewhat excessively drained soils are droughty.

In places the sloping and moderately steep soils are used as a source of sand and gravel. Ground water may be contaminated by effluent from sewage disposal systems on the Chenango, Haven, and Wyoming soils.

3. *Valois-Cambridge association*

Deep, well drained and moderately well drained, nearly level to very steep soils that formed in materials weathered from glacial till; on uplands

This soil association is in broad upland areas. The landscape is characterized by hummocky small hills, knobs, and knolls closely intermingled with small pockets and depressions.

This association makes up about 9 percent of the county. About 47 percent of the association is Valois soils, 43 percent is Cambridge soils, and 10 percent is minor soils.

Valois soils are well drained and are on hummocky hills and knobs. They are moderately permeable and have high available water capacity.

Cambridge soils are moderately well drained and are in the lower lying areas between the hills and knobs. They are very slowly permeable and have moderate available water capacity.

Frenchtown, Venango, and Alden soils are the most extensive minor soils. Frenchtown soils are in low, flat areas or depressions. Venango soils are on lower edges of hills and upper edges of pockets and depressions. Alden soils are in the bottoms of pockets and depressions.

Dairying is the most common type of farming in this association. The intermittent drainage pattern and scattered ponded pockets and depressions make this association difficult to farm. Large areas of these soils are in trees and pasture, but many cleared areas are reverting to brush or are idle. Cultivated areas need to be drained. The main limitations for town and country and recreation development are restricted permeability, hummocky topography, and a high water table.

4. *Sheffield-Platea association*

Deep, poorly drained and somewhat poorly drained, nearly level and gently sloping soils that formed in materials weathered from glacial till; on uplands

This soil association occupies broad upland areas (fig. 3) in the northwestern part of the county. The landscape is characterized by scattered gentle slopes on a broad plain dissected by narrow meandering streams.

This association makes up about 5 percent of the county. About 68 percent of the association is Sheffield soils, 22 percent is Platea soils, and 10 percent is minor soils.

Sheffield soils are poorly drained and nearly level. They are very slowly permeable and have moderate available water capacity.

Platea soils are somewhat poorly drained and gently sloping. They are very slowly permeable and have moderate available water capacity.

Alden and Holly soils are the most extensive minor soils. Alden soils are in depressions, and Holly soils are on flood plains.

Dairying is the most common type of farming in this association. Large tracts of land, however, are reverting to brush or are idle. Cultivated areas need to be drained. Many areas that are difficult to drain are in trees or pasture. The main limitations to soil use are a high water table and very slow permeability.

5. *Hanover-Alvira association*

Deep, moderately well drained and somewhat poorly drained, nearly level to moderately steep soils that formed in materials weathered from glacial till; on uplands

This soil association is in broad upland areas (fig. 4). The landscape is characterized by rather smooth or gently sloping areas dissected by deep, narrow valleys.

This association makes up about 4 percent of the county. About 50 percent of the association is Hanover soils, 30 percent is Alvira soils, and 20 percent is minor soils.

Hanover soils are moderately well drained and mostly gently sloping to moderately steep. They are moderately slowly permeable and have moderate available water capacity.

Alvira soils are somewhat poorly drained and gently sloping. These soils are slowly permeable and have moderate available water capacity.

Valois, Shelmadine, and Holly soils are the most extensive minor soils. Shelmadine soils are on flats and in depressions, Valois soils are on knobs and side slopes of valleys, and Holly soils are on narrow flood plains.

It was in this soil association that oil was first discovered in Venango County. Many places that are

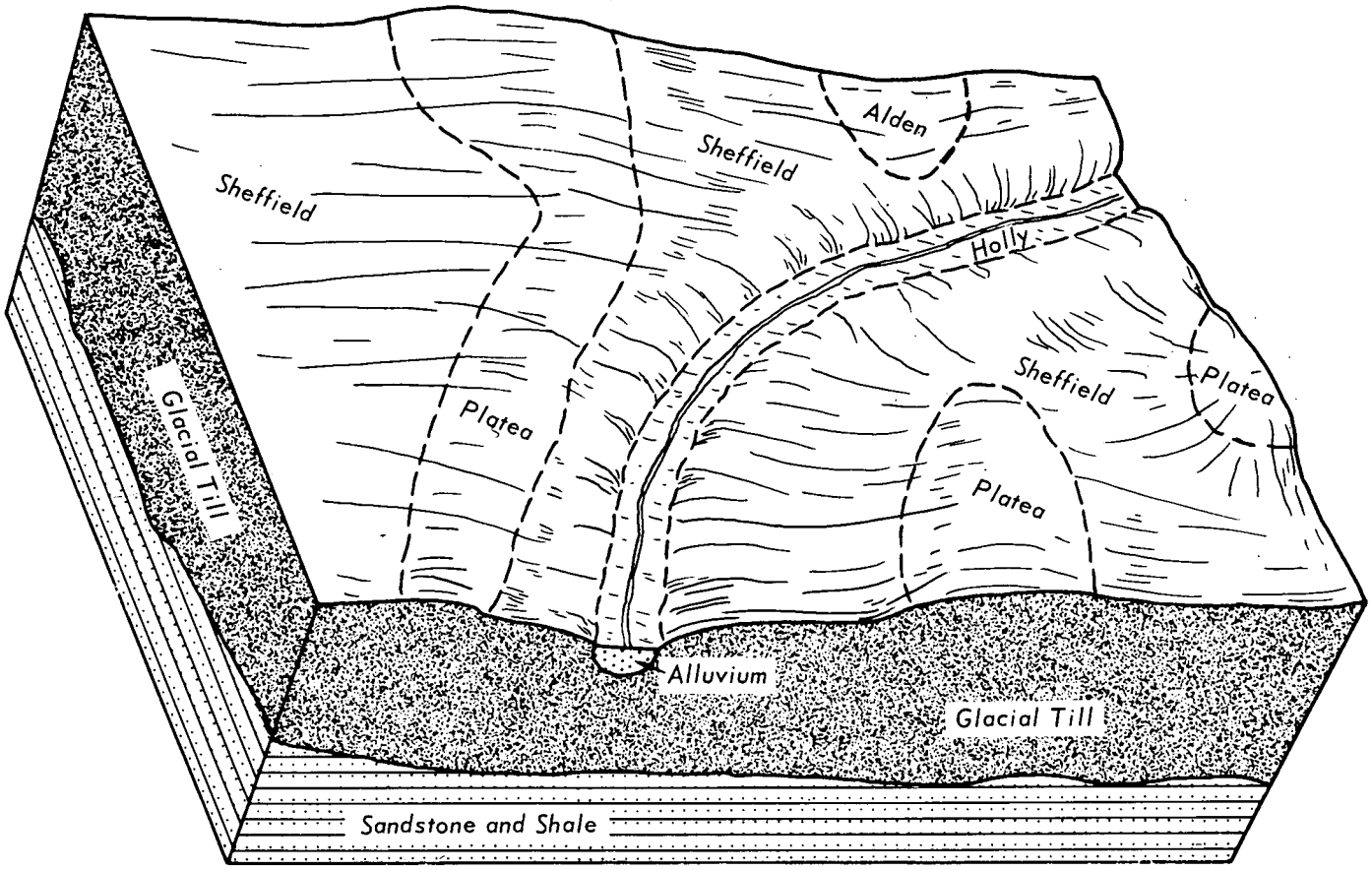

Figure 3.—**Underlying material and pattern of the soils in the Sheffield-Platea association.**

generally in pasture or are idle are dotted by oil wells and pumping equipment. Large areas of level, poorly drained soils and large areas of steep, well-drained soils are in trees. The main limitations to soil use are slow permeability and a seasonal high water table.

Descriptions of the Soils[2]

In this section the soils of Crawford County are described, and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless it is specifically mentioned otherwise, it is to be 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 both 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 is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the soil series is representative for mapping units in that series. If a given mapping unit has a profile that differs from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. The description of each mapping unit contains suggestions on how the soil can be managed.

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 mapping unit description is the capability unit in which the mapping unit has been placed.

The mapping unit descriptions mention the need for conservation practices to control erosion and reduce surface runoff and for artificial drainage to increase the suitability for crops. Examples of conservation practices are using diversions, stripcropping, contour farming, and growing cover crops and grass. Examples of drainage methods are surface field drains, surface main and lateral drains, subsurface drains, and diver-

[2] DARRELL G. GRICE, soil coorrelator, Soil Conservation Service, assisted in preparing this section.

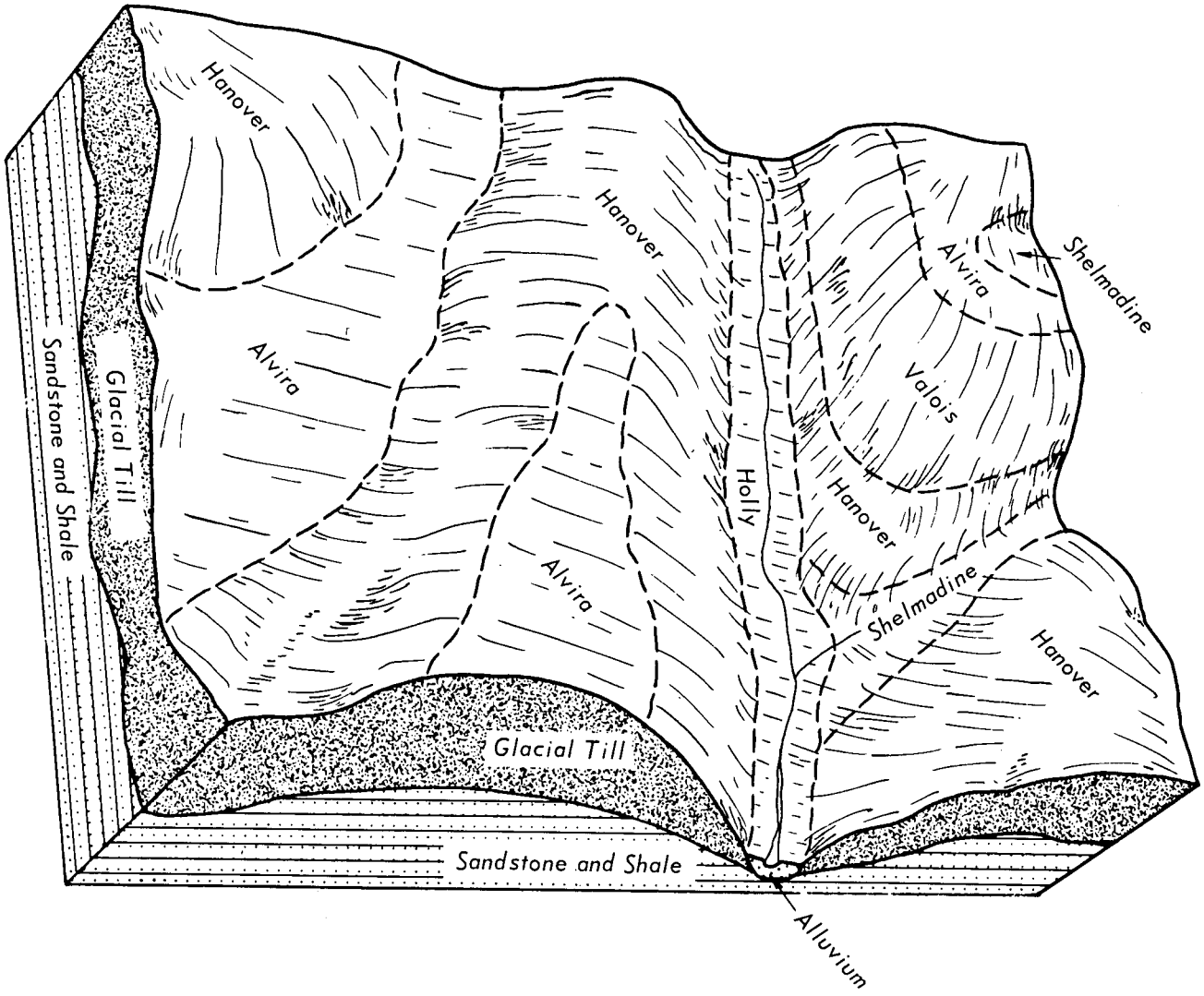

Figure 4.—**Underlying material and pattern of the soils in the Hanover-Alvira association.**

sions. The section "Estimated Yields" lists general management needs for crops and pasture.

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 (*9*).

Alden Series

The Alden series consists of deep, very poorly drained, nearly level soils that formed in material weathered from glacial till and local alluvium. These soils are on upland flats and in slight depressions.

In a representative profile the surface layer is black silt loam 7 inches thick. The subsoil, to a depth of 30 inches, is dark-gray, gray, and light brownish-gray, firm silty clay loam that has pale-brown and yellowish-brown mottles. The substratum extends to a depth of 60 inches. It is light brownish-gray gravelly loam that has yellowish-brown mottles.

Alden soils have moderately slow permeability and a high available water capacity. A high water table

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Alden silt loam	25,285	3.9	Haven silt loam, 3 to 8 percent slopes	5,140	.8
Alvira silt loam, 0 to 3 percent slopes	2,035	.3	Holly silt loam	37,595	5.8
Alvira silt loam, 3 to 8 percent slopes	6,490	1.0	Holly silty clay loam	17,545	2.7
Braceville gravelly loam, 0 to 3 percent slopes	1,480	.2	Philo silt loam	2,980	.5
Braceville gravelly loam, 3 to 8 percent slopes	6,895	1.1	Platea silt loam, 3 to 8 percent slopes	10,550	1.6
Cambridge silt loam, 0 to 3 percent slopes	4,785	.7	Pope loam	4,325	.7
Cambridge silt loam, 3 to 8 percent slopes	23,140	3.6	Red Hook loam	25,020	3.9
Cambridge silt loam, 8 to 15 percent slopes	34,070	5.3	Scio silt loam, 0 to 3 percent slopes	2,595	.4
Cambridge silt loam, 15 to 25 percent slopes	12,500	1.9	Scio silt loam, 3 to 8 percent slopes	3,650	.6
Cambridge very stony silt loam, 0 to 8 percent slopes	1,510	.2	Sheffield silt loam	27,820	4.3
Cambridge very stony silt loam, 8 to 25 percent slopes	3,395	.5	Shelmadine silt loam, 0 to 3 percent slopes	925	.1
Cambridge-Venango silt loams, 3 to 8 percent slopes	2,185	.3	Shelmadine silt loam, 3 to 8 percent slopes	595	.1
Canadice silt loam	2,460	.4	Valois gravelly silt loam, 3 to 8 percent slopes	5,125	.8
Caneadea silt loam, 0 to 3 percent slopes	1,055	.2	Valois gravelly silt loam, 8 to 15 percent slopes	6,945	1.1
Caneadea silt loam, 3 to 8 percent slopes	2,000	.3	Valois gravelly silt loam, 15 to 25 percent slopes	7,680	1.2
Carlisle muck	9,700	1.5	Valois soils, very steep	13,265	2.0
Chenango gravelly silt loam, 0 to 3 percent slopes	2,490	.4	Valois-Cambridge complex, 3 to 8 percent slopes	9,445	1.4
Chenango gravelly silt loam, 3 to 8 percent slopes	8,510	1.3	Valois-Cambridge complex, 8 to 15 percent slopes	1,270	.2
Chenango gravelly silt loam, 8 to 15 percent slopes	2,285	.4	Venango silt loam, 0 to 3 percent slopes	33,990	5.2
Frenchtown silt loam, 0 to 3 percent slopes	54,800	8.5	Venango silt loam, 3 to 8 percent slopes	142,860	22.0
Frenchtown silt loam, 3 to 8 percent slopes	21,170	3.3	Venango silt loam, 8 to 15 percent slopes	11,620	1.8
Frenchtown very stony silt loam, 0 to 8 percent slopes	3,480	.5	Venango very stony silt loam, 0 to 8 percent slopes	2,176	.3
Halsey silt loam	8,365	1.3	Venango very stony silt loam, 8 to 15 percent slopes	1,130	.2
Hanover silt loam, 0 to 3 percent slopes	815	.1	Wyoming gravelly sandy loam, 0 to 3 percent slopes	1,310	.2
Hanover silt loam, 3 to 8 percent slopes	6,455	1.0	Wyoming gravelly sandy loam, 3 to 8 percent slopes	5,205	.8
Hanover silt loam, 8 to 15 percent slopes	3,715	.6	Wyoming gravelly sandy loam, 8 to 15 percent slopes	3,605	.6
Hanover very stony silt loam, 0 to 8 percent slopes	555	.1	Wyoming gravelly sandy loam, 15 to 25 percent slopes	3,085	.5
Hanover very stony silt loam, 8 to 25 percent slopes	2,115	.3			
Haven silt loam, 0 to 3 percent slopes	6,425	1.0	Total	647,616	100.0

is at the surface most of the year. Nearly all areas of these soils are in woodland, but a few areas are in pasture or are idle. Management concerns are mainly the high water table and the moderately slow permeability.

Representative profile of Alden silt loam in a pasture 1 mile west of Conneaut Lake and 50 feet east of township road T–400:

A1—0 to 7 inches, black (N 2/0) silt loam; moderate, coarse, granular structure; firm, slightly sticky and slightly plastic; neutral; clear, wavy boundary.

B21g—7 to 10 inches, dark-gray (N 4/0) silty clay loam; few, fine, distinct, pale-brown (10YR 6/3) mottles; strong, coarse, prismatic structure parting to weak, coarse, blocky; firm, slightly sticky and plastic; neutral; abrupt, wavy boundary.

B22g—10 to 24 inches, gray (N 6/0) silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/8) mottles; strong, coarse, prismatic structure parting to weak, coarse, subangular blocky; firm, slightly sticky and plastic; neutral; clear, wavy boundary.

B23g—24 to 30 inches, light brownish-gray (10YR 6/2) silty clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, blocky structure; firm, slightly sticky and plastic; neutral; clear, wavy boundary.

IICg—30 to 60 inches, light brownish-gray (10YR 6/2) gravelly loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, thick, platy structure; firm, slightly sticky and slightly plastic; 15 percent coarse fragments; neutral; calcareous at a depth of 50 inches.

The solum ranges from 24 to 36 inches in thickness. The A1 horizon ranges from black (N 2/0) to very dark gray (10YR 3/1). It is slightly acid or neutral. The B horizon ranges from dark gray (N 4/0) to light brownish gray (10YR 6/2) and from silt loam to silty clay loam. In the B22g and the B23g horizons, mottles range from few to many, and reaction is slightly acid or neutral. The IIC horizon ranges from loam to gravelly loam. It is neutral to moderately alkaline and is calcareous at a depth of 40 inches or more.

Alden soils are associated on the landscape with the poorly drained Frenchtown soils, the somewhat poorly drained Venango soils, the moderately well drained Cambridge soils, and the well drained Valois soils. They are wetter than those soils.

Alden silt loam (0 to 3 percent slopes) (Ad).—This nearly level soil is in narrow, elongated areas 2 to 150 acres in size. Included with it in mapping are small areas of Frenchtown, Venango, and Halsey soils. Also included are a few areas of soils that have a surface layer of silty clay loam or mucky loam.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to pasture, woodland, and wildlife habitat. Surface runoff is ponded to slow. Interception of runoff water from higher areas and artificial drainage increase the suitability of this

soil for crops and pasture, but outlets are generally difficult to locate. Management concerns are mainly a high water table and moderately slow permeability. Capability unit IVw–2.

Alvira Series

The Alvira series consists of deep, somewhat poorly drained, nearly level and gently sloping soils. These soils formed in material, weathered from glacial till, that contains sandstone, shale, siltstone, and some quartzite. They are on uplands.

In a representative profile the surface layer is very dark grayish-brown silt loam 8 inches thick. The upper part of the subsoil, to a depth of 25 inches, is strong-brown and light brownish-gray, friable silt loam that has brown, grayish-brown, and reddish-brown mottles. The lower part of the subsoil extends to a depth of 74 inches. It is strong-brown and yellowish-brown, firm and brittle silt loam and silty clay loam that has light brownish-gray, yellowish-brown, pale-brown, and gray mottles.

Alvira soils have slow permeability and a moderate available water capacity. A seasonal high water table is within ½ to 1½ feet of the surface in wet periods. Most areas of these soils are cleared and are used for crops, hay, or pasture or are left idle. Management concerns are mainly the seasonal high water table and the slow permeability.

Representative profile of Alvira silt loam, 3 to 8 percent slopes, in a hay field 1.5 miles north of Titusville (Pennsylvania Department of Transportation test samples BP–23308 and BP–23309 were taken from this profile):

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine and medium, granular structure; friable, slightly sticky and slightly plastic; 5 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

B1—8 to 12 inches, strong-brown (7.5YR 5/6) silt loam; many, coarse, distinct, brown (10YR 5/3) and grayish-brown (10YR 5/2) mottles; weak, fine and medium, subangular blocky structure; friable, slightly sticky and plastic; few black coatings; 5 percent coarse fragments; very strongly acid; clear, wavy boundary.

B2gt—12 to 25 inches, light brownish-gray (2.5Y 6/2) silt loam; many, coarse, prominent, reddish-brown (5YR 4/4) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable, sticky and plastic; few black coatings, concretions, and streaks; thin continuous clay films in pores; 5 percent coarse fragments; very strongly acid; gradual, wavy boundary.

Bx1—25 to 34 inches, strong-brown (7.5YR 5/6) silt loam; light brownish-gray (10YR 6/2) prism faces; many, coarse, distinct, gray (10YR 6/1) mottles; moderate, very coarse, prismatic structure parting to moderate, medium, subangular blocky; firm and brittle, sticky and plastic; few black coatings and streaks; thin patchy clay films on ped faces; 5 percent coarse fragments; very strongly acid; gradual, wavy boundary.

Bx2—34 to 51 inches, strong-brown (7.5YR 5/6) silt loam; gray (10YR 6/1) prism faces; many, medium and coarse, distinct, yellowish-brown (10YR 5/6) mottles; strong, very coarse, prismatic structure parting to weak, medium, subangular blocky; firm and brittle, sticky and plastic; few black coatings and streaks; thick patchy clay films on ped faces; 10 percent coarse fragments; very strongly acid; gradual, wavy boundary.

Bx3—51 to 60 inches, yellowish-brown (10YR 5/6) silt loam; gray (10YR 6/1) prism faces; few, fine, faint, pale-brown (10YR 6/3) and dark yellowish-brown (10YR 3/4) mottles; strong, very coarse, prismatic structure parting to weak, medium, subangular blocky; firm and brittle, sticky and plastic; many thick clay films on ped faces; few black coatings and streaks; 10 percent coarse fragments; strongly acid; gradual, wavy boundary.

Bx4—60 to 74 inches, yellowish-brown (10YR 5/4) silty clay loam; gray (10YR 6/1) prism faces; few, medium, distinct, light brownish-gray (10YR 6/2) mottles; strong, very coarse, prismatic structure parting to moderate, medium, subangular blocky; firm and brittle, sticky and plastic; common black coatings; thick continuous clay films on ped faces; 5 percent coarse fragments; strongly acid.

The solum ranges from 40 to 80 inches in thickness. Depth to the fragipan ranges from 16 to 28 inches. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (7.5YR 4/4). It is very strongly acid to medium acid. Some profiles have an A1 horizon, which ranges from very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2).

The B2 horizon ranges from light gray (10YR 7/2) to grayish brown (10YR 5/2) and has weak to moderate, medium to coarse, subangular blocky or prismatic structure. It is very strongly acid or strongly acid. The Bx horizon ranges from grayish brown (10YR 5/2) to strong brown (7.5YR 5/6) and has medium to very coarse prismatic structure parting to weak or moderate, medium or coarse, subangular blocky. It is strongly acid to extremely acid.

Some profiles have a C horizon, which ranges from gray (10YR 5/1) to yellowish brown (10YR 5/6) and from loam to silt loam. It is very strongly acid or strongly acid.

Alvira soils are associated on the landscape with the poorly drained Shelmadine soils and the moderately well drained Hanover soils. They are better drained than the Shelmadine soils and are wetter than the Hanover soils.

Alvira silt loam, 0 to 3 percent slopes (AvA).—This nearly level soil is in broad areas 10 to 30 acres in size. Included with it in mapping are a few areas of gently sloping Alvira soils and a few small areas of Hanover, Shelmadine, Venango, and Cambridge soils.

This soil is suited to most crops commonly grown in the county. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to about 27 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a seasonal high water table and slow permeability. Capability unit IIIw–3.

Alvira silt loam, 3 to 8 percent slopes (AvB).—This gently sloping soil has the profile described as representative of the series. It is in broad areas 50 to 250 acres in size.

Included with this soil in mapping are a few small areas of nearly level Alvira soils and a few areas of sloping Alvira soils. Also included are a few areas of Hanover, Shelmadine, Venango, and Cambridge soils.

This soil is suited to most crops commonly grown in the county. The depth to which roots and moisture can penetrate is limited to about 25 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Surface runoff is medium. Conservation practices are needed to control erosion. Management concerns are mainly slow permeability and a seasonal high water table. Capability unit IIIw–2.

Braceville Series

The Braceville series consists of deep, moderately well drained, nearly level and gently sloping soils that formed in material weathered from water-sorted sand, silt, and gravel. These soils are on terraces and outwash plains in stream valleys.

In a representative profile the surface layer is very dark grayish-brown gravelly loam 10 inches thick. The upper part of the subsoil, to a depth of 22 inches, is yellowish-brown, friable and firm silt loam and gravelly silt loam. The lower part of the subsoil, between depths of 22 and 33 inches, is brown and yellowish-brown, firm and brittle gravelly silt loam that has light brownish-gray, yellowish-brown, and pale-brown mottles. The substratum extends to a depth of 54 inches. It is brown very gravelly sandy loam that has pale-brown and yellowish-brown mottles.

Braceville soils have moderately slow permeability and a moderate available water capacity. A seasonal high water table is within 1½ to 3 feet of the surface in wet periods. Nearly all areas of these soils are cleared and are used for crops, hay, or pasture. A few areas are in woodland or are idle. Management concerns are mainly the seasonal high water table, the moderately slow permeability, and coarse fragments.

Representative profile of Braceville gravelly loam, 0 to 3 percent slopes, in a cultivated field 0.2 mile east of Randolph School in Guys Mills (Pennsylvania Department of Transportation test samples BP–34609 and BP–34610 were taken from this profile):

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) gravelly loam; weak, fine, granular structure; friable, nonsticky and nonplastic; 15 percent coarse fragments; strongly acid; abrupt, smooth boundary.

B21—10 to 16 inches, yellowish-brown (10YR 5/6) silt loam; weak, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; 5 percent coarse fragments; medium acid; clear, smooth boundary.

B22—16 to 22 inches, yellowish-brown (10YR 5/4) gravelly silt loam; weak, fine, subangular blocky structure; firm, slightly sticky and slightly plastic; 30 percent coarse fragments; medium acid; clear, smooth boundary.

Bx1—22 to 27 inches, brown (10YR 5/3) gravelly silt loam; common, medium, faint, light brownish-gray (10YR 6/2) mottles and common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, very coarse, prismatic structure parting to weak, thick, platy; firm and brittle, slightly sticky and slightly plastic; few thin clay films in pores; 20 percent coarse fragments; medium acid; clear, smooth boundary.

Bx2—27 to 33 inches, yellowish-brown (10YR 5/4) gravelly silt loam; common, coarse, distinct, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/8) mottles; weak, very coarse, prismatic structure parting to weak, thick, platy; firm and brittle, slightly sticky and slightly plastic; few thin clay films in pores; 20 percent coarse fragments; strongly acid; clear, smooth boundary.

IIC—33 to 54 inches, brown (10YR 5/3) very gravelly sandy loam; few, fine, distinct, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/6) mottles; massive; firm, slightly sticky and nonplastic; 55 percent coarse fragments; strongly acid.

The solum ranges from 30 to 40 inches in thickness. Depth to the fragipan ranges from 18 to 26 inches. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark yellowish brown (10YR 4/4). It contains from 15 to 30 percent coarse fragments. The B2 horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/6) and from silt loam to gravelly loam. It is medium acid to very strongly acid. The Bx horizon ranges from brown (10YR 5/3) to yellowish brown (10YR 5/6) and from gravelly loam to gravelly silt loam. It is very strongly acid to medium acid. The C horizon contains from 30 to 65 percent coarse fragments. It is slightly acid to strongly acid.

Braceville soils are associated on the landscape with the well-drained to somewhat excessively drained Chenango soils, the somewhat excessively drained Wyoming soils, the somewhat poorly drained Red Hook soils, and the very poorly drained Halsey soils. They are not so well drained as the Chenango and Wyoming soils, and they are better drained than the Red Hook and Halsey soils.

Braceville gravelly loam, 0 to 3 percent slopes (BrA).—This nearly level soil has the profile described as representative of the series. It is in narrow bands 3 to 10 acres in size and in rounded areas 10 to 25 acres in size.

Included with this soil in mapping are small areas of gently sloping Braceville soils and small areas of soils that have a surface layer of silt loam. Also included are a few areas of Wyoming, Haven, Scio, Red Hook, and Chenango soils.

This soil is well suited to most crops commonly grown in the county. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to about 22 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a seasonal high water table, moderately slow permeability, and coarse fragments. Capability unit IIw–2.

Braceville gravelly loam, 3 to 8 percent slopes (BrB).—This gently sloping soil has a profile similar to the one described as representative of the series, but the fragipan is closer to the surface. It is in elongated and rounded areas 5 to 30 acres in size.

Included with this soil in mapping are a few areas of nearly level Braceville soils and a few areas of Chenango, Red Hook, and Haven soils. Also included are small areas where the soil has a surface layer of silt loam that is slightly thicker than that in the representative profile.

This soil is well suited to most crops commonly grown in the county. The depth to which roots and moisture can penetrate is limited to about 20 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Surface runoff is medium. Conservation practices are needed to control erosion. Management concerns are mainly a seasonal high water table, moderately slow permeability, and coarse fragments. Capability unit IIe–2.

Cambridge Series

The Cambridge series consists of deep, moderately well drained, nearly level to moderately steep soils. These soils formed in material, weathered from glacial till, that contains sandstone, siltstone, and shale. They are on upland knobs, benches, side slopes of valleys, and crests of slopes.

In a representative profile the surface layer is very dark brown silt loam 2 inches thick. It has a 3-inch cover of leaves and other organic material. The upper part of the subsoil, to a depth of 24 inches, is dark yellowish-brown and yellowish-brown, friable and firm

Figure 5.—**Field used for cultivated crops. The soil is nearly level and gently sloping Cambridge silt loam.**

silt loam that has light-gray mottles below a depth of 19 inches. The lower part of the subsoil extends to a depth of 50 inches. It is yellowish-brown and dark yellowish-brown, firm and brittle gravelly silt loam that has light brownish-gray, yellowish-brown, and pale-brown mottles.

Cambridge soils have very slow permeability and a moderate available water capacity. A seasonal high water table is within 1½ to 3 feet of the surface in wet periods. Most areas of these soils are cleared and are used for crops (fig. 5), hay, or pasture. A few areas are in woodland or are idle. Management concerns are mainly the very slow permeability and the seasonal high water table.

Representative profile of Cambridge silt loam, 3 to 8 percent slopes, in a wooded area 1 mile west of Buell's Corner and 900 feet south of Route 20106:

O1—3 to 2 inches, loose leaf litter.

O2—2 inches to 0, black (N 2/0) mat of roots and decomposed organic materials.

A1—0 to 2 inches, very dark brown (10YR 2/2) silt loam; weak, medium, granular structure; very friable, slightly sticky and slightly plastic; 10 percent coarse fragments; very strongly acid; clear, smooth boundary.

B1—2 to 7 inches, dark yellowish-brown (10YR 4/4) silt loam; weak, fine, subangular blocky structure; friable, nonsticky and nonplastic; 10 percent coarse fragments; strongly acid; gradual, wavy boundary.

B21—7 to 19 inches, yellowish-brown (10YR 5/4) silt loam; weak, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; 10 percent coarse fragments; very strongly acid; clear, wavy boundary.

B22—19 to 24 inches, yellowish-brown (10YR 5/4) silt loam; many, medium, distinct, light-gray (10YR 7/2) mottles; weak, coarse, subangular blocky structure; firm, sticky and plastic; 10 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

Bx1—24 to 34 inches, yellowish-brown (10YR 5/4) gravelly silt loam; light brownish-gray (10YR 6/2) prism faces; many, coarse, prominent, light brownish-gray (10YR 6/2) mottles and few, medium, distinct, yellowish-brown (10YR 5/8) mottles; weak, very coarse, prismatic structure parting to weak, coarse, subangular blocky; firm and brittle, sticky and plastic; thick continuous clay films on prism faces; 20 percent coarse fragments; strongly acid; gradual, wavy boundary.

Bx2—34 to 40 inches, dark yellowish-brown (10YR 4/4) gravelly silt loam; light brownish-gray (10YR 6/2) prism faces; many, coarse, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/8) mottles; weak, very coarse, prismatic structure parting to moderate, medium, subangular blocky; firm and brittle, sticky and plastic; thick continuous clay films on prism faces; 20 percent coarse fragments; medium acid; diffuse, wavy boundary.

Bx3—40 to 50 inches, dark yellowish-brown (10YR 4/4) gravelly silt loam; light brownish-gray (10YR 6/2) prism faces; common, coarse, distinct, pale-brown (10YR 6/3) mottles and common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, very coarse, prismatic structure parting to moderate, medium, subangular blocky; firm and brittle, sticky and plastic; thick clay films on prism faces; 25 percent coarse fragments; slightly acid.

The solum ranges from 42 to 56 inches in thickness. The A1 horizon ranges from very dark brown (10YR 2/2) to

very dark grayish brown (10YR 3/2) and is very strongly acid or strongly acid. Some profiles have an Ap horizon, which ranges from dark brown (10YR 4/3) to dark grayish brown (10YR 4/2), and an A2 horizon, which ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2).

The B1 horizon ranges from yellowish brown (10YR 5/6) to dark yellowish brown (10YR 4/4) or strong brown (7.5YR 5/6). It is strongly acid to extremely acid. The B2 horizon ranges from dark yellowish brown (10YR 4/4) to strong brown (7.5YR 5/6). The Bx horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) and from loam to gravelly silt loam. Some profiles have a C horizon; it ranges from loam to gravelly silt loam.

Cambridge soils are associated on the landscape with the somewhat poorly drained Venango soils, the poorly drained Frenchtown soils, and the moderately well drained Hanover soils. They are better drained than the Venango and Frenchtown soils and are less acid below a depth of 24 inches than the Hanover soils.

Cambridge silt loam, 0 to 3 percent slopes (CaA).—This nearly level soil is in round or rectangular areas 2 to 50 acres in size. Included with it in mapping are a few areas of gently sloping Cambridge soils and a few areas of Valois, Venango, Frenchtown, and Hanover soils. Also included are some areas of soils that have a surface layer of gravelly silt loam, a few areas of stony soils, and a few areas where the soil lacks a fragipan and is 20 to 30 inches deep to bedrock.

This soil is well suited to most crops commonly grown in the county. Surface runoff is medium. The depth to which roots and moisture can penetrate is limited to about 28 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a seasonal high water table and very slow permeability. Capability unit IIw–3.

Cambridge silt loam, 3 to 8 percent slopes (CaB).—This gently sloping soil has the profile described as representative of the series. It is in broad, elongated and circular areas 50 to 200 acres in size.

Included with this soil in mapping are a few areas of Venango, Frenchtown, Valois, Scio, and Braceville soils and some areas of Cambridge soils that have a surface layer of gravelly silt loam. Also included are a few areas of soils that lack a fragipan, a few areas of soils that have bedrock at a depth of 20 to 30 inches, and a few areas of soils that have a more clayey subsoil.

This soil is well suited to most crops commonly grown in the county. The depth to which roots and moisture can penetrate is limited to about 24 inches by a firm and brittle layer. Surface runoff is medium. Conservation practices are needed to control erosion. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a seasonal high water table and very slow permeability. Capability unit IIe–2.

Cambridge silt loam, 8 to 15 percent slopes (CaC).—This sloping soil is in narrow, elongated areas 10 to 50 acres in size and in broad areas 150 to 300 acres in size. Included with it in mapping are a few areas of Venango, Frenchtown, Valois, and Braceville soils. Also included are some areas of Cambridge soils that have a gravelly silt loam or stony surface layer, a few areas of soils that lack a fragipan, a few areas of soils that have bedrock at a depth of 20 to 30 inches, and a few areas of soils that have a more clayey subsoil.

This soil is suited to most crops commonly grown in the county and to woodland and wildlife habitat. The depth to which roots and moisture can penetrate is limited to about 22 inches by a firm and brittle layer. Surface runoff is medium. Conservation practices are needed to control erosion and reduce runoff. Drainage of the wetter areas increases the suitability of this soil for crops. Management concerns are mainly slope, a seasonal high water table, and very slow permeability. Capability unit IIIe–2.

Cambridge silt loam, 15 to 25 percent slopes (CaD).—This moderately steep soil is in long narrow bands 10 to 50 acres in size and in some rounded areas 3 to 6 acres in size. Included with it in mapping are a few areas of Valois and Venango soils, a few areas of sloping Cambridge soils, and a few areas of Cambridge soils that have a surface layer of gravelly silt loam. Also included are a few areas of soils that have bedrock at a depth of 20 to 30 inches, a few areas of stony soils, and a few areas of soils that lack a fragipan.

This soil is poorly suited to most crops commonly grown in the county, but it is suited to crops that require limited tillage and to hay, pasture, woodland, and wildlife habitat. Surface runoff is medium. Conservation practices are needed to reduce runoff and control erosion. Management concerns are mainly slope, a seasonal high water table, and very slow permeability. Capability unit IVe–1.

Cambridge very stony silt loam, 0 to 8 percent slopes (CbB).—This nearly level to gently sloping soil has a profile similar to the one described as representative of the series, but the surface has as much as a 3 percent cover of stones. It is in broad, rounded areas 50 to 400 acres in size.

Included with this soil in mapping are a few areas of sloping Cambridge soils and a few areas of Venango and Frenchtown soils. Also included are a few areas of soils where the stone cover is more than 3 percent.

This soil is suited to pasture, woodland, and wildlife habitat. It is not suited to crops, because it is so stony. Surface runoff is medium. Management concerns are mainly stoniness, a seasonal high water table, and very slow permeability. Capability unit VIs–1.

Cambridge very stony silt loam, 8 to 25 percent slopes (CbD).—This sloping to moderately steep soil has a profile similar to the one described as representative of the series, but the surface has as much as 3 percent cover of stones, and mottles occur deeper in the profile. It is in broad areas 20 to 400 acres in size.

Included with this soil in mapping are a few areas of gently sloping Cambridge soils, a few areas of Valois and Venango soils, and a few areas of soils where the stone cover is more than 3 percent.

This soil is suited to pasture, woodland, and wildlife habitat. It is not suited to crops, because it is so stony. Surface runoff is medium. Management concerns are mainly stoniness, a seasonal high water table, slope, and very slow permeability. Capability unit VIs–1.

Cambridge-Venango silt loams, 3 to 8 percent slopes (CcB).—These undulating soils are so intermingled that it was not practical to separate them at the scale used in mapping. The Cambridge soil makes up about 50 to 70 percent of this mapping unit, and the Venango soil makes up about 30 to 40 percent. The Cambridge soil is on the higher lying mounded areas, and the Venango soil is on the lower lying areas.

Included with these soils in mapping are many small areas of Frenchtown and Valois soils, a few areas of nearly level Cambridge and Venango soils, a few areas of Cambridge and Venango soils that have a surface layer of gravelly silt loam, and some areas of soils that have a surface layer of loam or stony loam.

The soils in this mapping unit are suited to most crops commonly grown in the county and to woodland and wildlife habitat. Artificial drainage increases the suitability for crops. Surface runoff is medium. Practices to control erosion are needed. Management concerns are mainly very slow permeability, a seasonal high water table, and complex slopes. Capability unit IIIw–2.

Canadice Series

The Canadice series consists of deep, poorly drained, nearly level soils that formed in material weathered from glacial lake sediments. These soils are on upland flats and in depressions.

In a representative profile the surface layer is very dark grayish-brown silt loam 8 inches thick. The subsoil, to a depth of 39 inches, is grayish-brown and gray, firm silty clay loam that has yellowish-brown and strong-brown mottles. The substratum extends to a depth of 50 inches. It is gray silty clay loam that has strong-brown mottles.

Canadice soils have very slow permeability and a high available water capacity. A high water table is at or near the surface much of the year. Most areas of these soils are in woodland, but some small areas are in pasture or are idle. Management concerns are mainly the high water table and very slow permeability.

Representative profile of Canadice silt loam in a pasture 2 miles west by northwest of Conneaut Lake and 650 feet south of township road T–402:

Ap—0 to 8 inches, very dark grayish-brown (2.5Y 3/2) silt loam; weak, medium and coarse, subangular blocky structure; friable, slightly sticky and slightly plastic; medium acid; abrupt, smooth boundary.

B21tg—8 to 14 inches, grayish-brown (10YR 5/2) silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium and coarse, subangular blocky structure; firm, slightly sticky and slightly plastic; thick continuous clay films on ped faces; slightly acid; gradual, smooth boundary.

B22tg—14 to 20 inches, gray (N 5/0) silty clay loam; many, coarse, distinct, strong-brown (7.5YR 5/8) mottles; strong, coarse, prismatic structure parting to strong, coarse, subangular blocky; firm, sticky and plastic; thick continuous clay films on prism and ped faces; slightly acid; gradual, smooth boundary.

B23tg—20 to 30 inches, gray (N 5/0) silty clay loam; many, coarse, prominent, strong-brown (7.5YR 5/8) mottles; strong, coarse, prismatic structure parting to strong, coarse, subangular blocky; firm, sticky and plastic; thick continuous clay films on prism and ped faces; slightly acid; clear, smooth boundary.

B24tg—30 to 39 inches, gray (N 5/0) silty clay loam; many, coarse, distinct, strong-brown (7.5YR 5/8) mottles; moderate, coarse, prismatic structure parting to weak, medium, subangular blocky; firm, slightly sticky and slightly plastic; thick continuous clay films on prism and ped faces; neutral; clear, smooth boundary.

C—39 to 50 inches, gray (N 5/0) silty clay loam; common, medium, distinct, strong-brown (7.5YR 5/8) mottles; massive; firm, slightly sticky and plastic; mildly alkaline; calcareous.

The solum ranges from 38 to 56 inches in thickness. The Ap horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (2.5Y 3/2 or 10YR 3/2). It is strongly acid to slightly acid.

In the B horizon, ped faces range from gray (N 5/0) to grayish brown (10YR 5/2), matrix colors range from dark grayish brown (10YR 4/2) to gray (10YR 5/1), and mottles range from strong brown (7.5YR 5/6) to yellowish brown (10YR 5/8). The B horizon ranges from silty clay loam to silty clay. It is medium acid to neutral in the upper part and neutral to moderately alkaline in the lower part. The C horizon ranges from silty clay loam to silty clay. It is mildly alkaline to strongly alkaline.

Canadice soils are associated on the landscape with the somewhat poorly drained Caneadea soils, the somewhat poorly drained Red Hook soils, the very poorly drained Halsey soils, and the moderately well drained Braceville soils. They are wetter than the Caneadea and Red Hook soils and have more clay in the B and C horizons than the Red Hook, Halsey, and Braceville soils.

Canadice silt loam (0 to 3 percent slopes) (Cd).—This nearly level soil is in circular or irregularly shaped areas of 3 to 60 acres or more. Included with it in mapping are a few areas of nearly level Caneadea, Red Hook, Halsey, and Holly soils. Also included are a few areas of Canadice soils that have a surface layer of silty clay loam.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to crops that tolerate wetness and to woodland and wildlife habitat. Surface runoff is ponded to very slow. A high water table is at or near the surface most of the year. Artificial drainage is needed to remove surface water and to lower the high water table. Management concerns are mainly the high water table and very slow permeability. Capability unit IVw–1.

Caneadea Series

The Caneadea series consists of deep, somewhat poorly drained, nearly level and gently sloping soils that formed in material weathered from glacial lake deposits. These soils are on old lake beds in valleys.

In a representative profile the surface layer is very dark grayish-brown silt loam 8 inches thick. The subsurface layer, to a depth of 11 inches, is olive-brown silt loam that has yellowish-brown mottles. The subsoil, to a depth of 41 inches, is brown, grayish-brown, and dark grayish-brown, firm to very firm silty clay loam that has reddish-yellow, dark grayish-brown, and gray mottles. The substratum extends to a depth of 70 inches. It is grayish-brown silty clay loam that has pale-brown mottles.

Caneadea soils have very slow permeability and a moderate available water capacity. A seasonal high water table is within ½ to 1½ feet of the surface in wet periods. About half the acreage of these soils is in crops, and the rest is in pasture and hay. A few areas are in woodland or are idle. Management concerns are mainly the seasonal high water table and the very slow permeability.

Representative profile of Caneadea silt loam, 3 to 8 percent slopes, in a cultivated field 1 mile southwest of Conneautville and northwest of the intersection of Route 20038 and township road T–725 (Pennsylvania Department of Transportation test samples BP–47221 and BP–47222 were taken from this profile):

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, granular structure; friable, slightly sticky and slightly plastic; medium acid; abrupt, smooth boundary.

B&A—8 to 11 inches, olive-brown (2.5Y 4/4) silt loam; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; dark grayish-brown (2.5Y 4/2) coatings on ped faces; weak, fine, subangular blocky structure; friable, sticky and plastic; strongly acid; clear, smooth boundary.

B21t—11 to 22 inches, brown (10YR 5/3) silty clay loam; many, medium, distinct, reddish-yellow (7.5YR 6/8) mottles; strong, medium and coarse, blocky structure; very firm, very sticky and very plastic; many thick clay films on ped faces; strongly acid; gradual, smooth boundary.

B22gt—22 to 29 inches, grayish-brown (10YR 5/2) silty clay loam; many, coarse, distinct, dark grayish-brown (2.5Y 4/2) mottles and many, medium, distinct, gray (10YR 6/1) mottles; moderate, coarse, blocky structure parting to moderate, medium, subangular blocky; firm, very sticky and plastic; many thick clay films on ped faces; slightly acid; gradual, smooth boundary.

B23gt—29 to 41 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; many, medium, distinct, gray (10YR 6/1) mottles; moderate, coarse, blocky structure parting to moderate, medium, subangular blocky; firm, very sticky and plastic; many thick clay films on ped faces; slightly acid; gradual, smooth boundary.

C—41 to 70 inches, grayish-brown (10YR 5/2) silty clay loam; many, medium, distinct, pale-brown (10YR 6/3) mottles; moderate, thick, platy structure; very firm, sticky and plastic; many, thick, continuous clay films on ped faces; mildly alkaline; calcareous.

The solum ranges from 30 to 45 inches in thickness. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to grayish brown (10YR 5/2). It is strongly acid to slightly acid. The B2 horizon ranges from dark grayish brown (2.5Y 4/2) to brown (10YR 5/3) and from silty clay loam to silty clay. It has medium or coarse, blocky or prismatic structure. It is strongly acid or medium acid in the upper part and slightly acid or neutral in the lower part. The C horizon ranges from silty clay loam to silty clay. It is mildly alkaline to strongly alkaline.

Caneadea soils are associated on the landscape with the poorly drained Canadice soils, the somewhat poorly drained Venango and Platea soils on nearby uplands, and the poorly drained to very poorly drained Holly soils on nearby flood plains. They are not so wet as the Canadice soils, they have more clay in the B horizon than the Venango and Platea soils, and they have less sand in the C horizon than the Holly soils.

Caneadea silt loam, 0 to 3 percent slopes (CeA).—This nearly level soil has a profile similar to the one described as representative of the series, but mottles are about 3 inches closer to the surface. It is in elongated and rounded areas 3 to 30 acres or more in size.

Included with this soil in mapping are a few areas of Canadice and Red Hook soils and a few areas of gently sloping Caneadea soils.

This soil is suited to most crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. Surface runoff is medium. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a seasonal high water table and very slow permeability. Capability unit IIIw–2.

Caneadea silt loam, 3 to 8 percent slopes (CeB).—This gently sloping soil has the profile described as representative of the series. It is in broad, rounded areas of 50 to 175 acres and in elongated and irregularly shaped areas of 3 to 10 acres.

Included with this soil in mapping are a few areas of sloping Caneadea soils and a few areas of soils that have lost about 50 percent of the original surface layer through erosion. Also included are a few areas of Venango, Braceville, Red Hook, Frenchtown, and Cambridge soils.

This soil is suited to most crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. Artificial drainage increases the suitability of this soil for crops. Surface runoff is medium. Conservation practices are needed to control erosion. Management concerns are mainly a seasonal high water table and very slow permeability. Capability unit IIIw–2.

Carlisle Series

The Carlisle series consists of deep, very poorly drained, nearly level soils that formed in material weathered from woody and herbaceous organic deposits. These soils are in valleys and are subject to flooding and ponding.

In a representative profile the surface layer is black, well-decomposed muck 6 inches thick. It is underlain by dark reddish-brown muck that extends to a depth of about 78 inches. This layer has weak, subangular blocky structure in the upper part and is massive in the lower part. Below this is massive, weak-red muck that extends to a depth of 162 inches. Massive, weak-red silty clay is below a depth of 162 inches.

Carlisle soils have moderately rapid permeability and a high available water capacity. A high water table is at the surface throughout the year. Most areas are under water most of the year. Nearly all areas of these soils are in black alder, cattails, and sedges (fig. 6) or in woodland. Management concerns are mainly the high water table, the hazard of flooding, and the large amount of organic material.

Representative profile of Carlisle muck in an undisturbed area in Randolph Township, 0.25 mile east of Randolph High School in Guys Mills:

Oa1—0 to 6 inches, black (10YR 2/1) sapric material (muck), very dark brown (10YR 2/2) rubbed; weak, medium, granular structure; very friable; 5 percent woody and herbaceous fibers, rubbed; 5 percent mineral content; strongly acid; clear, smooth boundary.

Oa2—6 to 10 inches, dark reddish-brown (5YR 2/2) sapric material (muck), dark reddish brown (5YR 2/2) rubbed; weak, medium, subangular blocky structure; very friable; 20 percent fibers, unrubbed, less than 5 percent woody and herbaceous fibers, rubbed; less than 5 percent mineral content; strongly acid; clear, smooth boundary.

Oa3—10 to 22 inches, dark reddish-brown (5YR 2/2) sapric material (muck), dark reddish brown on broken face and rubbed; weak, medium, subangular blocky structure; very friable; 5 percent woody and herbaceous fibers, rubbed; less than 5 percent mineral content; strongly acid; clear, smooth boundary.

Oa4—22 to 30 inches, dark reddish-brown (5YR 2/2) sapric material (muck), very dusky red (2.5YR 2/2) rubbed; massive; very friable; 5 percent herbaceous fibers, rubbed; less than 5 percent mineral content; strongly acid; clear, smooth boundary.

Oe1—30 to 37 inches, dark reddish-brown (5YR 3/3) hemic material (muck), dark reddish brown (5YR 3/3) rubbed; massive; very friable; 25 percent herbaceous fibers, rubbed; less than 5 percent mineral content; strongly acid; clear, smooth boundary.

Oa5—37 to 60 inches, dark reddish-brown (5YR 3/3) sapric

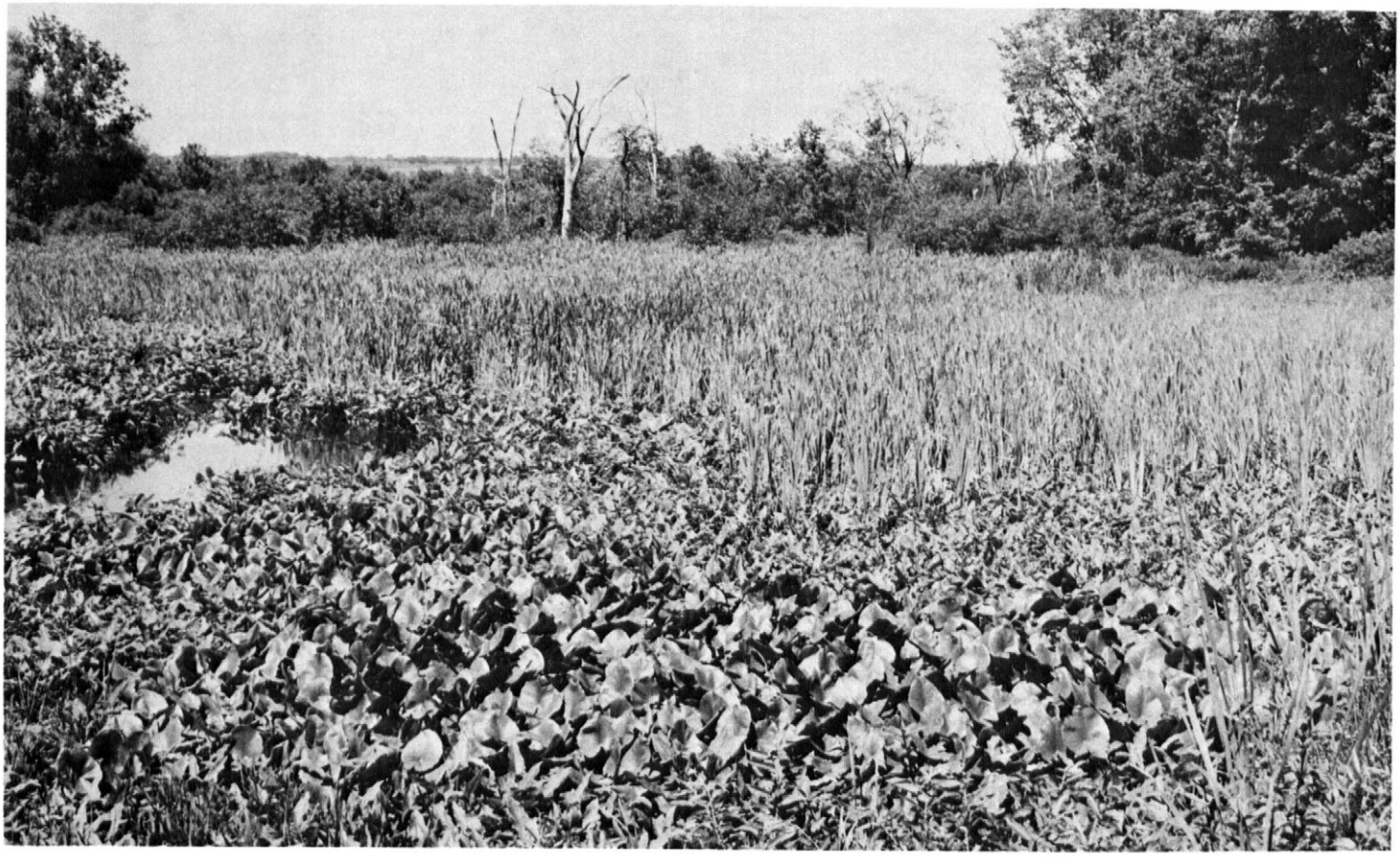

Figure 6.—**Typical vegetation on Carlisle soils, which have a high water table.**

material (muck), dark reddish brown (5YR 2/2) rubbed; massive; very friable; 5 percent herbaceous fibers, rubbed; less than 5 percent mineral content; medium acid; clear, smooth boundary.

Oa6—60 to 78 inches, dark reddish-brown (5YR 3/3) sapric material (muck), dark gray (10YR 4/1) rubbed and pressed; massive; firm; 5 percent herbaceous fibers, rubbed; less than 5 percent mineral content; neutral; clear, smooth boundary.

Oa7—78 to 162 inches, weak-red (2.5YR 4/2) sapric material (muck), weak red rubbed and pressed; massive; firm; 5 percent herbaceous fibers, unrubbed; 20 percent mineral content; neutral; abrupt, smooth boundary.

IIC—162 to 170 inches, weak-red (2.5YR 4/2) silty clay; massive; firm; less than 5 percent coarse fragments; mildly alkaline; calcareous.

The organic materials range from 55 to 175 inches in thickness. The Oa1 layer ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and from strongly acid to slightly acid. The Oa2, Oa3, Oa4, and Oe1 layers range from very dark brown (10YR 2/2) to dark reddish brown (5YR 3/3). The Oa5, Oa6, and Oa7 layers range from dark reddish brown (5YR 2/2) to dark yellowish brown (10YR 4/4). Some profiles do not have some of these layers. The IIC horizon ranges from loamy sand to silty clay.

Carlisle soils are associated on the landscape with the poorly drained and very poorly drained Holly soils, the somewhat poorly drained Red Hook soils, the very poorly drained Halsey soils, and the moderately well drained Braceville soils. Carlisle soils are organic soils, but all the associated soils are mineral soils.

Carlisle muck (0 to 3 percent slopes) {CM}.—This nearly level soil is in long, broad areas of 600 to 1,000 acres or more and in oval-shaped areas of 10 to 200 acres. The composition of this mapping unit is more variable than that of most other mapping units in the county, but mapping has been controlled well enough for the anticipated uses of the soils.

Included with this soil in mapping are a few areas of soils that have mineral soil less than 51 inches below the surface and some areas of peat. Also included are a few areas of Holly, Red Hook, and Halsey soils.

These soils are better suited to use as wildlife habitat and natural areas than to other uses because they have a high water table and surface runoff is very slow to ponded. Artificial drainage is impractical because of lack of adequate outlets. Management concerns are mainly the high water table and the hazard of flooding. Capability unit VIIw–1.

Chenango Series

The Chenango series consists of deep, well-drained to somewhat excessively drained, nearly level to sloping soils. These soils formed in material, weathered from glacial outwash, that contains sandstone, shale, quartzite, granite, granitic gneiss, and some limestone rocks. They are on outwash plains and terraces in major stream valleys.

In a representative profile the surface layer is very dark grayish-brown gravelly silt loam 9 inches thick.

The subsoil, to a depth of 30 inches, is yellowish-brown, friable gravelly loam. The substratum extends to a depth of 72 inches. It is yellowish-brown and dark yellowish-brown stratified sand and gravel and very gravelly sandy loam.

Chenango soils have moderate to moderately rapid permeability and a low available water capacity. Most areas of these soils are cultivated, but a few areas are in pasture and woodland. Small areas are used as a source of sand and gravel. Management concerns are mainly droughtiness and the moderately rapid permeability. Ground water pollution is a hazard where these soils are used for sewage effluent disposal.

Representative profile of Chenango gravelly silt loam, 0 to 3 percent slopes, in a cultivated field 0.25 mile north of Meadville and 400 feet west of French Creek:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam; weak, fine, granular structure; very friable, nonsticky and nonplastic; 20 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

B21—9 to 17 inches, yellowish-brown (10YR 5/6) gravelly loam; weak, fine, granular structure; friable, nonsticky and nonplastic; 25 percent coarse fragments; strongly acid; gradual, wavy boundary.

B22—17 to 30 inches, yellowish-brown (10YR 5/4) gravelly loam; weak, fine, subangular blocky structure; friable, nonsticky and nonplastic; 25 percent coarse fragments; strongly acid; abrupt, wavy boundary.

IIC—30 to 40 inches, yellowish-brown (10YR 5/4) stratified sand and gravel; single grained; loose; 70 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

IIIC—40 to 54 inches, dark yellowish-brown (10YR 4/4) very gravelly sandy loam; massive; very friable, nonplastic and nonsticky; 60 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

IVC—54 to 72 inches, dark yellowish-brown (10YR 3/4) stratified sand and gravel; single grained; very friable, nonsticky and nonplastic; strongly acid; abrupt, smooth boundary.

The solum ranges from 24 to 36 inches in thickness. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 4/3). The B horizon ranges from dark brown (7.5YR 4/4) to yellowish brown (10YR 5/6) and from fine sandy loam to silt loam. It is very strongly acid or strongly acid. The content of coarse fragments ranges from 20 to 35 percent in the B horizon and from 35 to 70 percent in the IIC horizon.

Chenango soils are associated on the landscape with the moderately well drained Braceville soils, the somewhat poorly drained Red Hook soils, the very poorly drained Halsey soils, and the somewhat excessively drained Wyoming soils. They are better drained than the Braceville, Red Hook, and Halsey soils, and they have more silt and very fine sand than the Wyoming soils.

Chenango gravelly silt loam, 0 to 3 percent slopes (CoA).—This nearly level soil has the profile described as representative of the series. It is in elongated areas of 50 to 75 acres and in broad, irregularly shaped areas of 30 to 100 acres.

Included with this soil in mapping are a few areas of Wyoming, Braceville, Red Hook, Valois, and Haven soils. Also included are small areas of gently sloping Chenango soils and a few soils that have a medium acid to neutral subsoil and substratum.

This soil is well suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is slow. The soil is droughty during dry periods, and the available water capacity is low. Irrigation is needed, especially during dry spells, for adequate crop response. Management concerns are mainly coarse fragments, moderately rapid permeability, and a hazard of ground water pollution. Capability unit IIs–1.

Chenango gravelly silt loam, 3 to 8 percent slopes (CoB).—This gently sloping soil is in elongated areas 5 to 15 acres in size and in rounded areas 2 to 10 acres in size. Included with it in mapping are a few areas of nearly level and gently sloping Wyoming, Braceville, Red Hook, Valois, and Haven soils.

This soil is well suited to most crops commonly grown in the county and to hay, pasture, and woodland. Surface runoff is medium. Conservation practices are needed to control erosion and prevent stream pollution. Irrigation is needed for adequate crop response, especially during dry spells. Management concerns are mainly slope, moderately rapid permeability, and a hazard of ground water pollution. Capability unit IIs–1.

Chenango gravelly silt loam, 8 to 15 percent slopes (CoC).—This sloping soil is in long narrow areas 10 to 25 acres in size and in rounded areas 1 to 3 acres in size. Included with it in mapping are a few areas of Wyoming and Haven soils and a few areas of moderately steep and gently sloping Chenango soils.

This soil is suited to most crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. The soil is droughty during dry periods, and irrigation is needed. Surface runoff is rapid. Conservation practices are needed to control erosion. Management concerns are mainly low available water capacity, slope, moderately rapid permeability, and a hazard of ground water pollution. Capability unit IIIe–3.

Frenchtown Series

The Frenchtown series consists of deep, poorly drained, nearly level and gently sloping soils. These soils formed in material, weathered from glacial till, that contains sandstone, shale, and some crystalline rocks. They are on low uplands.

In a representative profile the surface layer is dark grayish-brown silt loam 8 inches thick. The upper part of the subsoil, to a depth of 20 inches, is light brownish-gray and dark grayish-brown, friable silt loam that has yellowish-red and light brownish-gray mottles. The lower part of the subsoil, to a depth of 56 inches, is dark yellowish-brown, firm and brittle gravelly silt loam that has gray and yellowish-brown mottles. The substratum extends to a depth of 74 inches. It is dark yellowish-brown gravelly loam that has pale-brown mottles.

Frenchtown soils have slow permeability and a moderate available water capacity. A high water table is at or near the surface much of the year. Most areas of these soils are in woodland. Some areas are in crops, hay, or pasture, and a few are used for growing Christmas trees or are idle. Management concerns are mainly the high water table and the slow permeability.

Representative profile of Frenchtown silt loam, 3 to 8 percent slopes, in an idle field 0.25 mile north of the Crawford County Fair Grounds:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; friable, non-

sticky and nonplastic; 5 percent coarse fragments; strongly acid; abrupt, smooth boundary.

B1g—8 to 14 inches, light brownish-gray (10YR 6/2) silt loam; common, medium, distinct, yellowish-red (5YR 5/6) mottles; weak, thin, platy structure; friable, slightly sticky and slightly plastic; 10 percent coarse fragments; strongly acid; clear, wavy boundary.

B2gt—14 to 20 inches, dark grayish-brown (10YR 4/2) silt loam; many, coarse, prominent, light brownish-gray (10YR 6/2) and yellowish-red (5YR 5/8) mottles; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; common thin clay films on ped faces; 10 percent coarse fragments; strongly acid; clear, wavy boundary.

Bx—20 to 56 inches, dark yellowish-brown (10YR 4/4) gravelly silt loam; gray (10YR 6/1) prism faces; common, medium, distinct, gray (10YR 6/1) and yellowish-brown (10YR 5/6) mottles; moderate, very coarse, prismatic structure parting to weak, medium, subangular blocky; firm and brittle, slightly sticky and slightly plastic; common black coatings on blocky ped faces; thick continuous clay films on prisms and blocky ped faces; 20 percent coarse fragments; strongly acid; clear, wavy boundary.

C—56 to 74 inches, dark yellowish-brown (10YR 4/4) gravelly loam; few, fine, distinct, pale-brown (10YR 6/3) mottles; massive; friable, nonsticky and nonplastic; 30 percent coarse fragments; slightly acid.

The solum ranges from 40 to 80 inches in thickness. The Ap horizon ranges from dark gray (10YR 4/1) to grayish brown (2.5Y 5/2). Some profiles have an A1 horizon, which ranges from dark grayish brown (10YR 4/2) to black (N 2/0) and is 2 to 5 inches thick.

The B2gt horizon ranges from dark grayish brown (10YR 4/2) to gray (10YR 6/1) or light brownish gray (10YR 6/2) and from silt loam to silty clay loam. It is very strongly acid to medium acid. Depth to the Bx horizon ranges from 16 to 24 inches. The Bx horizon ranges from gray (10YR 5/1) to dark brown (7.5YR 4/4) and from silt loam to clay loam. It is very strongly acid to medium acid.

The C horizon ranges from dark brown (10YR 3/3) to yellowish brown (10YR 5/6) and from loam to silt loam.

Frenchtown soils are associated on the landscape with the very poorly drained Alden soils, the somewhat poorly drained Venango soils, and the moderately well drained Cambridge soils. They are better drained than the Alden soils and are wetter than the Venango and Cambridge soils.

Frenchtown silt loam, 0 to 3 percent slopes (FhA).—This nearly level soil is in broad, elongated areas 10 to 100 acres or more in size. Included with it in mapping are a few areas of gently sloping Frenchtown and Venango soils, a few areas of Alden soils, and some areas of soils that have bedrock at a depth of 20 to 30 inches.

This soil is suited to most crops commonly grown in the county. It is better suited to crops that tolerate wetness and to hay, pasture, woodland, and wildlife habitat than to other uses. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to 22 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a high water table and slow permeability. Capability unit IIIw–3.

Frenchtown silt loam, 3 to 8 percent slopes (FhB).—This gently sloping soil has the profile described as representative of the series. It is in long curved areas 10 to 100 acres or more in size.

Included with this soil in mapping are a few areas of nearly level Frenchtown soils and a few areas of Alden, Cambridge, and Venango soils. Also included are some areas of soil that have bedrock at a depth of 20 to 30 inches.

This soil is suited to most crops commonly grown in the county. It is better suited to crops that tolerate wetness and to hay, pasture, woodland, and wildlife habitat than to other uses. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to about 20 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Conservation practices to control erosion are needed on long slopes. Management concerns are mainly a high water table and slow permeability. Capability unit IIIw–3.

Frenchtown very stony silt loam, 0 to 8 percent slopes (FvB).—This nearly level to gently sloping soil has a profile similar to the one described as representative of the series, but the surface of this soil has as much as a 5 percent cover of stones 10 to 36 inches in diameter. It is in rectangular areas of 50 to 300 acres and in rounded areas of 5 to 25 acres.

Included with this soil in mapping are a few areas of Alden, Venango, and Cambridge soils and a few areas of sloping Frenchtown soils.

This soil is suited to pasture, woodland, and wildlife habitat. It is not suited to crops, because it is so stony. Surface runoff is slow. Management concerns are mainly stoniness, a high water table, and slow permeability. Capability unit VIIs–1.

Halsey Series

The Halsey series consists of deep, very poorly drained, nearly level soils that formed in material weathered from glacial outwash and local alluvium. These soils are in depressions on outwash plains and terraces in major stream valleys.

In a representative profile the surface layer is very dark gray silt loam 8 inches thick. The subsoil, to a depth of 30 inches, is gray, friable sandy loam that has yellowish-brown mottles. The substratum extends to a depth of 60 inches. It is gray sandy loam and gravelly loamy sand that has yellowish-brown, dark yellowish-brown, and strong-brown mottles.

Halsey soils have moderately slow permeability and a high available water capacity. A high water table is at the surface most of the year, and depressions are ponded much of the year. Nearly all areas of these soils are in pasture and woodland. Some small areas are used for wildlife habitat or are idle. Management concerns are mainly the high water table and the moderately slow permeability.

Representative profile of Halsey silt loam in a pasture 0.5 mile south of Guys Mills and 0.75 mile north of State Highway 27:

Ap—0 to 8 inches, very dark gray (N 3/0) silt loam; weak, very fine, subangular blocky structure; friable, slightly sticky and slightly plastic; less than 5 percent coarse fragments; slightly acid; abrupt, smooth boundary.

B2g—8 to 22 inches, gray (10YR 6/1) sandy loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, thick, platy structure; friable, slightly sticky and slightly plastic; slightly acid; clear, wavy boundary.

B3g—22 to 30 inches, gray (10YR 6/1) sandy loam; common, medium, distinct, yellowish-brown (10YR

5/6) mottles; weak, thin and medium, platy structures; friable, slightly sticky and slightly plastic; less than 5 percent coarse fragments; neutral; clear, smooth boundary.

C1—30 to 38 inches, gray (10YR 5/1) sandy loam; common, medium, distinct, yellowish-brown (10YR 5/6), strong-brown (7.5YR 5/6), and dark yellowish-brown (10YR 3/4) mottles; moderate, thick, platy structure; firm, sticky and nonplastic; 10 percent coarse fragments; neutral; clear, smooth boundary.

IIC2—38 to 60 inches, gray (N 5/0) gravelly loamy sand; massive; friable, nonsticky and nonplastic; 40 percent coarse fragments; neutral; calcareous at a depth of 50 inches.

The solum ranges from 24 to 34 inches in thickness. The A horizon ranges from black (N 2/0) to very dark gray (10YR 3/1) or very dark brown (10YR 2/2). It is medium acid to neutral. The B horizon ranges from gray (10YR 5/1) to light brownish-gray (10YR 6/2) and from sandy loam to loam. It is medium acid to neutral. The C horizon ranges from gray (10YR 5/1) to light olive brown (2.5Y 5/4), and stratified sand and gravel is within a depth of 40 inches. The IIC2 horizon is neutral or mildly alkaline.

Halsey soils are associated on the landscape with the somewhat poorly drained Red Hook soils, the moderately well drained Braceville soils, and the poorly drained Canadice soils. They are wetter than those soils.

Halsey silt loam (0 to 3 percent slopes) (Ha).—This nearly level soil is in broad, elongated and rectangular areas several acres to several hundred acres or more in size. In most places the soil has a cradle knoll relief.

Included with this soil in mapping are small areas of Red Hook, Braceville, Canadice, Caneadea, Frenchtown, and Alden soils. Also included are some areas of soils that have a surface layer of mucky silt loam.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to crops that tolerate wetness and to pasture and wildlife habitat than to other uses. Surface runoff is slow. Artificial drainage increases the suitability of this soil for crops and pasture, but outlets are difficult to locate. Management concerns are mainly a high water table and moderately slow permeability. Capability unit IVw–2.

Hanover Series

The Hanover series consists of deep, moderately well drained, nearly level to moderately steep soils. These soils formed in material, weathered from glacial till, that contains sandstone, siltstone, shale, and some crystalline rocks. They are on upland knobs, benches, crests of slopes, and side slopes of valleys.

In a representative profile the surface layer is dark-brown silt loam 9 inches thick. The upper part of the subsoil, to a depth of 25 inches, is yellowish-brown, friable and firm silt loam. The lower part of the subsoil extends to a depth of 71 inches. It is yellowish-brown and dark yellowish-brown, very firm and brittle silt loam and loam that has light brownish-gray and yellowish-brown mottles.

Hanover soils have moderately slow permeability and a moderate available water capacity. A seasonal high water table is within 1½ to 3 feet of the surface in wet periods. Most areas of these soils are cleared and are used for crops, hay, or pasture. A few areas are in woodland or are idle. Management concerns are mainly the moderately slow permeability and the seasonal high water table.

Representative profile of Hanover silt loam, 3 to 8 percent slopes, in a cultivated field 2.5 miles northeast of Titusville and 200 feet north of the intersection of Route 20103 and township road T–920 (Pennsylvania Department of Transportation test samples BP–21612 and BP–21613 were taken from this profile):

Ap—0 to 9 inches, dark-brown (10YR 4/3) silt loam; weak, fine, granular structure; friable, slightly sticky and nonplastic; 5 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

B1—9 to 15 inches, yellowish-brown (10YR 5/6) silt loam; weak, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; 10 percent coarse fragments; very strongly acid; clear, wavy boundary.

B2t—15 to 25 inches, yellowish-brown (10YR 5/4) silt loam, moderate, medium, subangular blocky structure; firm, slightly stick and slightly plastic; common thin clay films on ped faces and lining pores; 15 percent coarse fragments; very strongly acid; clear, wavy boundary.

Bx1—25 to 44 inches, yellowish-brown (10YR 5/4) silt loam; common, medium, faint, light brownish-gray (10YR 6/2) mottles; moderate, very coarse, prismatic structure parting to moderate, medium, subangular blocky; very firm and brittle, slightly sticky and slightly plastic; common thick clay films on ped faces; common black coatings; 15 percent coarse fragments; very strongly acid; clear, wavy boundary.

Bx2—44 to 56 inches, dark yellowish-brown (10YR 4/4) loam; few, fine, faint, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/4) mottles; weak, very coarse, prismatic structure parting to weak, thin, platy; very firm and brittle, slightly sticky and slightly plastic; common thick clay films on ped faces and in pores; 15 percent coarse fragments; very strongly acid; gradual, wavy boundary.

Bx3—56 to 71 inches, yellowish-brown (10YR 5/4) silt loam; common, medium, faint, light brownish-gray (10YR 6/2) mottles and few, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, very coarse, prismatic structure parting to weak, thin, platy; very firm and brittle, slightly sticky and slightly plastic; common thick clay films on ped faces and in pores; 15 percent coarse fragments; strongly acid.

The solum ranges from 60 to 94 inches in thickness. The Ap horizon ranges from dark grayish brown (10YR 4/2) to dark brown (10YR 4/3). It is very strongly acid or strongly acid. The Bt horizon ranges from dark brown (7.5YR 4/4) to yellowish brown (10YR 5/6) and from loam to silty clay loam. It is medium acid to very strongly acid. The Bx horizon ranges from dark brown (7.5YR 4/4) to yellowish brown (10YR 5/6) and from loam to silt loam or clay loam. It has weak to moderate, very coarse, prismatic structure parting to weak platy or weak to moderate subangular blocky. It is very strongly acid or strongly acid. Some profiles have a C horizon, which ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) and from loam to silty clay loam. It is medium acid to neutral.

Hanover soils are associated on the landscape with the somewhat poorly drained Alvira soils and the poorly drained Frenchtown soils. They are better drained than those soils.

Hanover silt loam, 0 to 3 percent slopes (HnA).—This nearly level soil is in elongated and rounded areas 2 to 15 or more acres in size. Included with it in mapping are small areas of gently sloping Hanover soils and small areas of Alviras. Shelmadine, and Valois soils. Also included are small areas of stony Hanover soils and a few areas of soils that have a surface layer of sandy loam.

This soil is well suited to most crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to about 28 inches by a firm and brittle layer. Artificial drainage increases the suitability of the soil for crops. Management concerns are mainly a seasonal high water table and moderately slow permeability. Capability unit IIw–2.

Hanover silt loam, 3 to 8 percent slopes (HnB).—This gently sloping soil has the profile described as representative of the series. It is in elongated, irregularly shaped areas of 50 to several hundred acres and in rounded areas of 5 to 50 acres.

Included with this soil in mapping are a few areas of nearly level Hanover soils and small areas of Alvira, Shelmadine, Cambridge, and Venango soils. Also included are small areas of stony Hanover soils and a few areas of soils that have a surface layer of sandy loam.

This soil is well suited to most crops commonly grown in the county. Surface runoff is medium. The depth to which roots and moisture can penetrate is limited to about 25 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a seasonal high water table and moderately slow permeability. Capability unit IIe–2.

Hanover silt loam, 8 to 15 percent slopes (HnC).—This sloping soil is in irregularly shaped areas of 5 to 50 acres and in long bands of 50 to 100 acres. Included with it in mapping are a few areas of Alvira, Cambridge, and Valois soils. Also included are small areas of Hanover soils that have a gravelly silt loam, sandy loam, or stony surface layer.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. The depth to which roots and moisture can penetrate is limited to about 22 inches by a firm and brittle layer. Surface runoff is rapid. Conservation practices are needed to control erosion and reduce runoff. Management concerns are mainly slope, a seasonal high water table, and moderately slow permeability. Capability unit IIIe–2.

Hanover very stony silt loam, 0 to 8 percent slopes (HoB).—This nearly level and gently sloping soil has a profile similar to the one described as representative of the series, but the surface of this soil has as much as a 3 percent cover of stones. It is in broad, rounded areas 10 to several hundred acres in size.

Included with this soil in mapping are a few areas of sloping Hanover, Alvira, and Shelmadine soils. Also included are a few areas of soils that have a stone cover of more than 3 percent and a few soils that have a surface layer of sandy loam.

This soil is better suited to pasture, woodland, and wildlife habitat than to other uses. It is not suited to crops, because it is so stony. Surface runoff is medium. Management concerns are mainly stoniness, a seasonal high water table, and moderately slow permeability. Capability unit VIs–1.

Hanover very stony silt loam, 8 to 25 percent slopes (HoD).—This sloping and moderately steep soil has a profile similar to the one described as representative of the series, but this soil has a 0.1 to 3 percent cover of stones, and mottles are at a greater depth and are not so evident. It is in broad, elongated areas 20 to 500 acres in size.

Included with this soil in mapping are a few areas of sloping Alvira and Shelmadine soils. Also included are a few areas of soils that have a surface layer of sandy loam.

This soil is better suited to pasture, woodland, and wildlife habitat than to other uses. It is not suited to crops, because it is so stony. Surface runoff is rapid. Management concerns are mainly stoniness, slope, a seasonal high water table, and moderately slow permeability. Capability unit VIs–1.

Haven Series

The Haven series consists of deep, well-drained, nearly level and gently sloping soils that formed in material weathered from glacial stream deposits. These soils are on outwash plains and terraces in major valleys.

In a representative profile the surface layer is very dark brown silt loam 3 inches thick. It has a 1-inch cover of organic material. The subsurface layer, to a depth of 8 inches, is dark-brown silt loam. The subsoil, to a depth of 30 inches, is yellowish-brown and dark-brown, friable silt loam. The substratum is yellowish-brown very gravelly loamy sand that extends to a depth of 65 inches.

Haven soils have moderate permeability and a moderate available water capacity. Most areas of these soils are used for cultivated crops. Some areas are in towns and urban developments, and some are in woodland. Management concerns are mainly slope and a hazard of ground water pollution.

Representative profile of Haven silt loam, 3 to 8 percent slopes, in an idle field 1.5 miles north of Teepleville and 200 feet west of township road T–791:

O2—1 inch to 0, black (10YR 2/1) organic material.
A1—0 to 3 inches, very dark brown (10YR 2/2) silt loam; weak, medium, granular structure; friable, nonsticky and nonplastic; many fine roots; less than 5 percent coarse fragments; very strongly acid; abrupt, smooth boundary.
A2—3 to 8 inches, dark-brown (10YR 4/3) silt loam; weak, medium, granular structure; friable, nonsticky and nonplastic; many roots; less than 5 percent coarse fragments; very strongly acid; clear, wavy boundary.
B1—8 to 20 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; common roots; less than 5 percent coarse fragments; very strongly acid; diffuse, smooth boundary.
B2—20 to 30 inches, dark-brown (7.5YR 4/4) silt loam; moderate, thick, platy structure parting to weak, fine, subangular blocky; friable, sticky and slightly plastic; few roots; 10 percent coarse fragments; very strongly acid; abrupt, smooth boundary.
IIC—30 to 65 inches, yellowish-brown (10YR 5/4) very gravelly loamy sand; massive; very friable, nonsticky and nonplastic; 50 percent coarse fragments; very strongly acid.

The solum ranges from 20 to 34 inches in thickness. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 4/3). It is very strongly acid or strongly acid. The B horizon ranges from dark brown (7.5YR 4/4) to light olive brown (2.5Y 5/6) and from loam to silt loam. The C horizon ranges from yellowish brown (10YR 5/4) to light olive brown (2.5Y 5/6).

Haven soils are associated on the landscape with the

well drained to somewhat excessively drained Chenango soils, the somewhat excessively drained Wyoming soils, the moderately well drained Braceville soils, the somewhat poorly drained Red Hook soils, and the very poorly drained Halsey soils. They have less gravel in the B horizon than Chenango and Wyoming soils, and they are better drained than Braceville, Red Hook, and Halsey soils.

Haven silt loam, 0 to 3 percent slopes (HvA).—This nearly level soil is in elongated areas 35 to 100 acres in size and in oval-shaped areas 5 to 15 acres in size. Included with it in mapping are small areas of Chenango, Wyoming, Braceville, and Red Hook soils. Also included are small areas of gently sloping Haven soils and some areas of Haven soils that have a surface layer of fine sandy loam.

This soil is well suited to all crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. Surface runoff is slow. The main management concern is a hazard of ground water pollution. Capability unit I–2.

Haven silt loam, 3 to 8 percent slopes (HvB).—This gently sloping soil has the profile described as representative of the series. It is in elongated areas of 25 to 50 acres and in rounded and angular areas of 2 to 6 acres.

Included with this soil in mapping are small areas of Wyoming, Chenango, Braceville, and Red Hook soils, small areas of nearly level Haven soils, and some areas of Haven soils that have a surface layer of fine sandy loam. Also included are areas of soils that have a thicker surface layer and subsoil.

This soil is well suited to most crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. Surface runoff is medium. Conservation practices are needed to reduce runoff and control erosion. Management concerns are mainly slope and a hazard of ground water pollution. Capability unit IIe–1.

Holly Series

The Holly series consists of deep, poorly drained to very poorly drained, nearly level soils that formed in material weathered from recent stream deposits. These soils are on flood plains of major stream valleys.

In a representative profile the surface layer is dark grayish-brown silt loam 12 inches thick. The subsoil, to a depth of 36 inches, is light brownish-gray, friable silt loam and loam that has yellowish-brown mottles. The substratum extends to a depth of 54 inches. It is gray fine sandy loam that has strong-brown mottles.

Holly soils have moderate to moderately slow permeability and a moderate to high available water capacity. A high water table is at or near the surface much of the year. The soils are subject to flooding from stream overflow. Most areas of these soils are used for pasture. Some areas are in crops (fig. 7) or woodland or are

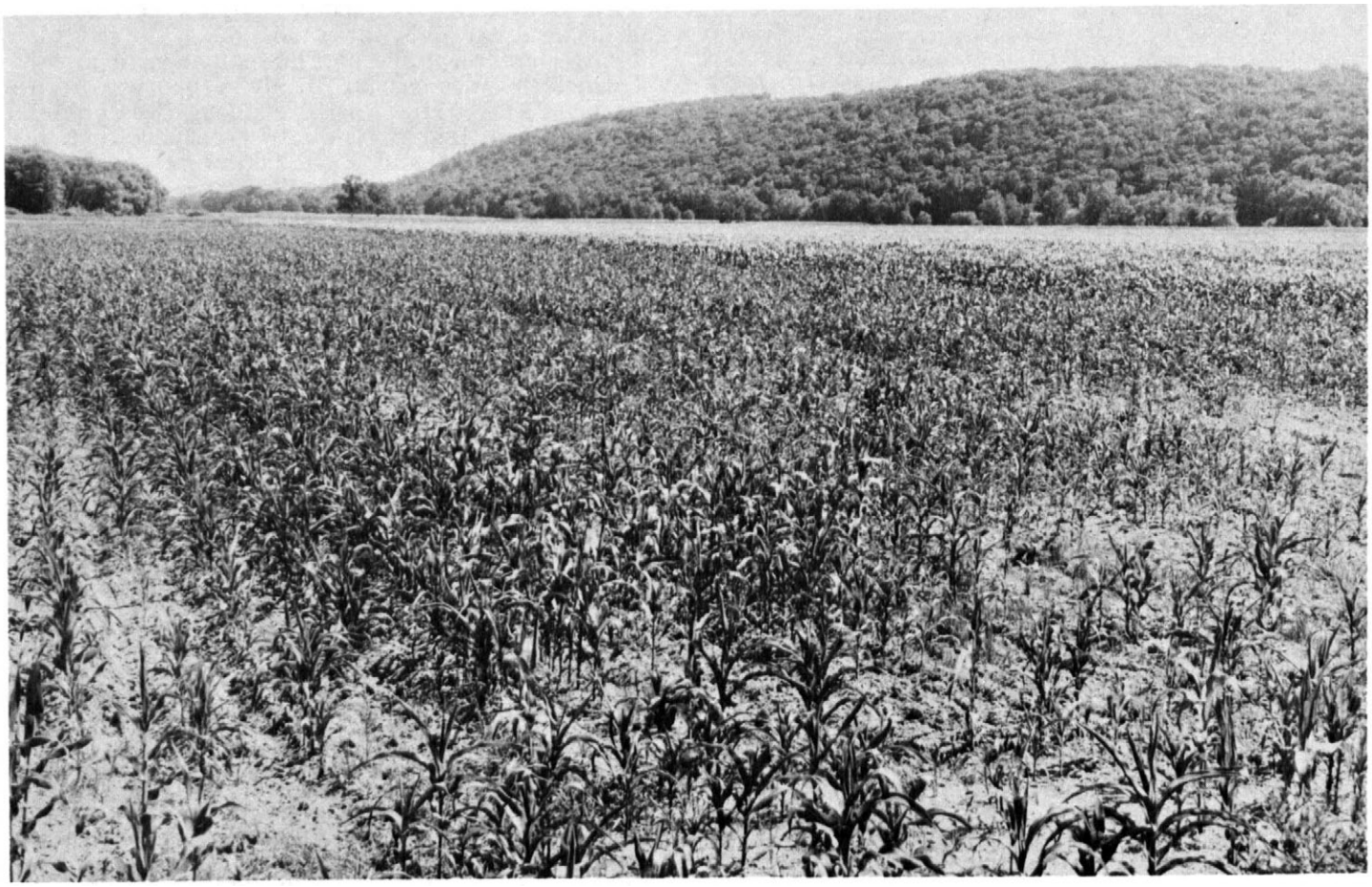

Figure 7.—**Corn growing in an undrained area of Holly silt loam. If drained, this soil is better suited to crops.**

idle. Management concerns are mainly the hazard of flooding, the high water table, and the moderately slow permeability.

Representative profile of Holly silt loam in a recreation area 6 miles southeast of Meadville and 250 feet west of French Creek:

Ap—0 to 12 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, granular structure; friable, slightly sticky and slightly plastic; medium acid; clear, smooth boundary.

B21g—12 to 20 inches, light brownish-gray (10YR 6/2) silt loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; medium acid; clear, smooth boundary.

B22g—20 to 36 inches, light brownish-gray (10YR 6/2) loam; many, common, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; medium acid; clear, smooth boundary.

Cg—36 to 54 inches, gray (10YR 6/1) fine sandy loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; massive; friable, slightly sticky and slightly plastic; 10 percent coarse fragments; medium acid.

The solum ranges from 20 to 38 inches in thickness. The Ap horizon ranges from dark grayish brown (10YR 4/2) to dark gray (10YR 4/1). It is medium acid to neutral. The B horizon ranges from light brownish gray (10YR 6/2) to gray (10YR 5/1) and from silty clay loam to fine sandy loam. It is strongly acid to slightly acid. The C horizon ranges from gravelly sandy loam to clay loam. It is very strongly acid to medium acid.

Holly soils are associated on the landscape with the well drained Pope soils, the moderately well drained Philo soils, the somewhat poorly drained Caneadea and Red Hook soils, the poorly drained Canadice soils, and the very poorly drained Halsey soils. Holly soils are wetter than Pope, Philo, Caneadea, and Red Hook soils. They lack the very gravelly C horizon of Red Hook soils and have less clay in the B horizon than Canadice soils. They have less sand than Halsey soils.

Holly silt loam (0 to 3 percent slopes) (Hy).—This nearly level soil has the profile described as representative of the series. It is in wide bands and narrow bands along streams.

Included with this soil in mapping are areas of Philo, Pope, Red Hook, and Braceville soils and some small areas of Holly silty clay loam. Also included are areas of soils that have a surface layer of mucky or gravelly silt loam.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is slow, and flooding is occasional to frequent. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly the hazard of flooding, a high water table, and moderate to moderately slow permeability. Capability unit IIIw–1.

Holly silty clay loam (0 to 3 percent slopes) (Hz).—This nearly level soil has a profile similar to the one described as representative of the series, but it has a surface layer of silty clay loam. It is in narrow bands along streams.

Included with this soil in mapping are areas of Holly silt loam and areas of Carlisle and Halsey soils.

This soil is not suited to crops. It is better suited to pasture, woodland, or wildlife habitat than to other uses. Surface runoff is slow, and flooding is very frequent. Artificial drainage increases the suitability of this soil for pasture, but outlets are difficult to locate. Management concerns are mainly the hazard of flooding, a high water table, and moderate to moderately slow permeability. Capability unit VIw–1.

Philo Series

The Philo series consists of deep, moderately well drained, nearly level soils that formed in material weathered from stream deposits. These soils are on flood plains.

In a representative profile the surface layer is very dark grayish-brown silt loam 9 inches thick. The subsoil, to a depth of 22 inches, is dark-brown and yellowish-brown, friable silt loam. The upper part of the substratum, between depths of 22 and 44 inches, is yellowish-brown and dark-brown, very friable very fine sandy loam that has gray and pale-brown mottles. The lower part of the substratum is dark-brown, friable and very friable sandy loam and loamy sand that extends to a depth of 72 inches.

Philo soils have moderate to moderately slow permeability and a high available water capacity. A seasonal high water table is within 1½ to 3 feet of the surface in wet periods. Philo soils are subject to stream overflow, particularly following snowmelt in spring. Most areas of these soils are in crops, hay, or pasture. Some small areas are idle, and others are used for urban development. Management concerns are mainly the hazard of flooding, the moderately slow permeability, and the seasonal high water table.

Representative profile of Philo silt loam in a cultivated field 3 miles east of Meadville between French Creek and U.S. Highway 322 along Route 20027 (Pennsylvania Department of Transportation test samples BP–21604 and BP–21605 were taken from this profile):

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, coarse, granular structure; friable, slightly sticky and slightly plastic; medium acid; abrupt, smooth boundary.

B21—9 to 15 inches, dark-brown (7.5YR 4/4) silt loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; strongly acid; clear, wavy boundary.

B22—15 to 22 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; strongly acid; clear, wavy boundary.

IIC1—22 to 34 inches, yellowish-brown (10YR 5/4) very fine sandy loam; common, medium, prominent, gray (10YR 6/1) mottles; massive; very friable, nonsticky and and slightly plastic; strongly acid; clear, wavy boundary.

IIC2—34 to 44 inches, dark-brown (7.5YR 4/4) very fine sandy loam; common, medium, distinct, gray (10YR 6/1) mottles and few, fine, distinct, pale-brown (10YR 6/3) mottles; massive; very friable, nonsticky and slightly plastic; very strongly acid; gradual, wavy boundary.

IIIC3—44 to 56 inches, dark-brown (10YR 4/3) sandy loam; common, medium, distinct, gray (10YR 6/1) mottles and common, fine, distinct, pale-brown (10YR 6/3) mottles; massive; friable, nonsticky and nonplastic; very strongly acid; gradual, wavy boundary.

IVC4—56 to 72 inches, dark-brown (10YR 4/3) loamy sand; single grained; very friable, nonsticky and nonplastic; very strongly acid.

The solum ranges from 22 to 36 inches in thickness. Depth to mottles that have a chroma of 2 ranges from 18 to 24

inches. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 4/3). It is medium acid or strongly acid. The B horizon is dark brown (10YR 4/3 to 7.5YR 4/4) or yellowish brown (10YR 5/6) and ranges from very fine sandy loam to silt loam. It is medium acid to very strongly acid. The C horizon is stratified and ranges from silt loam to loamy sand. It is very strongly acid to medium acid.

Philo soils are associated on the landscape with the well-drained Pope soils and the poorly drained and very poorly drained Holly soils. They are wetter than Pope soils and are better drained than Holly soils.

Philo silt loam (0 to 3 percent slopes) (Ph).—This nearly level soil is in long bands 50 to several hundred acres in size. Included with it in mapping are small areas of Holly, Pope, Red Hook, and Braceville soils. Also included are small areas of Philo soils that have a surface layer of fine sandy loam.

This soil is suited to most crops commonly grown in the county and to hay, pasture, woodland, and wildlife habitat. Surface runoff is slow. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly the hazard of flooding, a seasonal high water table, and moderately slow permeability. Capability unit IIw–1.

Platea Series

The Platea series consists of deep, somewhat poorly drained, gently sloping soils. These soils formed in material, weathered from glacial till, that contains gray sandstone, shale, and some limestone. They are on uplands.

In a representative profile the surface layer is dark grayish-brown silt loam 9 inches thick. The upper part of the subsoil, to a depth of 17 inches, is light olive-brown, friable silt loam that has strong-brown mottles. The lower part of the subsoil extends to a depth of 60 inches. It is olive-brown and grayish-brown, very firm and brittle silt loam and silty clay loam that has mottles of grayish brown, yellowish red, strong brown, light brownish gray, and olive gray.

Platea soils have very slow permeability and a moderate available water capacity. A seasonal high water table is within ½ to 1½ feet of the surface in wet periods. Most areas of these soils are in crops or pasture, but a few areas are in woodland or are idle. Management concerns are mainly the seasonal high water table and the very slow permeability.

Representative profile of Platea silt loam, 3 to 8 percent slopes, in a cultivated field about 1 mile west of Beaver Center on township road T–779 and 0.1 mile east of the intersection of township roads T–779 and T–308 (Pennsylvania Department of Transportation test samples BP–23316 and BP–23317 were taken from this profile):

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, granular structure; friable, slightly sticky and slightly plastic; less than 5 percent coarse fragments; medium acid; abrupt, smooth boundary.

B1—9 to 13 inches, light olive-brown (2.5Y 5/4) silt loam; common medium, prominent, strong-brown (7.5 YR 5/8) mottles; weak, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; less than 5 percent coarse fragments; very strongly acid; clear, wavy boundary.

B2—13 to 17 inches, light olive-brown (2.5Y 5/4) silt loam; common, medium, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable, sticky and plastic; few thin clay films on ped faces; 5 percent coarse fragments; very strongly acid; gradual, wavy boundary.

Bx1—17 to 22 inches, olive-brown (2.5Y 4/4) silt loam; light brownish-gray (2.5Y 6/2) prism faces; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles and many, coarse, prominent, yellowish-red (5YR 5/6) mottles; moderate, coarse, prismatic structure parting to weak, thick, platy; very firm and brittle, sticky and plastic; common thick clay films on ped faces; common black coatings; 5 percent coarse fragments; strongly acid; clear, wavy boundary.

Bx2—22 to 32 inches, olive-brown (2.5Y 4/4) silt loam; light brownish-gray (2.5Y 6/2) prism faces; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; strong, very coarse, prismatic structure parting to weak, thick, platy; very firm and brittle, sticky and plastic; common, thick, continuous clay films on ped faces; common black coatings; 20 percent coarse fragments; medium acid; gradual, wavy boundary.

Bx3—32 to 42 inches, olive-brown (2.5Y 4/4) silt loam; gray (10YR 6/1) prism faces; common, medium, faint, grayish-brown (2.5Y 5/2) mottles; strong, very coarse, prismatic structure parting to moderate, thick, platy; very firm and brittle, sticky and plastic; common thick clay films on prism faces and in pores; common black coatings; 10 percent coarse fragments; slightly acid; gradual, wavy boundary.

Bx4—42 to 53 inches, grayish-brown (2.5Y 5/2) silt loam; gray (10YR 6/1) prism faces; few, fine, faint, light brownish-gray (10YR 6/2) mottles and few, medium, faint, olive-gray (5Y 5/2) mottles; strong, very coarse, prismatic structure parting to weak, thick, platy; very firm and brittle, sticky and plastic; common thick clay films on prism faces and in pores; few black coatings; 10 percent coarse fragments; neutral; gradual, wavy boundary.

Bx5—53 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam; few, fine, faint, light brownish-gray (10YR 6/2) mottles; weak, very coarse, prismatic structure parting to moderate, medium, blocky and weak, platy; very firm and brittle, sticky and plastic; common thick clay films on ped faces; 20 percent coarse fragments; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. The Ap horizon ranges from dark grayish brown (10YR 4/2) to dark brown (10YR 4/3). It is very strongly acid to medium acid. The B2 horizon ranges from strong brown (7.5YR 5/6) to light olive brown (2.5Y 5/4) and from silt loam to silty clay loam. It is extremely acid or very strongly acid. The Bx horizon ranges from silt loam to silty clay loam. It is medium acid or strongly acid in the upper part and slightly acid to mildly alkaline in the lower part.

Platea soils are associated on the landscape with the poorly drained Sheffield soils and the very poorly drained Alden soils. Platea soils are better drained than those soils.

Platea silt loam, 3 to 8 percent slopes (PkB).—This gently sloping soil is in elongated, oval, and irregularly shaped areas 4 to 25 acres in size. Included with it in mapping are a few small areas of nearly level Platea soils and a few areas of Sheffield, Alden, and Cambridge soils.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. The depth to which roots and moisture can penetrate is limited to about 17 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Surface runoff is medium. Conservation practices are needed to control erosion. Management concerns are mainly very slow permeability and a seasonal high water table. Capability unit IIIw–2.

Pope Series

The Pope series consists of deep, well-drained, nearly level soils that formed in material weathered from stream deposits. These soils are on flood plains along major streams.

In a representative profile the surface layer is dark grayish-brown loam 11 inches thick. The subsoil, to a depth of 30 inches, is yellowish-brown, friable silt loam. The substratum is yellowish-brown fine sandy loam that extends to a depth of 57 inches.

Pope soils have moderate permeability and a high available water capacity. Most areas of these soils are cleared and are used for crops, hay, and pasture or urban developments, but a few areas are used for woodland and recreation. The main management concern is the hazard of flooding.

Representative profile of Pope loam in a cultivated field 1.3 miles east of Cambridge Springs in a recreation area adjacent to French Creek:

Ap—0 to 11 inches, dark grayish-brown (10YR 4/2) loam; weak, fine, granular structure; friable, nonsticky and nonplastic; medium acid; clear, smooth boundary.

B2—11 to 30 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; medium acid; clear, smooth boundary.

C—30 to 57 inches, yellowish-brown (10YR 5/4) fine sandy loam; massive; friable, nonsticky and nonplastic; strongly acid.

The solum ranges from 30 to 46 inches in thickness. The Ap horizon ranges from brown (10YR 5/3) to dark grayish brown (10YR 4/2). It contains 0 to 10 percent coarse fragments. The B horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4). It ranges mainly from loam to silt loam, but some profiles have thin layers of sandy loam. The C horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4) and from loam to loamy sand. It contains 0 to 15 percent coarse fragments. Reaction throughout the profile ranges from medium acid to very strongly acid.

Pope soils are associated on the landscape with the moderately well drained Philo soils and the poorly drained and very poorly drained Holly soils. They are better drained than those soils.

Pope loam (0 to 3 percent slopes) (Po).—This nearly level soil is in broad, elongated areas a few acres to several hundred acres in size. Included with this soil in mapping are a few areas of soils that have a surface layer of silt loam and sandy loam and a few areas of Philo, Holly, and Haven soils. Also included are several areas of soils near Meadville and Saegertown that have a thick, very dark brown surface layer.

This soil is well suited to most crops commonly grown in the county and to truck crops, hay, pasture, woodland, and wildlife habitat. Surface runoff is slow. The main management concern is the hazard of flooding. Capability unit I–1.

Red Hook Series

The Red Hook series consists of deep, somewhat poorly drained, nearly level to gently sloping soils that formed in material weathered from glacial outwash. These soils are on terraces in stream valleys.

In a representative profile the surface layer is black loam 6 inches thick. The upper part of the subsoil, to a depth of 13 inches, is brown, friable gravelly sandy loam that has strong-brown mottles. The lower part of the subsoil extends to a depth of 32 inches. It is grayish-brown, friable gravelly sandy loam that has yellowish-brown and strong-brown mottles. The substratum is dark grayish-brown very gravelly sandy loam that extends to a depth of 60 inches.

Red Hook soils have moderate permeability and a moderate to high available water capacity. A seasonal high water table is within ½ to 1½ feet of the surface in wet periods. Most areas of these soils are in woodland, pasture, or crops or are idle. A few areas are used for growing Christmas trees. Management concerns are mainly the high water table and the slow permeability.

Representative profile of Red Hook loam in an idle field 4 miles west of Teepleville, 2 miles east of Ferries Corners, and 50 feet north of Route 20079:

A1—0 to 6 inches, black (10YR 2/1) loam; weak, fine, granular structure; very friable, nonsticky and nonplastic; 10 percent coarse fragments; medium acid; abrupt, smooth boundary.

B1—6 to 13 inches, brown (10YR 5/3) gravelly sandy loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable, nonsticky and nonplastic; 15 percent coarse fragments; medium acid; clear, wavy boundary.

B21g—13 to 24 inches, grayish-brown (10YR 5/2) gravelly sandy loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable, nonsticky and nonplastic; 20 percent coarse fragments; medium acid; clear, wavy boundary.

B22g—24 to 32 inches, grayish-brown (10YR 5/2) gravelly sandy loam; common, medium, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; friable, nonsticky and nonplastic; 20 percent coarse fragments; medium acid; abrupt, wavy boundary.

IIC—32 to 60 inches, dark grayish-brown (10YR 4/2) very gravelly sandy loam; massive; friable, nonsticky and nonplastic; 65 percent coarse fragments; slightly acid in upper part and mildly alkaline in lower part.

The solum ranges from 24 to 34 inches in thickness. Some profiles have an Ap horizon, which ranges from 6 to 9 inches in thickness. The A1 horizon ranges from very dark grayish brown (10YR 3/2) to black (10YR 2/1). It is strongly acid or medium acid. The B horizon ranges from brown (10YR 5/3) to light brownish gray (10YR 6/2) and from sandy loam to silt loam. It is strongly acid to slightly acid. The C horizon is gravelly or very gravelly sandy loam, and in places, it is stratified sand and gravel below a depth of 40 inches.

Red Hook soils in Crawford County are less acid than is within the range defined for the series, but this difference does not significantly alter their usefulness or behavior.

Red Hook soils are associated on the landscape with the very poorly drained Halsey soils, the moderately well drained Braceville soils, the somewhat excessively drained Wyoming soils, and the well drained to somewhat excessively drained Chenango soils. They are not so wet as the Halsey soils but are wetter than the Braceville, Wyoming, and Chenango soils.

Red Hook loam (0 to 5 percent slopes) (Rh).—This nearly level to gently sloping soil is in broad, elongated areas of 200 to 600 acres and in rectangular areas of 5 to 50 acres or more. Included with it in mapping are areas of poorly drained soils and small areas of Braceville, Halsey, Caneadea, Wyoming, Chenango, Haven, and Carlisle soils. Also included are some areas of soils that have a layer of gravelly silt loam below a depth of 35 inches.

This soil is suited to most crops commonly grown in the county. It is better suited to shallow-rooted crops and plants that tolerate wetness and to pasture, woodland, and wildlife habitat than to other uses. Surface runoff is slow. Artificial drainage increases the suitability of this soil for crops. The main management concern is a high water table. Capability unit IIIw–2.

Scio Series

The Scio series consists of deep, moderately well drained, nearly level and gently sloping soils that formed in material weathered from stream deposits. These soils are on terraces along major streams.

In a representative profile the surface layer is dark-brown silt loam 9 inches thick. The subsoil, to a depth of 30 inches, is yellowish-brown and brown, friable silt loam that has light brownish-gray mottles below a depth of 19 inches. The substratum extends to a depth of 65 inches. It is dark-brown and brown very fine sandy loam that has brown and gray mottles.

Scio soils have moderate permeability and a high available water capacity. A seasonal high water table is within 1½ to 3 feet of the surface in wet periods. Most areas of these soils are used for crops, but a few areas are in woodland or are idle. The main management concern is the seasonal high water table.

Representative profile of Scio silt loam, 0 to 3 percent slopes, in a cultivated field in Hayfield Township, 0.75 mile northwest of Coon's Corners and 800 feet east of township road T–498:

Ap—0 to 9 inches, dark-brown (10YR 3/3) silt loam; weak, fine, granular structure; friable, sticky and nonplastic; medium acid; abrupt, smooth boundary.

B21—9 to 14 inches, yellowish-brown (10YR 5/6) silt loam; weak, medium, subangular blocky structure; friable, nonsticky and nonplastic; strongly acid; gradual, smooth boundary.

B22—14 to 19 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; strongly acid; clear, wavy boundary.

B23—19 to 30 inches, brown (10YR 5/3) silt loam; common, medium, distinct, light brownish-gray (10YR 6/2) mottles; weak, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; medium acid; abrupt, wavy boundary.

C1—30 to 48 inches, dark-brown (10YR 4/3) very fine sandy loam; common, medium, faint, brown (10YR 5/3) mottles; massive; friable, nonsticky and nonplastic; medium acid; abrupt, smooth boundary.

C2—48 to 65 inches, brown (10YR 5/3) very fine sandy loam; many, medium, distinct, gray (10YR 6/1) mottles; massive; friable, slightly sticky and slightly plastic; 5 percent coarse fragments; slightly acid.

The solum ranges from 24 to 36 inches in thickness. The Ap horizon ranges from brown (10YR 4/3) to very dark grayish brown (10YR 3/2). The B horizon ranges from dark brown (7.5 YR 4/4) to olive (5Y 5/6) and from very fine sandy loam to silt loam. It is strongly acid or medium acid. The C horizon ranges from dark brown (10YR 4/3) to olive brown (2.5Y 4/4) and from silt loam to sandy loam.

Scio soils are associated on the landscape with the well-drained Haven soils, the somewhat poorly drained Red Hook soils, and the very poorly drained Halsey soils. They are wetter than the Haven soils and are better drained than the Red Hook and Halsey soils.

Scio silt loam, 0 to 3 percent slopes (ScA).—This nearly level soil is in rounded areas 3 to 10 acres or more in size. Included with it in mapping are small areas of gently sloping Scio soils, a few areas of soils that have a surface layer of gravelly loam, and a few small areas of Red Hook, Haven, and Braceville soils.

This soil is well suited to all crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is slow. Artificial drainage increases the suitability of this soil for crops. The main management concern is a seasonal high water table. Capability unit IIw–2.

Scio silt loam, 3 to 8 percent slopes (ScB).—This gently sloping soil has the profile described as representative of the series. It is in elongated and circular areas 3 to 10 acres or more in size.

Included with this soil in mapping are a few small areas of Braceville, Red Hook, and Haven soils.

This soil is well suited to all crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Artificial drainage increases the suitability of this soil for crops. Conservation practices are needed to control runoff and erosion. The main management concern is a seasonal high water table. Capability unit IIe–2.

Sheffield Series

The Sheffield series consists of deep, poorly drained, nearly level soils. These soils formed in material, weathered from glacial till, that contains sandstone, shale, and some limestone.

In a representative profile the surface layer is dark-gray silt loam 10 inches thick. The subsoil extends to a depth of 54 inches. The upper part is grayish-brown, firm silt loam and silty clay loam that has mottles of light brownish gray, yellowish brown, and dark yellowish brown. The middle part, between depths of 24 and 40 inches, is grayish-brown, firm and brittle heavy silt loam that has light brownish-gray mottles. The lower part of the subsoil is yellowish-brown heavy silt loam that has pale-brown mottles.

Sheffield soils have very slow permeability and a moderate available water capacity. A high water table is at or near the surface much of the year. Most areas of these soils are used for woodland, but some are in crops, pasture, or hay or are idle. Management concerns are mainly the high water table and the very slow permeability.

Representative profile of Sheffield silt loam in a cultivated field 3 miles west of Beaver Center and 50 feet west of township road T–308 (Pennsylvania Department of Transportation test samples BP–55528 and BP–55529 were taken from this profile):

Ap—0 to 10 inches, dark-gray (10YR 4/1) silt loam; weak, fine, granular structure; friable, slightly sticky and slightly plastic; medium acid; clear, smooth boundary.

B1g—10 to 16 inches, grayish-brown (10YR 5/2) silt loam; common, medium, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; firm, sticky and plastic; medium acid; clear, wavy boundary.

B2gt—16 to 24 inches, grayish-brown (10YR 5/2) silty clay loam; many, medium, prominent, dark yellowish-brown (10YR 4/4) mottles; moderate, medium, subangular blocky structure; firm, very sticky and very plastic; many thin clay films on ped faces; strongly acid; clear, wavy boundary.

Bx1g—24 to 28 inches, grayish-brown (10YR 5/2) heavy silt loam; many, coarse, faint, light brownish-gray (10YR 6/2) mottles; weak, coarse, subangular blocky structure; firm and brittle, very sticky and very plastic; many thin clay films in pores; neutral; clear, wavy boundary.

Bx2g—28 to 40 inches, grayish-brown (10YR 5/2) heavy silt loam; many, coarse, faint, light brownish-gray (10YR 6/2) mottles; weak, very coarse, prismatic structure parting to weak, coarse, subangular blocky; firm and brittle, very sticky and very plastic; thick clay films in pores; neutral; clear, wavy boundary.

B3g—40 to 54 inches, yellowish-brown (10YR 5/4) heavy silt loam; common, medium, distinct, pale-brown (10YR 6/3) mottles; light brownish-gray (10YR 6/2) prism faces; weak, very coarse, prismatic structure parting to weak, thick, platy; firm, very sticky and very plastic; neutral.

The solum ranges from 40 to 56 inches in thickness. The Ap horizon ranges from gray (10YR 5/1) to dark grayish brown (10YR 4/2). It is medium acid or strongly acid. The B2 horizon ranges from grayish brown (10YR 5/2) to gray (10YR 6/1) and from heavy silt loam to silty clay loam. The Bx horizon ranges from dark yellowish brown (10YR 4/4) to grayish brown (10YR 5/2) and from silt loam to silty clay loam. It is neutral or mildly alkaline. Some profiles have a C horizon, which ranges from yellowish brown (10 YR 5/6) to olive brown (2.5Y 4/4) and from silt loam to silty clay loam.

Sheffield soils are associated on the landscape with the very poorly drained Alden soils and the somewhat poorly drained Platea soils. They are better drained than the Alden soils and are wetter than the Platea soils.

Sheffield silt loam (0 to 3 percent slopes) (Sh).—This nearly level soil is in broad, contiguous areas as much as a thousand or more acres in size. Included with it in mapping are small areas of gently sloping Sheffield soils and small areas of Platea and Alden soils.

This soil is poorly suited to most crops grown in the county. It is better suited to crops that tolerate wetness and to hay, pasture, woodland, and wildlife habitat than to other uses. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to about 24 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly a high water table and very slow permeability. Capability unit IIIw–3.

Shelmadine Series

The Shelmadine series consists of deep, poorly drained, nearly level and gently sloping soils. These soils formed in material, weathered from glacial till, that contains sandstone, shale, siltstone, granite, and quartzite. They are on upland flats and in depressions.

In a representative profile the surface layer is very dark gray silt loam 3 inches thick. The next layer is gray silt loam 5 inches thick. The upper part of the subsoil, to a depth of 22 inches, is grayish-brown and gray, friable silt loam that has strong-brown mottles below a depth of 13 inches. The lower part of the subsoil, between depths of 22 and 45 inches, is grayish-brown and dark-brown, very firm and brittle silt loam and gravelly silty clay loam that has strong-brown and gray mottles. The substratum is brown channery loam that extends to a depth of 56 inches.

Shelmadine soils have slow permeability and a moderate available water capacity. A high water table is at or near the surface much of the year. Most areas of these soils are in pasture or woodland, but a few areas are idle. Management concerns are mainly the high water table and the slow permeability.

Representative profile of Shelmadine silt loam, 0 to 3 percent slopes, in a pasture 4 miles northeast of Titusville along township road T–918:

A1—0 to 3 inches, very dark gray (10YR 3/1) silt loam; weak, medium and coarse, subangular blocky structure; friable, nonsticky and nonplastic; 5 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

A2g—3 to 8 inches, gray (10YR 5/1) silt loam; weak, fine, granular structure; friable, slightly sticky and slightly plastic; 5 percent coarse fragments; strongly acid; clear, smooth boundary.

B1g—8 to 13 inches, grayish-brown (10YR 5/2) silt loam; weak, fine, granular structure; friable, sticky and plastic; 5 percent coarse fragments; strongly acid; clear, wavy boundary.

B2tg—13 to 22 inches, gray (10YR 6/1) silt loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; friable, sticky and plastic; common thin clay films on ped faces; 5 percent coarse fragments; strongly acid; clear, wavy boundary.

Bx1—22 to 34 inches, grayish-brown (10YR 5/2) silt loam; grayish-brown (10YR 5/2) prism faces; many, coarse, distinct, strong-brown (7.5YR 5/6) mottles; strong, very coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; very firm and brittle, sticky and plastic; common black coatings; common thin clay films on ped faces; 5 percent coarse fragments; very strongly acid; gradual, wavy boundary.

Bx2—34 to 45 inches, dark-brown (10YR 4/3) gravelly silty clay loam; gray (10YR 6/1) prism faces; many, coarse, distinct, gray (10YR 6/1) mottles; moderate, very coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; very firm and brittle, sticky and plastic; common black coatings; many thick clay films on ped faces; 20 percent coarse fragments; very strongly acid; gradual, wavy boundary.

C—45 to 56 inches, brown (10YR 5/3) channery loam; massive; friable, nonsticky and nonplastic; 25 percent coarse fragments; very strongly acid.

The solum ranges from 42 to 60 inches in thickness. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). Some profiles have an Ap horizon, which ranges from very dark gray (10YR 3/1) to grayish brown (10YR 5/2). It is extremely acid or very strongly acid.

The B2 horizon ranges from gray (10YR 6/1) to grayish brown (10YR 5/2) and from silt loam to channery silty clay loam. It is extremely acid to strongly acid. Depth to the fragipan ranges from 20 to 30 inches. The Bx horizon ranges from dark brown (7.5YR 4/2) to yellowish brown (10YR 5/4) and from silt loam to channery or gravelly silty clay loam. It is extremely acid to strongly acid.

The C horizon ranges from gray (10YR 5/1) to brown (10YR 5/3) and from channery loam to silt loam.

Shelmadine soils are associated on the landscape with the somewhat poorly drained Alvira soils and the moderately well drained Hanover soils. They are wetter than those soils.

Shelmadine silt loam, 0 to 3 percent slopes (SmA).—This nearly level soil has the profile described as representative of the series. It is in fan-shaped areas of 5 to 20 acres and in elongated areas of 20 to 50 acres.

Included with this soil in mapping are a few areas of gently sloping Shelmadine and Alvira soils and small areas of very stony Shelmadine soils.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to crops that

tolerate wetness and to hay, pasture, woodland, and wildlife habitat than to other uses. Surface runoff is slow to ponded. The depth to which roots and moisture can penetrate is limited to about 22 inches by a firm and brittle layer. Artificial drainage makes the soil more suitable for crops. Management concerns are mainly a high water table and slow permeability. Capability unit IVw–1.

Shelmadine silt loam, 3 to 8 percent slopes (SmB).—This gently sloping soil is in fan-shaped and elongated areas 5 to 50 acres in size. Included with it in mapping are small areas of nearly level Shelmadine and Alvira soils and small areas of very stony Shelmadine soils.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to crops that tolerate wetness and to hay, pasture, woodland, and wildlife habitat than to other uses. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to about 20 inches by a firm and brittle layer. Artificial drainage makes the soil more suitable for crops. Management concerns are mainly a high water table and slow permeability. Capability unit IVw–1.

Valois Series

The Valois series consists of deep, well-drained, gently sloping to very steep soils. These soils formed in material, weathered from glacial till, that contains sandstone, siltstone, shale, some limestone, and granite. They are on upland hills, ridges, knobs, and side slopes of steep valleys.

In a representative profile the surface layer is dark-brown gravelly silt loam 8 inches thick. The upper part of the subsoil, to a depth of 23 inches, is yellowish-brown and dark yellowish-brown, friable gravelly silt loam. The lower part of the subsoil, between depths of 23 and 57 inches, is dark-brown and brown, friable gravelly loam. The substratum is dark yellowish-brown gravelly loam that extends to a depth of 70 inches.

Valois soils have moderate permeability and a high available water capacity. Most areas of these soils are cleared and are used for crops, hay, or pasture, but some areas are in woodland. Management concerns are mainly coarse fragments and slope.

Representative profile of Valois gravelly silt loam, 3 to 8 percent slopes, in a cultivated field, 5 miles south of Meadville (Pennsylvania Department of Transportation test samples BP–21608 and BP–21609 were taken from this profile):

Ap—0 to 8 inches, dark-brown (7.5YR 3/2) gravelly silt loam; moderate, fine, granular structure; friable, slightly sticky and slightly plastic; 15 percent coarse fragments; medium acid; abrupt, smooth boundary.

B1—8 to 15 inches, yellowish-brown (10YR 5/4) gravelly silt loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; 15 percent coarse fragments; very strongly acid; clear, wavy boundary.

B21t—15 to 23 inches, dark yellowish-brown (10YR 4/4) gravelly silt loam; moderate, fine to medium, subangular blocky structure; friable, slightly sticky and slightly plastic; few thin clay films on ped faces and in pores; 30 percent coarse fragments; very strongly acid; gradual, wavy boundary.

B22t—23 to 33 inches, dark-brown (10YR 4/3) gravelly loam; weak, fine to medium, subangular blocky structure; friable, slightly sticky and slightly plastic; few thin clay films in pores and on ped faces; 35 percent coarse fragments; very strongly acid; gradual, wavy boundary.

B23t—33 to 41 inches, dark-brown (10YR 4/3) gravelly loam; weak, fine and medium, subangular blocky structure; friable, slightly sticky and slightly plastic; few thin clay films in pores and on ped faces; 35 percent coarse fragments; very strongly acid; gradual, wavy boundary.

B24t—41 to 57 inches, brown (10YR 5/3) gravelly loam; small patches of yellowish red (5YR 5/6); weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; few thin clay films on ped faces and in pores; 35 percent coarse fragments; strongly acid; clear, wavy boundary.

C—57 to 70 inches, dark yellowish-brown (10YR 4/4) gravellly loam; moderate, medium, platy structures; firm, slightly sticky and slightly plastic; 20 percent coarse fragments; medium acid.

The solum ranges from 46 to 70 inches in thickness. Depth to bedrock ranges from 48 to 120 inches or more. The Ap horizon ranges from dark brown (7.5YR 3/2) to brown (10YR 5/3) and from sandy loam to gravelly silt loam. The B1 horizon ranges from yellowish brown (10YR 5/4) to strong brown (7.5YR 5/6) and from gravelly loam to channery silt loam. It is very strongly acid or strongly acid. The B2 horizon ranges from strong brown (7.5YR 5/6) to dark brown (10YR 4/3) and from loam to gravelly silt loam. The C horizon ranges from dark brown (7.5YR 4/2) to yellowish brown (10YR 5/6) and from fine sandy loam to loam. It is medium acid to neutral.

Valois soils in Crawford County have a more strongly developed B horizon than is within the range defined for the series, but this difference does not significantly alter their behavior or usefulness.

Valois soils are associated on the landscape with the moderately well drained Cambridge soils, the somewhat poorly drained Venango soils, the poorly drained Frenchtown soils, and the very poorly drained Alden soils. They are better drained than those soils.

Valois gravelly silt loam, 3 to 8 percent slopes (VaB).—This gently sloping soil has the profile described as representative for the series. It is in elongated and oval-shaped areas 2 to 50 acres in size.

Included with this soil in mapping are a few areas of nearly level Valois soils and a few areas of Chenango, Wyoming, Cambridge, Venango, and Frenchtown soils. Also included are a few areas of soils that have a surface layer of sandy loam and a few areas of soils that have bedrock at a depth of 20 to 40 inches.

This soil is well suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is medium. Conservation practices are needed to control erosion and runoff. Management concerns are mainly slope and coarse fragments. Capability unit IIe–1.

Valois gravelly silt loam, 8 to 15 percent slopes (VaC).—This sloping soil is in elongated areas 5 to 50 acres in size and in circular areas 2 to 10 acres in size. Included with it in mapping are small areas of gently sloping Valois soils and a few areas of Chenango, Cambridge, and Venango soils. Also included are some areas of stony Valois soils, some areas of soils that have a surface layer of silt loam, and some areas of soils that have bedrock at a depth of 20 to 40 inches.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is medium. Conservation practices are needed to control erosion and runoff. Management concerns are mainly slope and coarse fragments. Capability unit IIIe–1.

Valois gravelly silt loam, 15 to 25 percent slopes

(VaD).—This moderately steep soil is in long, wavy areas 20 to 300 acres in size and in smaller, rounded areas 2 to 10 acres in size. Included with it in mapping are small areas of sloping Valois soils and small areas of Cambridge soils. Also included are some areas of soils that have a gravel-free surface layer and a few areas of severely eroded soils.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to crops that require limited tillage or to hay, pasture, woodland, or wildlife habitat. Surface runoff is rapid. Conservation practices are needed to control runoff and reduce erosion. Management concerns are mainly slope and coarse fragments. Capability unit IVe–1.

Valois soils, very steep (25 to 60 percent slopes) (VLF).—These soils have a profile similar to the one described as representative of the series, but the surface layer ranges from gravelly silt loam to channery loam or fine sandy loam, and in some areas the surface has a 1 to 15 percent cover of stones. The composition of this mapping unit is more variable than that of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated uses of the soils.

Included with these soils in mapping are a few areas of soils that have bedrock at a depth of 20 to 40 inches and some sizeable areas of moderately well drained and well drained soils that have a slowly permeable fragipan. Also included are some areas of Wyoming and Chenango soils and some areas of soils where part or all of the original surface layer has been removed by erosion.

Steepness is the dominant limitation for use of these soils. Surface runoff is very rapid, and the hazard of erosion is high in cultivated or disturbed areas. Because of the steepness, very rapid surface runoff, and high erosion hazard, these soils are better suited to pasture, woodland, or wildlife habitat than to other uses. Where the soils are wooded, only practices of good woodland management are needed. Management concerns are mainly slope and coarse fragments. Capability unit VIe–1.

Valois-Cambridge complex, 3 to 8 percent slopes (VmB).—These undulating soils are so intermingled that it was not practical to separate them at the scale used in mapping. The Valois soil makes up about 50 to 70 percent of this complex, and the Cambridge soil makes up about 20 to 40 percent. The surface layer ranges from gravelly silt loam to fine sandy loam. These soils are in broad, irregular areas of several acres to 100 acres or more. The Valois soil is on the higher mounded areas, and the Cambridge soil is in the lower surrounding areas.

Included with this complex in mapping are some areas of nearly level Valois and Cambridge soils, some areas of Venango, Frenchtown, and Alden soils, and some areas of soils that have a stony surface and a sandy loam or mucky silt loam surface layer.

The soils in this complex are well suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Artificial drainage of the Cambridge soil increases its suitability for crops. Conservation practices are needed to control erosion and reduce runoff. Management concerns are mainly very slow permeability, a seasonal high water table, and complex slopes. Capability unit IIe–2.

Valois-Cambridge complex, 8 to 15 percent slopes (VmC).—These rolling soils are so intermingled that it was not practical to separate them at the scale used in mapping. The Valois soil makes up about 50 to 70 percent of this complex, and the Cambridge soil makes up about 20 to 40 percent. The surface layer ranges from gravelly silt loam to fine sandy loam. These soils are in crescent- and oval-shaped areas 3 to 5 acres or more in size. The Valois soil is on the higher mounded areas, and the Cambridge soil is in the lower surrounding areas.

Included with this complex in mapping are a few areas of gently sloping Valois and Cambridge soils, a few areas of Venango, Frenchtown, and Alden soils, and a few areas of stony Valois and Cambridge soils. Also included are a few areas of soils that have a surface layer of sandy loam.

The soils in this complex are suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Artificial drainage of the Cambridge soil increases its suitability for crops. Surface runoff is medium. Conservation practices are needed to control erosion and reduce runoff. Management concerns are mainly very slow permeability and complex slopes. Capability unit IIIe–2.

Venango Series

The Venango series consists of deep, somewhat poorly drained, nearly level to sloping soils. These soils formed in material, weathered from glacial till, that contains sandstone, siltstone, and shale. They are on upland flats, knobs, benches, and side slopes of valleys.

In a representative profile the surface layer is dark-brown silt loam 9 inches thick. The upper part of the subsoil, to a depth of 20 inches, is yellowish-brown and olive-brown, friable gravelly silt loam and silt loam that has strong-brown, yellowish-red, and olive-gray mottles. The lower part of the subsoil, between depths of 20 and 50 inches, is dark-brown and olive-brown, firm and brittle silt loam and gravelly silt loam. The substratum is olive-brown gravelly silt loam that extends to a depth of 62 inches.

Venango soils have very slow permeability and a moderate available water capacity. A seasonal high water table is within ½ to 1½ feet of the surface in wet periods. Most areas of these soils are cleared and are used for crops, hay, or pasture, or they are idle. Management concerns are mainly the seasonal high water table and the very slow permeability.

Representative profile of Venango silt loam, 3 to 8 percent slopes, in a cultivated field 0.5 mile north of Blystone Corner and 50 feet east of Route 20127 (Pennsylvania Department of Transportation test samples BP–35548 and BP–35549 were taken from this profile):

Ap—0 to 9 inches, dark-brown (10YR 4/3) silt loam; few, medium, distinct, pale-brown (10YR 6/3) mottles; weak, medium, granular structure; friable, nonsticky and nonplastic; 10 percent coarse fragments; neutral; clear, wavy boundary.

B21—9 to 14 inches, yellowish-brown (10YR 5/4) gravelly silt loam; few, fine, distinct, strong-brown (7.5YR 5/6) and yellowish-red (5YR 5/8) mottles; weak,

fine, granular structure; friable, slightly sticky and slightly plastic; 15 percent coarse fragments; strongly acid; clear, irregular boundary.

B22—14 to 20 inches, olive-brown (2.5Y 4/4) silt loam; common, fine, distinct, light olive-gray (5Y 6/2) and strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; friable, slightly sticky and slightly plastic; 10 percent coarse fragments; strongly acid; gradual, wavy boundary.

Bx1—20 to 32 inches, dark-brown (10YR 4/3) silt loam; light olive-gray (5Y 6/2) prism faces; strong, very coarse, prismatic structure parting to weak, coarse, subangular blocky; firm and brittle, slightly sticky and slightly plastic; thin clay films in pores and pockets; 10 percent coarse fragments; medium acid; clear, wavy boundary.

Bx2—32 to 36 inches, olive-brown (2.5Y 4/4) gravelly silt loam; light brownish-gray (2.5Y 6/2) prism faces; moderate, very coarse, prismatic structure parting to weak, coarse, subangular blocky; firm and brittle, slightly sticky and plastic; thin continuous clay films in pores and pockets; 35 percent coarse fragments; slightly acid; clear, wavy boundary.

Bx3—36 to 50 inches, olive-brown (2.5Y 4/4) gravelly silt loam; light brownish-gray (2.5Y 6/2) prism faces; weak, very coarse, prismatic structure parting to weak, coarse, subangular blocky; firm and brittle, slightly sticky and slightly plastic; thin clay films on secondary ped faces; 30 percent coarse fragments; neutral; gradual, wavy boundary.

C—50 to 62 inches, olive-brown (2.5Y 4/4) gravelly silt loam; massive; firm, slightly sticky and slightly plastic; 40 percent coarse fragments; neutral.

The solum ranges from 36 to 60 inches in thickness. Some profiles have an A1 horizon, which ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The Ap horizon ranges from dark brown (10YR 3/3) to dark gray (10YR 4/1). It is very strongly acid to neutral. The B2 horizon ranges from dark brown (10YR 4/3) to light olive brown (2.5Y 5/4) and from gravelly loam to light silty clay loam. It is very strongly acid or strongly acid. The Bx horizon ranges from grayish brown (10YR 5/2) to olive (5Y 4/4) or yellowish brown (10YR 5/6) and from silt loam to gravelly loam. It is strongly acid to neutral. The C horizon ranges from dark brown (10YR 4/3) to olive brown (2.5Y 4/4). It is neutral or mildly alkaline.

Venango soils are associated on the landscape with the well drained Valois soils, the moderately well drained Cambridge soils, the poorly drained Frenchtown soils, and the very poorly drained Alden soils. They are wetter than the Valois and Cambridge soils and are better drained than the Frenchtown and Alden soils.

Venango silt loam, 0 to 3 percent slopes (VnA).—This nearly level soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thicker. It is in elongated and oval-shaped areas 5 to 25 acres in size.

Included with this soil in mapping are a few small areas of gently sloping Venango soils and a few areas of Frenchtown, Alden, Cambridge, Red Hook, and Caneadea soils. Also included are a few areas of soils that have a sandy loam, stony, or gravelly surface layer and a few areas of soils that have bedrock at a depth of 20 to 40 inches. A few areas of soils that are slightly acid or neutral in the upper part of the subsoil are also included.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is slow. The depth to which roots and moisture can penetrate is limited to 24 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Management concerns are mainly very slow permeability and a seasonal high water table. Capability unit IIIw–2.

Venango silt loam, 3 to 8 percent slopes (VnB).—This gently sloping soil has the profile described as representative of the series. It is in broad, irregularly shaped and elongated areas of 3 to 500 acres and in narrow, elongated and oval-shaped areas of 3 to 15 acres.

Included with this soil in mapping are a few areas of nearly level Venango soils and a few areas of Frenchtown, Cambridge, Caneadea, and Red Hook soils. Also included are a few areas of soils that have a sandy loam, stony, or gravelly surface layer and a few areas of soils that have bedrock at a depth of 20 to 30 inches. A few areas of soils that are slightly acid or neutral in the upper part of the subsoil are also included.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Surface runoff is medium. The depth to which roots and moisture can penetrate is limited to about 20 inches by a firm and brittle layer. Artificial drainage increases the suitability of this soil for crops. Conservation practices are needed to control erosion. Management concerns are mainly very slow permeability and a seasonal high water table. Capability unit IIIw–2.

Venango silt loam, 8 to 15 percent slopes (VnC).—This sloping soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are somewhat thinner. It is in elongated areas 3 to 25 acres in size.

Included with this soil in mapping are a few areas of Valois, Cambridge, Frenchtown, Red Hook, and Caneadea soils and a few areas of soils that have a sandy loam, stony, or gravelly surface layer. Also included are a few areas of gently sloping Venango soils and a few areas of soils that are slightly acid or neutral in the upper part of the subsoil.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. The depth to which roots and moisture can penetrate is limited to about 16 inches by a firm and brittle layer. Surface runoff is medium. Conservation practices are needed to control erosion. Artificial drainage of wet spots and seeps increases the suitability of this soil for crops. Management concerns are mainly slope, a seasonal high water table, and very slow permeability. Capability unit IIIe–4.

Venango very stony silt loam, 0 to 8 percent slopes (VoB).—This nearly level to gently sloping soil has a profile similar to the one described as representative of the series, but the surface layer is darker colored and has as much as a 3 percent cover of stones. It is in irregularly shaped and elongated areas 10 to 50 acres in size.

Included with this soil in mapping are a few areas of Alden, Frenchtown, and Cambridge soils and a few areas of sloping to moderately steep Venango soils. Also included are a few areas of soils that are slightly acid or neutral in the upper part of the subsoil and a few soils that lack a fragipan.

This soil is suited to pasture, woodland, and wildlife habitat. It is not suited to crops, because it is so stony. Surface runoff is slow. Management concerns are mainly stoniness, very slow permeability, and a seasonal high water table. Capability unit VIs–1.

Venango very stony silt loam, 8 to 15 percent slopes (VoC).—This sloping soil has a profile similar to the one described as representative of the series, but the surface layer has as much as a 3 percent cover of stones, the profile is thinner, and mottles are deeper in the profile. It is in elongated areas of 25 to 100 acres and in circular areas of 4 to 20 acres.

Included with this soil in mapping are a few areas of Valois and Cambridge soils and a few areas of gently sloping Venango soils. Also included are a few areas of soils that have a sandy loam or gravelly surface layer.

This soil is suited to pasture, woodland, and wildlife habitat. It is not suited to crops, because it is so stony. Surface runoff is medium. Management concerns are mainly stoniness and very slow permeability. Capability unit VIs–1.

Wyoming Series

The Wyoming series consists of deep, somewhat excessively drained, nearly level to moderately steep soils that formed in material weathered from water-sorted sand, silt, and gravel. These soils are on glacial outwash terraces, valley trains, and kames.

In a representative profile the surface layer is brown gravelly sandy loam 4 inches thick. It has a 2-inch covering of organic material. The subsurface layer, to a depth of 9 inches, is brown gravelly sandy loam. The subsoil, to a depth of 25 inches, is brown and yellowish-brown, friable gravelly sandy loam. The substratum is dark yellowish-brown very gravelly sand that extends to a depth of 60 inches.

Wyoming soils have rapid permeability and a low available water capacity. Most areas of these soils are cleared and are used for crops, hay, or pasture. A few areas are in woodland, and a few are idle. Many areas have been used as a source of sand and gravel. Management concerns are mainly coarse fragments, the rapid permeability, and the low available water capacity.

Representative profile of Wyoming gravelly sandy loam, 8 to 15 percent slopes, in a wooded area 0.5 mile north of State Highway 277 and 0.4 mile west of the intersection of township roads T–741 and T–776:

O1—2 inches to 1 inch, loose leaves and twigs.
O2—1 inch to 0, black organic litter.
A1—0 to 4 inches, brown (10YR 5/3) gravelly sandy loam; weak, fine, granular structure; very friable, nonsticky and nonplastic; 20 percent coarse fragments; very strongly acid; abrupt, smooth boundary.
A2—4 to 9 inches, brown (10YR 5/3) gravelly sandy loam; weak, fine, granular structure; very friable, nonsticky and nonplastic; 25 percent coarse fragments; very strongly acid; clear, wavy boundary.
B1—9 to 12 inches, brown (10YR 5/3) gravelly sandy loam; weak, fine, subangular blocky structure; friable, nonsticky and nonplastic; 25 percent coarse fragments; strongly acid; gradual, wavy boundary.
B2—12 to 18 inches, yellowish-brown (10YR 5/4) gravelly sandy loam; moderate, fine, subangular blocky structure; friable, nonsticky and nonplastic; 35 percent coarse fragments; strongly acid; gradual, wavy boundary.
B3—18 to 25 inches, yellowish-brown (10YR 5/4) gravelly sandy loam; weak, fine, subangular blocky structure; friable, nonsticky and nonplastic; 45 percent coarse fragments; strongly acid; abrupt, wavy boundary.
C—25 to 60 inches, dark yellowish-brown (10YR 4/4) very gravelly sand; massive; very friable, nonsticky and nonplastic; 60 percent coarse fragments; very strongly acid.

The solum ranges from 24 to 35 inches in thickness. Some profiles have an Ap horizon which ranges from brown (10YR 5/3) to very dark grayish brown (10YR 3/2). It contains 20 to 50 percent coarse fragments. The B horizon ranges from brown (7.5YR 5/4) to dark brown (10YR 4/3) and from fine sandy loam to sandy loam. It contains 20 to 60 percent coarse fragments. The C horizon ranges from sandy loam to sand and contains 40 to 70 percent coarse fragments. It is very strongly acid to medium acid.

Wyoming soils are associated on the landscape with the well drained Haven soils, the well drained to somewhat excessively drained Chenango soils, the moderately well drained Braceville soils, and the somewhat poorly drained Red Hook soils. Wyoming soils have a gravelly B horizon that the Haven soils lack. They have more very fine sand and less silt than the Chenango soils. They are better drained than the Braceville and Red Hook soils.

Wyoming gravelly sandy loam, 0 to 3 percent slopes (WyA).—This nearly level soil is in angular areas 5 to 25 acres in size. Included with it in mapping are a few areas of Braceville, Red Hook, Chenango, and Haven soils and a few areas of gently sloping Wyoming soils.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Irrigation is needed in dry periods for adequate crop growth. Surface runoff is slow. Management concerns are mainly coarse fragments, the hazard of ground water pollution, rapid permeability and a low available water capacity. Capability unit IIIs–1.

Wyoming gravelly sandy loam, 3 to 8 percent slopes (WyB).—This gently sloping soil is in elongated areas of 25 to 100 acres and in circular areas of 2 to 5 acres. Included with it in mapping are a few small areas of Chenango and Haven soils and a few areas of sloping Wyoming soils. Also included are a few areas of similar soils that have a surface layer of fine sandy loam and silt loam.

This soil is suited to most crops commonly grown in the county and to pasture, woodland, and wildlife habitat. Irrigation is needed in dry periods for adequate crop response. Surface runoff is slow. Management concerns are mainly slope, rapid permeability, the hazard of ground water pollution, coarse fragments, and a low available water capacity. Capability unit IIIs–1.

Wyoming gravelly sandy loam, 8 to 15 percent slopes (WyC).—This sloping soil has the profile described as representative of the series. It is in elongated areas of 10 to 20 acres and in circular and oblong areas of 3 to 10 acres.

Included with this soil in mapping are a few areas of Chenango and Haven soils and a few areas of moderately steep and gently sloping Wyoming soils. Also included are a few areas of similar soils that have a surface layer of fine sandy loam and silt loam.

This soil is poorly suited to most crops commonly grown in the county. It is better suited to drought-resistant crops and to hay, pasture, woodland, and wildlife habitat. Surface runoff is medium. Conservation practices are needed to control erosion and reduce runoff. Irrigation is needed for adequate crop response. Management concerns are mainly a low available water capacity, slope, rapid permeability, the hazard of ground water pollution, and coarse fragments. Capability unit IVe–2.

Wyoming gravelly sandy loam, 15 to 25 percent slopes (WyD).—This moderately steep soil has a profile similar to the one described as representative of the series, but the subsoil is about 4 inches thinner. It is in oblong, crescent- and oval-shaped areas 2 to 10 acres in size.

Included with this soil in mapping are a few areas of Chenango and Valois soils and a few areas of sloping Wyoming soils.

This soil is better suited to pasture, woodland, or wildlife habitat than to other uses. Management concerns are mainly slope, rapid permeability, low available water capacity, and coarse fragments. Capability unit VIe–1.

Use and Management of the Soils

In this section information about various uses and methods of management of the soils in Crawford County is given. The system of capability classification used by the Soil Conservation Service is explained, and the use of the soils for crops and pasture, for woodland, and for wildlife habitat is discussed. Data on engineering properties of the soils and interpretations of these properties as they affect construction and conservation engineering are given, and the limitations of the soils for uses related to community development and recreation are listed.

Use of the Soils for Crops and Pasture[3]

In the following pages the capability classification is explained, and yields are given for specified crops under two levels of management. The principal crops grown in the county are corn, wheat, oats, and hay. Some cabbage, cucumbers, and beans are grown for canning.

Capability grouping

Some farmers, particularly those who farm on a large scale, find it practical to use and manage alike some of the different kinds of soil on their land. These farmers can make good use of the capability classification system (*11*), a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on permanent limitations of soils when used for field crops, the risk of damage when they are farmed, and the way the soils 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 that require 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 for range, for forest trees, or for engineering.

In the capability system, the soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numbers 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 not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or to 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 a 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, range, woodland, wildlife habitat, 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–1 or IIIw–2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or

[3] Prepared in cooperation with ROBERT L. BOND, State resource conservationist, Soil Conservation Service.

TABLE 2.—*Estimated acre yields*

[In columns A are yields for average management, and in columns B are yields for improved management. The

Soil	Corn		Oats		Wheat	
	A	B	A	B	A	B
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*
Alden silt loam		70				
Alvira silt loam, 0 to 3 percent slopes	50	85	50	60		30
Alvira silt loam, 3 to 8 percent slopes	50	85	50	60		30
Braceville gravelly loam, 0 to 3 percent slopes	60	110	35	75	25	40
Braceville gravelly loam, 3 to 8 percent slopes	60	110	35	75	25	40
Cambridge silt loam, 0 to 3 percent slopes	55	95	55	65	20	35
Cambridge silt loam, 3 to 8 percent slopes	55	95	55	65	20	35
Cambridge silt loam, 8 to 15 percent slopes	50	85	50	60	15	30
Cambridge silt loam, 15 to 25 percent slopes	45	75	45	55	15	25
Cambridge very stony silt loam, 0 to 8 percent slopes						
Cambridge very stony silt loam, 8 to 25 percent slopes						
Cambridge-Venango silt loams, 3 to 8 percent slopes	50	90	50	70		30
Canadice silt loam		70				
Caneadea silt loam, 0 to 3 percent slopes	45	80	45	60		
Caneadea silt loam, 3 to 8 percent slopes	45	80	45	60		
Carlisle muck						
Chenango gravelly silt loam, 0 to 3 percent slopes	60	100	50	75	35	45
Chenango gravelly silt loam, 3 to 8 percent slopes	60	100	50	75	35	45
Chenango gravelly silt loam, 8 to 15 percent slopes	55	90	45	70	30	40
Frenchtown silt loam, 0 to 3 percent slopes	45	80	45	60		
Frenchtown silt loam, 3 to 8 percent slopes	45	80	45	60		
Frenchtown very stony silt loam, 0 to 8 percent slopes						
Halsey silt loam		80				
Hanover silt loam, 0 to 3 percent slopes	75	110	60	75	40	50
Hanover silt loam, 3 to 8 percent slopes	75	110	60	75	35	45
Hanover silt loam, 8 to 15 percent slopes	70	105	55	70	30	40
Hanover very stony silt loam, 0 to 8 percent slopes						
Hanover very stony silt loam, 8 to 25 percent slopes						
Haven silt loam, 0 to 3 percent slopes	85	115	65	75	40	50
Haven silt loam, 3 to 8 percent slopes	85	115	65	75	40	50
Holly silt loam	65	100	50	70		
Holly silty clay loam						
Philo silt loam	90	125	65	80	35	45
Platea silt loam, 3 to 8 percent slopes	50	85	50	65		30
Pope loam	100	130	70	80	40	50
Red Hook loam	50	95	40	70		
Scio silt loam, 0 to 3 percent slopes	60	110	55	80	25	40
Scio silt loam, 3 to 8 percent slopes	60	110	55	80	25	40
Sheffield silt loam	45	80	40	60		
Shelmadine silt loam, 0 to 3 percent slopes	45	70				
Shelmadine silt loam, 3 to 8 percent slopes	45	70				
Valois gravelly silt loam, 3 to 8 percent slopes	75	105	60	75	35	45
Valois gravelly silt loam, 8 to 15 percent slopes	70	100	55	70	30	40
Valois gravelly silt loam, 15 to 25 percent slopes	65	90	50	65	25	35
Valois soils, very steep						
Valois-Cambridge complex, 3 to 8 percent slopes	55	95	55	65	20	35
Valois-Cambridge complex, 8 to 15 percent slopes	50	85	50	60	15	30
Venango silt loam, 0 to 3 percent slopes	50	85	50	65		30
Venango silt loam, 3 to 8 percent slopes	50	85	50	65		30
Venango silt loam, 8 to 15 percent slopes	45	80	45	60		25
Venango very stony silt loam, 0 to 8 percent slopes						
Venango very stony silt loam, 8 to 15 percent slopes						
Wyoming gravelly sandy loam, 0 to 3 percent slopes	50	85	45	70	30	40
Wyoming gravelly sandy loam, 3 to 8 percent slopes	50	85	40	65	30	40
Wyoming gravelly sandy loam, 8 to 15 percent slopes	45	75	40	65	25	35
Wyoming gravelly sandy loam, 15 to 25 percent slopes						

[1] AUM is animal-unit-month, a term used to express the carrying capacity of pasture. It is the number of months during the the pasture.

kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Estimated yields

Table 2 shows estimates of yields, under two levels of management, of the principal crops grown in Crawford County. The estimates are averages for a period of 10 years or more and do not apply to just one season. It is expected that yields, especially under improved management, will increase 10 to 25 percent by 1985 as a result of new varieties of crops and improvements in technology. Yields increased 2 percent a year in Pennsylvania during the 1960's.

of field and forage crops

absence of data indicates that the soil is not suited to the specified crop at the specified level of management]

Potatoes		Hay				Pasture			
		Alfalfa-grass mixture		Grass-legume mixture		Bluegrass		Tall grass	
A	B	A	B	A	B	A	B	A	B
Bu	*Bu*	*Tons*	*Tons*	*Tons*	*Tons*	*AUM* [1]	*AUM* [1]	*AUM* [1]	*AUM* [1]
				1.0	2.5	1.3	3.8	1.7	4.8
	400		3.0	1.5	2.8	2.0	4.3	2.5	5.8
	400		3.0	1.5	2.8	2.0	4.3	2.5	5.8
300	450	2.2	3.6	1.8	3.0	2.4	4.5	3.7	6.8
300	450	2.2	3.6	1.8	3.0	2.4	4.5	3.7	6.8
300	500	2.1	3.5	1.8	3.0	2.4	4.5	3.5	6.7
300	500	2.1	3.5	1.8	3.0	2.4	4.5	3.5	6.7
250	450	2.0	3.4	1.7	2.8	2.3	4.3	3.3	6.5
		1.8	3.2	1.6	2.6	2.2	4.0	3.0	6.2
						1.9	3.6		
						1.7	3.4		
	400		3.4	1.6	3.0	2.2	4.5	3.3	6.5
				1.2	2.8	1.7	4.3	2.0	5.3
				1.4	2.6	1.8	4.0	2.4	5.0
				1.4	2.6	1.8	4.0	2.4	5.0
400	500	2.4	4.2	1.8	3.2	2.4	4.8	4.0	8.0
400	500	2.4	4.2	1.8	3.2	2.4	4.8	4.0	8.0
350	450	2.2	4.0	1.6	2.8	2.2	4.3	3.7	7.7
				1.4	2.6	1.8	4.0	2.4	5.0
				1.4	2.6	1.8	4.0	2.4	5.0
				1.2	2.8	1.7	4.3	2.0	5.3
400	500	2.8	4.2	2.0	3.3	2.7	5.0	4.7	8.0
400	500	2.8	4.2	2.0	3.3	2.7	5.0	4.7	8.0
	500	2.6	4.0	1.9	3.2	2.5	4.8	4.3	7.7
						2.0	4.0		
						1.8	3.8		
500	600	3.2	4.5	2.3	3.5	3.0	5.3	5.3	8.5
500	600	3.2	4.5	2.3	3.5	3.0	5.3	5.3	8.5
				2.3	3.4	3.0	5.2	3.8	6.5
						2.5	4.0		
500	600	3.0	4.3	2.5	3.5	3.3	5.3	5.0	8.2
	400		3.0	1.5	2.8	2.0	4.3	2.5	5.8
550	650	3.5	4.5	2.8	3.5	3.7	5.3	5.8	8.5
				1.2	2.4	1.7	3.7	2.0	4.5
300	550	2.2	4.2	1.8	3.0	2.4	4.5	3.7	6.7
300	550	2.2	4.2	1.8	3.0	2.4	4.5	3.7	6.7
				1.4	2.6	1.8	4.0	2.4	5.0
				1.2	2.4	1.7	3.7	2.0	4.5
				1.2	2.4	1.7	3.7	2.0	4.5
450	500	2.8	4.2	2.0	3.4	2.7	5.2	4.7	8.0
400	450	2.6	4.0	1.9	3.2	2.5	4.8	4.3	7.7
		2.4	3.8	1.8	3.0	2.4	4.5	4.0	7.2
						.8	3.0	2.4	5.8
300	500	2.1	3.5	1.8	3.0	2.4	4.5	3.5	6.7
250	450	2.0	3.4	1.7	2.8	2.3	4.3	3.3	6.5
	400		3.0	1.5	2.8	2.0	4.3	2.5	5.8
	400		3.0	1.5	2.8	2.0	4.3	2.5	5.8
	350		2.8	1.3	2.6	1.7	4.0	2.2	5.3
						1.7	3.4		
						1.5	3.2		
		2.0	3.6	1.0	2.8	1.3	4.3	3.3	6.8
		2.0	3.6	1.0	2.8	1.3	4.3	3.3	6.8
		1.8	3.4	.8	2.4	1.0	3.7	3.0	6.5
						.8	3.0		

[1] grazing season that 1 acre will provide grazing for 1 animal unit (1 cow, 1 horse, 1 mule, 5 hogs, or 7 sheep) without damage to

In columns A are yields to be expected under average management. Average management is defined as follows:

For cultivated crops:

1. Surface and internal drainage are improved, but not enough to provide optimum growing conditions where natural drainage is restricted.
2. Moderate amounts of lime and fertilizer are applied, but a better program of soil testing is needed.
3. Most crop residue is returned to the soil. If low-residue crops are grown, organic

TABLE 3.—*Soil interpretations*

Soil series and map symbols	Hazards and limitations that affect management					
	Erosion hazard	Equipment limitations	Seedling mortality	Plant competition		Windthrow hazard
				Conifers	Hardwoods	
Alden: Ad	Slight	Severe	Severe	Moderate	Moderate	Severe
Alvira: AvA, AvB	Slight	Moderate	Moderate	Severe	Moderate	Moderate
Braceville: BrA, BrB	Slight	Slight	Slight	Severe	Moderate	Slight
Cambridge:						
CaA, CaB, CaC	Slight	Slight	Slight	Severe	Moderate	Slight
CaD	Moderate	Moderate	Slight	Severe	Moderate	Slight
CbB	Slight	Slight	Slight	Severe	Moderate	Slight
CbD	Moderate	Moderate	Slight	Severe	Moderate	Slight
CcB	Slight	Moderate	Moderate	Severe	Severe	Moderate
Canadice: Cd	Slight	Severe	Severe	Moderate	Moderate	Severe
Caneadea: CeA, CeB	Slight	Moderate	Moderate	Severe	Severe	Moderate
Carlisle: CM. Not suitable for commerical timber.						
Chenango: CoA, CoB, CoC.	Slight	Slight	Moderate	Severe	Moderate	Slight
Frenchtown: FhA, FhB, FvB.	Slight	Severe	Severe	Moderate	Moderate	Severe
Halsey: Ha	Slight	Severe	Severe	Moderate	Moderate	Severe
Hanover:						
HnA, HnB, HnC	Slight	Slight	Slight	Severe	Moderate	Slight
HoB	Slight	Slight	Slight	Severe	Moderate	Slight
HoD	Moderate	Moderate	Slight	Severe	Moderate	Slight
Haven: HvA, HvB	Slight	Slight	Moderate	Severe	Moderate	Slight
Holly: Hy, Hz	Slight	Severe	Severe	Severe	Severe	Moderate
Philo: Ph	Slight	Slight	Slight	Severe	Moderate	Slight
Platea: PkB	Slight	Moderate	Moderate	Severe	Severe	Moderate
Pope: Po	Slight	Slight	Slight	Severe	Moderate	Slight
Red Hook: Rh	Slight	Severe	Severe	Moderate	Moderate	Severe
Scio: ScA, ScB	Slight	Slight	Slight	Severe	Moderate	Slight
Sheffield: Sh	Slight	Severe	Severe	Moderate	Moderate	Severe
Shelmadine: SmA, SmB	Slight	Severe	Severe	Moderate	Moderate	Severe

for woodland

Species suitability		Site quality
To favor in existing stands	For planting or seeding	
Pin oak, red maple, sycamore	White pine, white spruce	Excellent for pin oak. Poor for all others.
Yellow-poplar, red oak, ash, sugar maple, red maple, black cherry.	Yellow-poplar, black cherry, larch, Norway spruce, white spruce, white pine.	Good.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, black cherry, larch, red pine, Norway spruce, white pine.	Very good.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, black cherry, larch, Norway spruce, white pine.	Excellent.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, black cherry, larch, Norway spruce, white pine.	Excellent.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, black cherry, larch, Norway spruce, white pine.	Excellent.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, black cherry, larch, Norway spruce, white pine.	Excellent.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, black cherry, larch, Norway spruce, white pine.	Excellent.
Pin oak, red maple, sycamore	White pine, white spruce	Excellent for pin oak. Poor for all others.
Red oak, yellow-poplar, sugar maple, black cherry, ash.	Yellow-poplar, larch, white pine, black cherry, Norway spruce.	Very good.
Yellow-poplar, red oak, ash, sugar maple, black cherry.	Yellow-poplar, black cherry, larch, red pine, Norway spruce, white pine.	Excellent.
Red oak, ash, sugar maple, black cherry, yellow-poplar.	Yellow-poplar, larch, Norway spruce, white spruce, white pine, black cherry.	Excellent.
Pin oak, red maple, sycamore	White pine, white spruce	Excellent for pin oak. Poor for all others.
Yellow-poplar, black cherry, red oak, ash, sugar maple, black walnut.	Yellow-poplar, black cherry, larch, Norway spruce, red pine, white pine, black walnut.	Excellent.
Yellow-poplar, black cherry, red oak, ash, sugar maple, black walnut.	Yellow-poplar, black cherry, larch, Norway spruce, red pine, white pine, black walnut.	Excellent.
Yellow-poplar, black cherry, red oak, ash, sugar maple, black walnut.	Yellow-poplar, black cherry, larch, Norway spruce, red pine, white pine, black walnut.	Excellent.
Yellow-poplar, black cherry, red oak, ash, black walnut, sugar maple.	Yellow-poplar, black walnut, black cherry, larch, Norway spruce, white pine.	Very good.
Pin oak, red maple, sycamore	White pine, white spruce	Excellent for pin oak. Fair for all others.
Yellow-poplar, black cherry, ash, red oak, black walnut, sugar maple.	Yellow-poplar, black cherry, Norway spruce, red pine, white pine, black walnut, larch.	Excellent.
Yellow-poplar, ash, sugar maple, red oak, black cherry.	Yellow-poplar, larch, Norway spruce, white pine, black cherry.	Very good.
Yellow-poplar, red oak, black cherry, sugar maple, black walnut, ash.	Yellow-poplar, black cherry, Norway spruce, white pine, black walnut, larch.	Excellent.
Black cherry, red oak, ash, sugar maple, yellow-poplar.	Norway spruce, yellow-poplar, larch, white pine, black cherry.	Very good.
Red oak, ash, sugar maple, red maple, black cherry, yellow-poplar.	Yellow-poplar, larch, Norway spruce, white pine, white spruce, black cherry.	Very good.
Yellow-poplar, red oak, ash, sugar maple	Yellow-poplar, larch, Norway spruce, white pine	Very good.
Red oak, ash, sugar maple, white pine	White pine, larch, Norway spruce	Good.

TABLE 3.—*Soil interpretations*

Soil series and map symbols	Hazards and limitations that affect management					
	Erosion hazard	Equipment limitations	Seedling mortality	Plant competition		Windthrow hazard
				Conifers	Hardwoods	
Valois:						
VaB, VaC	Slight	Slight	Slight	Severe	Moderate	Slight
VaD	Moderate	Moderate	Slight	Severe	Moderate	Slight
VLF	Severe	Severe	Slight	Severe	Moderate	Slight
VmB, VmC	Slight	Slight	Slight	Severe	Moderate	Slight
Venango: VnA, VnB, VnC, VoB, VoC.	Slight	Moderate	Moderate	Severe	Severe	Moderate
Wyoming:						
WyA, WyB, WyC	Slight	Slight	Moderate	Severe	Moderate	Slight
WyD	Slight	Moderate	Moderate	Severe	Moderate	Slight

matter is supplied by growing cover crops and applying manure or other organic material.
4. Seedbed preparation is either inadequate or excessive, and the soil may be worked when it is too wet or too dry.
5. Weeds and insects are not adequately controlled.
6. Crop variety, seed quality, and plant population are not considered for a specified soil or location.
7. Control of erosion is inadequate.

For hay and pasture grasses:
1. Drainage is improved but not enough to provide optimum growing conditions where natural drainage is restricted.
2. Moderate amounts of lime and fertilizer are applied, but a better program of soil testing is needed.
3. Reseeding is generally delayed until after the legumes have disappeared from the forage stand and the grasses show serious nitrogen deficiency.
4. Grass-legume stands are of medium quality, crop variety and seed quality and quantity are not considered, and seedbed preparation may be inadequate.
5. Field operations are generally timely.
6. The entire pasture is grazed, and it may be overgrazed late in summer and in fall.
7. Runoff and erosion on steep slopes are not controlled.

Yields given in columns B are those to be expected under improved management. Improved management is defined as follows:

For cultivated crops:
1. Surface and internal drainage provide optimum growing conditions where natural drainage is restricted.
2. Lime, phosphate, potash, nitrogen, and other elements are supplied according to crop needs as indicated by soil tests.
3. All crop residue is returned to the soil. If low-residue crops are grown, organic matter is supplied by growing cover crops and by applying manure or other organic material.
4. Seedbed preparation is limited to that needed for crop production. Tillage is avoided when the soils are wet, and spring tillage is delayed until planting time. If plowed in fall, fields are left rough in winter.
5. Weeds and insects are adequately controlled.
6. Crop variety, seed quality, and plant population are considered for a specified soil and location.
7. Erosion is kept to a minimum.
8. Field operations are generally timely.

For hay and pasture grasses:
1. Surface and internal drainage provide optimum growing conditions.
2. Lime and fertilizer are applied at seeding time according to crop needs as indicated by soil tests, and they also are applied as topdressing as needed.
3. Stands are reseeded and reestablished regularly.
4. Grass-legume stands are of high quality, and crop variety is considered for a specified soil and location.
5. Field operations are timely.
6. Grazing is deferred and rotated as needed.

Use of the Soils for Woodland[4]

Crawford County originally had a dense cover of trees, but cutting for commercial purposes and clear-

[4] By V. C. MILES, woodland specialist, Soil Conservation Service.

for woodland—Continued

Species suitability		Site quality
To favor in existing stands	For planting or seeding	
Yellow-poplar, ash, sugar maple, red oak, black cherry.	Yellow-poplar, black cherry, larch, Norway spruce, red pine, white pine.	Very good.
Yellow-poplar, ash, sugar maple, red oak, black cherry.	Yellow-poplar, black cherry, larch, Norway spruce, red pine, white pine.	Very good.
Yellow-poplar, ash, sugar maple, red oak, black cherry.	Yellow-poplar, black cherry, larch, Norway spruce, red pine, white pine.	Very good.
Yellow-poplar, red oak, black cherry, ash, sugar maple.	Yellow-poplar, black cherry, larch, red pine, white pine, Norway spruce.	Very good.
Yellow-poplar, black cherry, red oak, ash, sugar maple.	Yellow-poplar, black cherry, larch, Norway spruce, white pine.	Excellent.
Yellow-poplar, black cherry, red oak, ash, sugar maple.	Yellow-poplar, larch, Norway spruce, white pine, black cherry.	Very good.
Yellow-poplar, black cherry, red oak, ash, sugar maple.	Yellow-poplar, larch, Norway spruce, white pine, black cherry.	Very good.

ing for farms has removed nearly all of the virgin stands of timber. Now the commercial woodland, which occupies 46 percent of the land area, consists of second and third growth stands.

The principal forest types that make up the present commercial woodland and the proportionate extent of each as given by the U.S. Forest Service (*4*) follow:

Forest type:	*Percent*
White pine — Fifty percent or more of the stand is eastern white pine.	5
Virginia-pitch pine — Fifty percent or more of the stand is Virginia pine, pitch pine, or other yellow pines or a combination of these.	1
Oak-hickory — Fifty percent or more of the stand is upland oak or hickory or both. The stand also includes the yellow-poplar-oak forest type.	27
Elm-ash-red maple — Fifty percent or more of the stand is American elm, black ash, or red maple or a combination of these. Red maple stands make up most of the acreage on upland sites.	23
Maple-beech-birch — Fifty percent or more of the stand is sugar maple, beech, or yellow birch or a combination of these. The stand includes the black cherry forest type.	18
Aspen-birch — Fifty percent or more of the stand is aspen, paper birch, gray birch, or pin cherry or a combination of these.	23
Other oak types	3

Saw timber makes up approximately 47 percent of the acreage in commercial forests, pole timber 17 percent, seedlings and saplings 30 percent, and nonstocked areas the rest (*4*).

In general, the soils in the county can support good stands of sugar maple, black cherry, ash, yellow-poplar, and red oak. Trees grow slowly on the shallow soils and on the very poorly drained soils.

In table 3 each soil is rated as to hazards and limitations that affect management, species suitability, and site quality for producing timber. These are discussed in the following paragraphs.

Erosion hazard.—The ratings for erosion hazard indicate the amount or intensity of practices required to reduce or control erosion on the different soils. A rating of *slight* indicates that the risk of erosion is low when wood products are harvested and that few, if any, practices are needed to control erosion. A rating of *moderate* indicates that erosion control measures are needed on skid trails and logging roads immediately after wood products are harvested. A rating of *severe* means that erosion, especially gullying, is a severe hazard when wood products are harvested. Harvesting and other operations should be done across the slope wherever possible. Skid trails and logging roads should be laid out on the lowest grades possible, and systems for water disposal should be carefully maintained during logging. Erosion control measures are needed on logging roads and skid trails immediately after logging.

Equipment limitations.—The ratings for equipment limitations are based on the characteristics of the soils and topographic features that restrict or prohibit the use of equipment for harvesting trees or planting seedlings. Steepness of slope, stoniness, and wetness are the principal soil limitations that restrict the use of equipment. The rating is *slight* if limitations are few. A rating of *moderate* indicates that some limitations exist, such as stones and boulders, moderately steep slopes, or wetness of the soil during part of the year. A rating of *severe* indicates that prolonged wetness of the soil, steepness, or stoniness severely limits the use of equipment. If the rating is severe, track-type equipment is best for general use, and winches or similar special equipment are needed for some kinds of work.

Seedling mortality.—Seedling mortality refers to the loss of naturally occurring or planted tree seedlings resulting from unfavorable characteristics of the soils. The rating is *slight* if no more than 25 percent of the planted seedlings are likely to die, and satisfactory

restocking from the initial planting can be expected. Adequate restocking ordinarily results from natural regeneration. *Moderate* indicates that between 25 and 50 percent of the planted seedlings are likely to die and that some replanting is ordinarily needed. Natural regeneration cannot always be relied on for adequate and early restocking. *Severe* indicates that more than 50 percent of the planted seedlings are likely to die, and that special preparation of the seedbed, superior planting techniques, and considerable replanting are needed for adequate and immediate restocking. Restocking cannot be expected to result from natural regeneration if the rating for seedling mortality is severe.

Plant competition.—Plant competition refers to the rate at which brush, grass, and undesirable trees are likely to invade the stand on the different kinds of soil. Plant competition is *slight* if unwanted plants do not prevent adequate natural regeneration and early growth and do not interfere with adequate development of planted seedlings. It is *moderate* if competing plants delay both establishment and growth of naturally or artificially regenerated seedlings but do not prevent the natural development of a fully stocked, normal stand. Competition is *severe* if adequate natural or artificial regeneration can be obtained only by intensive site preparation and maintenance, including weeding.

Windthrow hazard.—The ratings of windthrow hazard are based on soil characteristics that affect the development of tree roots and, consequently, the likelihood that trees will be uprooted by wind. A rating of *slight* indicates that normally no trees are blown down by wind. *Moderate* indicates that some trees are expected to be blown down during periods of excessive soil wetness and high wind. *Severe* indicates that many trees are expected to be blown down during periods of soil wetness and moderate or high wind.

Species suitability.—The trees listed under species suitability are well suited to the site, grow rapidly, and generally have good economic value. The trees to favor in existing stands should be considered in planning the development of existing woodland. The objectives of the landowner determine which species to favor when new plantations are planned. The trees listed for planting or seeding are those best suited to the particular soils.

Site quality.—Site quality indicates the general suitability of the soils for timber. The ratings are based on sample plots located within the county and in adjacent counties. Other soils in the county that have characteristics similar to those of the soils studied were assumed to have approximately the same rating.

The ratings are based on site index, the average height attained by the dominant and co-dominant trees at the age of 50 years. Foresters using this rating can determine the volume of timber that normal stands will produce at different ages. A rating of *excellent* indicates that the site index is 85 or better, and the expected yield at age 50 is more than 13,750 board feet per acre (International rule). *Very good* indicates that the site index is 75 to 84, and the expected yield at age 50 is about 13,750 board feet per acre. *Good* indicates that the site index is 65 to 74, and the expected yield at age 50 is about 9,750 board feet per acre. *Fair* indicates that the site index is 55 to 64, and the expected yield at age 50 is about 6,300 board feet per acre. *Poor* indicates that the site index is less than 54, and the expected yield at age 50 is less than 3,250 board feet per acre. Yield information on oak is based on data by G. L. Schnur (*6*). Published data for oak do not go beyond a site index of 80.

The site index for other trees, such as white pine, sugar maple, ash, yellow-poplar, and black cherry, vary somewhat, but the taller trees of the same species at age 50 grow on the better sites. More information on site index for other tree species can be obtained from the Soil Conservation Service and the Bureau of Forests, Pennsylvania Department of Environmental Resources.

Sixty-four percent of the existing woodland in the county is on excellent, very good, and good sites. Thirteen percent is on fair sites, and 23 percent is on poor sites.

The soils and the climate of Crawford County are generally favorable for growing trees. A landowner can improve the growth of the more desirable kinds of trees by using good woodland management. Help in planning a program of woodland improvement can be obtained from local technicians. How much effort the landowner is willing to make to improve woodland probably depends on general economic conditions.

The returns from soils rated *excellent, very good,* or *good* generally justify management costs. The potential yield, the quality of the particular species growing on the site, and the market potential should be considered. Low-value species and a high proportion of poor-quality stems on such sites may make the cost of management prohibitive. Also, the conversion of such woodland sites from their present quality to their potential quality may not be economically justifiable.

Soils rated *fair* are the most difficult to appraise for management. A thorough appraisal of the species and quality of the site is essential. The market possibility should also be investigated. A proper analysis of these interrelated factors is essential in determining the intensity of management.

The returns from soils rated *poor* generally do not justify the cost of management for wood products. Nonetheless, woodland is generally the most practical and economical use for these soils. Because of their unfavorable characteristics, these soils generally do not show a profitable return in crops or grass.

Use of the Soils for Wildlife [5]

Many species of wildlife, fish, and songbirds are found throughout Crawford County. The soils, topography, and patterns of land use are favorable for increasing the kinds and numbers of these species. The streams and lakes furnish good fishing for muskies, walleyes, largemouth and smallmouth bass, northern pike, and trout.

All the soils in the county are capable of supporting some kind of wildlife, and each kind of soil is generally occupied by several game and nongame species. In planning land use, the soils that are most suitable for

[5] By CLAYTON L. HEINEY, wildlife biologist, Soil Conservation Service.

crops and that have the highest economic value are generally not used entirely for wildlife. Instead, they are used for purposes that bring the highest cash return. Soils used mainly for wildlife are generally those that have severe limitations that make them unsuitable for cultivation.

The kinds and abundance of wildlife depend to a large extent on the type of habitat available. An area is inhabited by the species of wildlife whose habitat requirements are met by the vegetation in the area. The vegetation, in turn, depends to a great extent on the kinds of soil. If the area is altered by drainage, cultivation, or other practices used in managing farms or woodland, the kinds and patterns of vegetation change. This can cause a change in the kinds and numbers of wildlife.

The soils in Crawford County can be used to develop suitable wildlife habitat in woodlands, parks, preserves, and refuges. In addition, the streams, lakes, and reservoirs have potential for greater use.

The following paragraphs describe the major kinds of wildlife in Crawford County. The soil associations are described in the section "General Soil Map." The location of each soil association is shown on the general soil map at the back of this survey.

Cottontail rabbits are the most abundant small-game species in the county. These animals are found throughout the county and are most abundant in the upland areas of the Valois-Cambridge association. Rabbits prefer brushy areas interspersed with areas of cropland and grassland, and they are more numerous there than in large crop fields or wooded areas. The habitat can be improved for rabbits by cutting back the vegetation along the borders of wooded areas and by planting grasses and legumes in the borders.

Ring-necked pheasants are moderately abundant in the county. Large numbers of these birds, however, are raised by the Pennsylvania Game Commission and released each fall. Pheasant population is somewhat reduced by snow which covers the county for long periods during the winter. Pheasants are most numerous in the upland areas of the Venango-Frenchtown-Cambridge association where fields of corn and small grain are interspersed with grassland and woodland.

Ruffed grouse are abundant throughout the county on the Venango-Frenchtown-Cambridge association, the Valois-Cambridge association, the Sheffield-Platea association, and the Hanover-Alvira association. Ruffed grouse are found in heavily wooded areas, but they prefer brushy and open areas. Their habitat is much like that of white-tailed deer.

Gray squirrels are moderately abundant throughout the county on all soil associations except the Holly-Red Hook-Chenango association. They are most common in areas where mature oak, hickory, and walnut trees are plentiful. Squirrels prefer the more remote wooded areas of the county, but a few live in urban areas.

Wild turkeys live throughout the county on all soil associations except the Holly-Red Hook-Chenango association. They are most numerous in the large unbroken tracts of forest in the Valois-Cambridge association. Turkeys prefer mature forests that produce mast.

White-tailed deer are moderately abundant throughout the county. They prefer large wooded areas adjacent to corn fields or pastures. They are more numerous in the northern half of the county on the Venango-Frenchtown-Cambridge association, the Valois-Cambridge Association, and the Holly-Red Hook-Chenango association.

Raccoons are the most abundant of the small nongame animals in the county. They use areas of woodland for nesting, and are mostly found along streams. In summer they are most numerous along streams where fields of corn and small grain are interspersed with woodland. These areas are in the Venango-Frenchtown-Cambridge association, the Sheffield-Platea association, the Hanover-Alvira association, and the Holly-Red Hook-Chenango association.

Fox are moderately abundant in wooded areas throughout the county and especially on the Holly-Red Hook-Chenango association. They are also numerous in wooded areas on the Valois-Cambridge association. They prefer wooded or brushy areas interspersed with areas of cropland and grassland.

Beaver are quite abundant throughout the county. They are found mostly in streams, lakes, and wetland sites on the Holly-Red Hook-Chenango association where aspen, black alder, and willow grow plentifully.

A few bear migrate through the county. They are more numerous in the northeastern part of the county where the tracts of forest are larger and unbroken.

Waterfowl of many kinds are found in the county. Thousands of Canada geese migrate through it, and many stay and nest in the county. The major nesting sites are Pymatuning Lake and the Erie National Wildlife Area.

Cranes also migrate through the county. Approximately 35 of the birds nest along Woodcock Creek north of Blooming Valley. They are most common on the Holly-Red Hook-Chenango association.

Soil suitability is one of the important factors necessary for the production of desired populations of wildlife. Other important factors are present land use and existing wildlife populations. These two factors must be evaluated by onsite investigation and are not considered in this soil survey. Soil interpretations should be used along with other types of information to determine the suitability of an area for wildlife.

Every species of wildlife requires certain types of soil and vegetation and water for food and cover. Proper manipulation of soil, water, and plants to produce suitable habitat is the most effective means of maintaining and improving wildlife populations. Through knowledge of the properties of soils, it is possible to predict their suitability for the habitat elements essential for wildlife (*1*).

In table 4, the soils of Crawford County are rated according to their suitability for essential elements of wildlife habitat and for kinds of wildlife. The ratings are based on a system proposed by Allan, et al. (*1*).

The numerical ratings used in table 4 indicate the suitability of the soil for various habitat elements and kinds of wildlife. A rating of *1* indicates that the soil suitability is *good*. Habitat generally is easily created, improved, or maintained. Few soil limitations affect management, and satisfactory results can be expected.

A rating of *2* indicates that the soil suitability is *fair*. Habitat generally can be created, improved, or maintained. Moderate soil limitations affect manage-

TABLE 4.—*Suitability of the soils for elements of wildlife habitat and kinds of wildlife*

[A rating of 1 indicates the suitability is good; 2 indicates fair; 3 indicates poor; and 4 indicates very poor. See text for further explanation of ratings]

Soil series and map symbols	Elements of wildlife habitat							Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland	Woodland	Wetland
Alden: Ad	4	3	3	3	3	1	1	3	3	1
Alvira:										
AvA	2	1	1	1	1	2	3	1	1	3
AvB	2	1	1	1	1	3	4	1	1	4
Braceville:										
BrA	1	1	1	1	1	3	3	1	1	3
BrB	1	1	1	1	1	3	4	1	1	4
Cambridge:										
CaA	1	1	1	1	1	3	3	1	1	3
CaB	1	1	1	1	1	3	4	1	1	4
CaC	2	1	1	1	1	4	4	1	1	4
CaD	3	2	1	1	1	4	4	2	1	4
CbB	4	3	1	1	1	3	4	3	1	4
CbD	4	3	1	1	1	4	4	3	1	4
CcB	2	1	1	1	1	3	4	1	1	3
Canadice: Cd	3	2	2	3	3	1	1	3	3	1
Caneadea:										
CeA	2	1	1	1	1	2	2	1	1	2
CeB	2	1	1	1	1	3	4	1	1	4
Carlisle: CM	4	4	4	4	4	4	4	4	4	4
Chenango: CoA, CoB, CoC.	3	2	1	1	1	4	4	2	1	4
Frenchtown:										
FhA	3	2	2	1	1	1	1	2	1	1
FhB	3	2	2	1	1	3	4	2	1	4
FvB	4	3	2	1	1	3	4	3	2	4
Halsey: Ha	4	3	3	3	3	1	1	3	3	1
Hanover:										
HnA, HnB	1	1	1	1	1	3	4	1	1	4
HnC	2	1	1	1	1	4	4	1	1	4
HoB	4	3	1	1	1	3	4	3	1	4
HoD	4	3	1	1	1	4	4	3	1	4
Haven: HvA, HvB	3	2	1	1	1	4	4	2	1	4
Holly: Hy, Hz	3	2	2	2	2	1	1	2	2	1
Philo: Ph	1	1	1	1	1	3	3	1	1	3
Platea: PkB	2	1	1	1	1	3	4	1	1	4
Pope: Po	1	1	1	1	1	3	4	1	1	4
Red Hook: Rh	3	2	1	1	1	1	1	2	1	1
Scio:										
ScA	1	1	1	1	1	3	4	1	1	4
ScB	1	1	1	1	1	4	4	1	1	4
Sheffield: Sh	3	2	2	1	1	1	1	2	1	1
Shelmadine:										
SmA	3	2	2	1	1	1	1	2	1	1
SmB	3	2	2	1	1	3	4	2	1	4

TABLE 4.—*Suitability of the soils for elements of wildlife habitat and kinds of wildlife*—Continued

Soil series and map symbols	Elements of wildlife habitat							Kinds of wildlife		
	Grass and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland	Woodland	Wetland
Valois:										
VaB	1	1	1	1	1	3	4	1	1	4
VaC	2	1	1	1	1	4	4	1	1	4
VaD	3	2	1	1	1	4	4	2	1	4
VLF	4	2	1	1	1	4	4	2	1	4
VmB	1	1	1	1	1	3	4	1	1	4
VmC	2	1	1	1	1	4	4	1	1	4
Venango:										
VnA	2	1	1	1	1	2	2	1	1	2
VnB	2	1	1	1	1	3	4	1	1	4
VnC	2	1	1	1	1	4	4	1	1	4
VoB	4	3	2	1	1	3	2	3	2	3
VoC	4	3	2	1	1	4	4	3	2	4
Wyoming: WyA, WyB, WyC, WyD.	3	2	1	1	1	4	4	2	1	4

ment. Moderate intensity of management and frequent attention are required for satisfactory results.

A rating of *3* indicates that the soil suitability is *poor*. Habitat generally can be created and improved, but severe soil limitations affect management and make the habitat difficult and expensive to maintain.

A rating of *4* indicates that the soil suitability is *very poor*. Under prevailing soil conditions, it is impractical to create, improve, or maintain habitat. Unsatisfactory results are probable.

The ratings indicate only potential suitability for wildlife habitat. Changes in land use can modify the local environment and thus alter the kinds and numbers of wildlife inhabiting the area. Also, the ability of animals to move from place to place and to utilize more than one kind of habitat is not considered in the ratings.

The elements of wildlife habitat and kinds of wildlife in table 4 are described in the following paragraphs.

Grain and seed crops.—Domestic grain- and seed-producing annual plants, such as corn, wheat, and millet.

Grasses and legumes.—Domestic perennial grasses and herbaceous legumes, such as timothy, alfalfa, and reed canarygrass.

Wild herbaceous plants.—Wild grasses and weeds, such as goldenrod and pokeweed.

Hardwood trees.—Deciduous trees, shrubs, and vines, such as oak, dogwood, grapes, and briars.

Coniferous plants.—Cone-bearing trees and shrubs, such as pine, cedar, and yew.

Wetland plants.—Wild herbaceous plants on moist or wet sites, exclusive of submerged and floating aquatic plants. Included are such plants as smartweed, bulrushes, reed canarygrass, and cattails.

Shallow water areas.—Areas in which water is no deeper than 5 feet. Such areas may be natural or created by low dikes, level ditches, and water control devices on marshy streams.

Openland wildlife.—Birds and mammals that live in fields, pastures, meadows, lawns, and areas overgrown with grasses, herbs, vines, or shrubby plants. Examples are quail, pheasant, doves, woodcock, cottontail rabbits, meadowlarks, killdeer, and field sparrow.

Woodland wildlife.—Birds and mammals that live in wooded areas of hardwood or coniferous trees and shrubs or of both. Examples are grouse, turkeys, deer, squirrels, wood thrushes, warblers, and vireos.

Wetland wildlife.—Birds and mammals that live in marshes, swamps, and open water areas. Examples are ducks, geese, rails, snipe, muskrats, and beaver.

Engineering Uses of the Soils [6]

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 soil 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 of the soil survey can be helpful to those who—

[6] JOHN R. JAQUISH, engineer, Soil Conservation Service, assisted in preparing this section.

TABLE 5.—*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 kinds of soil. The
referring to other series that appear in the first column of this table. The symbol > means

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Coarse fraction greater than 3 inches	Percentage passing sieve—				Engineering classification	
				No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Unified	AASHO
	Feet	*Inches*	*Percent*						
Alden: Ad	0	0–10	0	95–100	90–100	85–100	80–100	ML or CL	A–4 or A–6
		10–30	0	90–100	85–100	85–100	80–100	ML or CL	A–4, A–6 or A–7
		30–60	15–25	90–100	85–95	75–95	45–90	ML, CL, or SM	A–4 or A–6
Alvira: AvA, AvB	0.5–1.5	0–25	5–15	90–100	85–100	85–100	65–95	ML or CL	A–4 or A–6
		25–74	5–30	70–95	65–95	60–85	40–75	ML, CL, SM, or SC	A–4 or A–6
Braceville: BrA, BrB	1.5–3.0	0–22	0–30	65–90	50–90	40–85	25–75	ML, SM, or GM	A–2 or A–4
		22–33	15–30	55–90	55–70	50–60	25–55	ML, GM, GC, or SM	A–2 or A–4
		33–54	25–55	40–70	35–55	25–45	15–35	GM or SM	A–2 or A–1
*Cambridge: CaA, CaB, CaC, CaD, CbB, CbD, CcB. For properties of the Venango part of CcB, see the Venango series.	1.5–3.0	0–24	5–10	90–100	90–100	70–90	55–85	ML or CL	A–4 or A–6
		24–50	10–25	60–90	55–85	45–70	30–60	ML, CL GM, GC, or SM	A–4, A–2, or A–6
Canadice: Cd	0–0.5	0–8	0	95–100	90–100	90–100	85–100	ML or CL	A–4 or A–6
		8–50	0	95–100	90–100	90–100	85–100	MH, CH, ML, or CL	A–4, A–6, or A–7
Caneadea: CeA, CeB	0.5–1.5	0–11	0	95–100	90–100	90–100	85–100	ML or CL	A–4 or A–6
		11–70	0	95–100	90–100	90–100	85–100	ML, CL, MH, or CH	A–6 or A–7
Carlisle: CM	0	0–162	0–30	95–100	95–100	90–100	90–100	Pt	A–8
		162–170	0–10	90–100	90–100	50–100	25–100	ML, CL, SC, or SM	A–2, A–4, or A–6
Chenango: CoA, CoB, CoC	>6	0–30	5–25	40–75	30–70	15–65	10–55	ML, SM, or GM	A–2, A–1, or A–4
		30–72	15–45	25–90	20–80	5–35	4–20	SM, GP, GM, or GW	A–1 or A–2
Frenchtown: FhA, FhB, FvB	0–0.5	0–20	0–10	90–100	90–100	85–100	75–95	ML or CL	A–4
		20–56	5–25	90–100	90–100	85–100	65–95	ML or CL	A–4 or A–6
		56–74	15–30	80–100	75–90	65–85	55–75	ML or CL	A–4 or A–6
Halsey: Ha	0	0–8	0–5	65–80	60–75	60–70	55–65	ML or CL	A–4
		8–30	0–10	40–60	25–35	20–30	15–25	SM, SC, GC, or GM	A–2 or A–1
		30–60	10–45	30–60	20–30	5–25	1–15	GW, GP, GM, or SP	A–1
Hanover: HnA, HnB, HnC, HoB, HoD.	1.5–3.0	0–25	0–15	90–100	85–100	80–100	65–95	ML or CL	A–4 or A–6
		25–71	10–20	60–100	50–100	40–100	30–90	ML, GM, SM, or CL	A–2 or A–4

significant in engineering

soils in such mapping units may have different properties, and for this reason it is necessary to follow carefully the instructions for more than; the symbol < means less than. Dashes indicate that estimates were not made]

USDA texture	Permeability	Available water capacity	Reaction	Optimum moisture for compaction	Maximum dry density	Shrink-swell potential	Corrosion potential	
							Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH*	*Percent*	*Pounds per cubic foot*			
Silt loam, silty clay loam	0.6–2.0	0.18–0.26	6.1–7.3	---	---	Low	High	Moderate.
Silty clay loam	0.2–0.6	0.18–0.24	6.1–7.3	14–18	105–115	Moderate	High	Moderate.
Gravelly loam	0.2–0.6	0.12–0.18	6.6–7.8	11–15	114–125	Low	High	Low.
Silt loam	0.6–2.0	0.14–0.20	4.5–6.0	15–17	109–114	Low	High	Moderate.
Silt loam, silty clay loam (fragipan).	0.06–0.2	0.06–0.12	4.0–5.5	10–13	119–124	Low	High	High.
Gravelly loam, silt loam, gravelly silt loam.	0.6–2.0	0.10–0.18	4.5–6.0	12–20	100–120	Low	Moderate	Moderate.
Gravelly silt loam (fragipan).	0.2–0.6	0.05–0.10	4.5–6.0	12–18	110–120	Low	Moderate	Moderate.
Very gravelly sandy loam	0.2–6.0	0.03–0.06	5.1–6.5	6–11	124–130	Low	Moderate	Moderate.
Silt loam	0.6–2.0	0.15–0.20	4.0–5.5	11–15	118–125	Low	Moderate	High.
Gravelly silt loam (fragipan).	<0.06	0.08–0.12	4.5–7.3	8–12	125–130	Low	Moderate	Moderate.
Silt loam	0.6–2.0	0.16–0.20	5.1–6.5	---	---	Moderate	High	Moderate.
Silty clay loam	<0.06	0.08–0.12	5.6–8.4	14–20	105–112	High	Moderate	Moderate.
Silt loam	0.6–2.0	0.16–0.20	5.1–6.5	---	---	Moderate	Moderate	Moderate.
Silty clay loam	<0.06	0.08–0.12	5.1–8.5	16–20	103–110	High	Low	Moderate.
Muck	2.0–6.0	0.20–0.30	4.5–7.3	---	---	Low	Moderate	Moderate.
Silty clay	0.06–0.6	0.08–0.14	6.6–8.4	---	---	Moderate	Moderate	Low.
Gravelly silt loam, gravelly loam.	0.6–6.0	0.06–0.12	4.5–5.5	10–15	115–126	Low	Moderate	Low.
Stratified sand and gravel, very gravelly sandy loam.	>6.0	0.03–0.10	4.5–6.5	6–11	125–130	Low	Moderate	Moderate.
Silt loam	0.6–2.0	0.14–0.20	4.5–6.5	14–17	110–115	Low	High	Moderate.
Gravelly silt loam (fragipan).	0.06–0.2	0.10–0.16	4.5–6.0	14–17	110–115	Low	High	High.
Gravelly loam	0.06–0.2	0.10–0.14	5.6–7.3	10–14	120–127	Low	High	Moderate.
Silt loam	0.6–2.0	0.08–0.12	5.6–7.3	---	---	Low	High	Moderate.
Sandy loam	0.2–0.6	0.03–0.06	5.6–7.3	10–16	105–115	Low	High	Moderate.
Sandy loam, gravelly loamy sand.	0.2–6.0	0.02–0.04	6.6–7.8	8–12	115–125	Low	High	Moderate.
Silt loam	0.6–2.0	0.16–0.20	4.5–6.0	12–16	110–120	Low	Low	Moderate.
Silt loam, loam (fragipan)	0.2–0.6	0.08–0.12	4.5–7.3	10–14	115–124	Low	Low	High.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Coarse fraction greater than 3 inches	Percentage passing sieve—				Engineering classification	
				No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Unified	AASHO
	Feet	*Inches*	*Percent*						
Haven: HvA, HvB	>6	0–30	0	80–100	75–100	70–100	55–95	ML or CL	A–4
		30–65	30–50	35–80	25–60	20–45	12–30	SP, SW, SM, GP, FW, GM, or GC	A–1 or A–2
Holly: Hy, Hz	0	0–36	0	95–100	90–100	90–100	70–90	ML or CL	A–4 or A–6
		36–54	0–40	90–100	80–95	55–75	45–70	ML, CL, or SM	A–4 or A–6
Philo: Ph	1.5–3.0	0–22	0	100	95–100	80–100	80–100	ML	A–4
		22–72	0–10	100	95–100	85–100	25–90	ML or SM	A–2 or A–4
Platea: PkB	0.5–1.5	0–17	0–5	95–100	95–100	90–100	75–90	ML	A–4 or A–6
		17–60	5–35	90–100	80–95	70–90	65–90	ML or CL	A–4 or A–6
Pope: Po	>3	0–30	0	80–100	70–100	60–100	45–100	ML or SM	A–4
		30–57	0–5	60–100	45–100	40–100	25–100	ML or SM	A–2 or A–4
Red Hook: Rh	0.5–1.5	0–32	0–20	85–100	80–100	65–95	30–60	ML, SM, or SC	A–2, A–4, or A–6
		32–60	20–65	40–55	30–55	10–40	1–12	SP, GW, or GP	A–1 or A–2
Scio: ScA, ScB	1.5–3.0	0–30	0	95–100	95–100	90–100	80–100	ML or CL	A–4
		30–65	0–10	60–100	50–100	25–100	15–80	ML, CL, SM, or GM	A–2 or A–4
Sheffield: Sh	0–0.5	0–24	0	95–100	90–100	80–100	70–90	ML or CL	A–4 or A–6
		24–54	0	95–100	90–100	80–95	65–85	ML or CL	A–4 or A–6
Shelmadine: SmA, SmB	0–0.5	0–22	0–5	80–100	75–95	60–90	55–80	ML or CL	A–4
		22–45	0–20	80–100	75–95	60–90	55–80	ML or CL	A–4, A–6, or A–7
		45–56	20–40	70–90	60–85	55–80	45–65	ML, CL, GM, or GC	A–4 or A–6
*Valois: VaB, VaC, VaD, VLF, VmB, VmC. For properties of the Cambridge part of VmB and VmC, see the Cambridge series.	>6	0–15	5–20	65–85	60–85	55–80	35–55	ML, GM, or SM	A–4
		15–57	10–45	55–85	45–85	35–80	20–60	ML, SM, GM, GC, or SC	A–2 or A–4
		57–70	15–50	40–80	35–75	25–70	15–55	SM, GM, ML, or SC	A–2 or A–4
Venango: VnA, VnB, VnC, VoB, VoC.	0.5–1.5	0–20	0–20	80–100	75–95	65–95	55–85	ML or CL	A–4
		20–50	10–45	60–90	55–85	40–75	30–65	ML, CL, GM, GC, or SM	A–2 or A–4
		50–62	20–45	55–80	50–80	35–55	25–55	ML, SM, GM, GC, or SC	A–2 or A–4
Wyoming: WyA, WyB, WyC, WyD.	>6	0–25	15–40	40–80	40–70	15–70	5–45	SM, SP, GM, GP, or GW	A–1, A–2, or A–4
		25–60	40–70	35–70	30–55	10–40	1–12	GP, GM, SM, or SP	A–1 or A–2

significant in engineering—Continued

USDA texture	Permeability	Available water capacity	Reaction	Optimum moisture for compaction	Maximum dry density	Shrink-swell potential	Corrosion potential	
							Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH*	*Percent*	*Pounds per cubic foot*			
Silt loam	0.6–2.0	0.14–0.20	4.5–5.5	12–15	110–120	Low	Moderate	Moderate.
Very gravelly loamy sand	0.6–6.0	0.03–0.08	4.5–5.5	8–12	115–130	Low	Low	Moderate.
Silt loam, silty clay loam	0.2–2.0	0.16–0.20	5.1–7.3	15–20	100–115	Low	High	Moderate.
Fine sandy loam	0.2–2.0	0.08–0.16	4.5–6.0	8–12	105–125	Low	High	Moderate.
Silt loam	0.2–2.0	0.18–0.24	4.5–6.0	15–20	100–115	Low	Moderate	Low.
Very fine sandy loam, sandy loam, loamy sand.	0.2–2.0	0.06–0.18	4.5–6.0	12–18	105–125	Low	Moderate	Moderate.
Silt loam	0.6–2.0	0.16–0.20	4.0–6.0	8–12	110–115	Low	Moderate	Moderate.
Silt loam, silty clay loam (fragipan).	<0.06	0.06–0.10	5.1–7.8	8–15	110–120	Low	Moderate	Low.
Loam, silt loam	0.6–2.0	0.14–0.18	4.5–6.0	15–20	105–112	Low	Moderate	Moderate.
Fine sandy loam	0.6–2.0	0.06–0.10	4.5–6.0	12–21	100–120	Low	Low	Moderate.
Loam, gravelly sandy loam	0.6–2.0	0.10–0.18	5.1–6.5	13–17	110–120	Low	High	Moderate.
Very gravelly sandy loam	0.6–6.0	0.08–0.12	6.1–7.8	10–15	100–120	Low	High	Low.
Silt loam	0.6–2.0	0.16–0.20	5.1–6.0	10–18	105–117	Low	Moderate	Moderate.
Very fine sandy loam	0.6–2.0	0.08–0.12	5.6–6.5	7–10	130–135	Low	Moderate	Moderate.
Silty loam, silty clay loam	0.6–2.0	0.16–0.20	5.1–6.5	12–18	108–120	Low	Moderate	Moderate.
Silt loam (fragipan)	<0.06	0.10–0.14	6.6–7.8	12–18	110–120	Moderate	Low	Low.
Silt loam	0.6–2.0	0.14–0.18	4.0–5.5	17–21	100–112	Low	High	High.
Silt loam, gravelly silty clay loam (fragipan).	0.06–0.2	0.10–0.14	4.0–5.5	17–21	100–112	Moderate	High	High.
Channery loam	0.06–0.2	0.08–0.12	4.5–5.5	14–19	108–116	Low	High	High.
Gravelly silt loam	0.6–2.0	0.10–0.14	4.5–6.0	---	---	Low	Low	Moderate.
Gravelly silt loam, gravelly loam.	0.6–2.0	0.06–0.10	4.5–5.5	10–15	115–120	Low	Low	Moderate.
Gravelly loam	0.6–6.0	0.04–0.08	5.6–7.3	10–15	120–126	Low	Low	Low.
Silt loam, gravelly silt loam	0.6–2.0	0.12–0.18	4.5–7.3	12–15	115–122	Low	High	High.
Silt loam, gravelly silt loam (fragipan).	<0.06	0.08–0.12	5.1–7.3	8–13	118–122	Low	High	Moderate.
Gravelly silt loam	<0.06	0.12–0.18	6.6–7.8	10–15	120–125	Low	High	Low.
Gravelly sandy loam	>6.0	0.06–0.14	4.5–5.5	8–14	118–130	Low	Low	Moderate.
Very gravelly sand	>6.0	0.04–0.08	4.5–6.0	8–12	118–130	Low	Low	Moderate.

TABLE 6.—*Soil interpretations*

[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 instructions for referring to other series that

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway and road location	Ponds Reservoir areas
Alden: Ad	Poor: high water table.	Unsuited: too silty.	Poor: high water table.	High water table; subject to frost action.	High water table.
Alvira: AvA, AvB	Fair to a depth of 25 inches: coarse fragments.	Unsuited: too silty.	Fair: subject to frost action; seasonal high water table.	Seasonal high water table; seepage above fragipan; subject to frost action.	Seasonal high water table.
Braceville: BrA, BrB	Fair to a depth of 16 inches: coarse fragments.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; seepage above fragipan; subject to frost action.	Seasonal high water table; pervious substratum in places.
*Cambridge: CaA, CaB, CaC, CaD, CbB, CbD, CcB. For interpretations of the Venango part of CcB, see the Venango series.	Fair to a depth of 19 inches: coarse fragments.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; seepage above fragipan; subject to frost action.	Seasonal high water table.
Canadice: Cd	Poor: high water table.	Unsuited: too silty.	Poor: high water table.	High water table; subject to frost action.	High water table.
Caneadea: CeA, CeB	Fair to a depth of 11 inches: thin layer.	Unsuited: too silty.	Poor: low strength.	Seasonal high water table; subject to frost action.	Seasonal high water table.
Carlisle: CM	Poor: high water table; organic muck.	Unsuited: organic materials.	Poor: high water table; organic materials.	High water table; organic materials.	High water table; unstable; organic materials; subject to flooding.
Chenango: CoA, CoB, CoC	Poor: coarse fragments.	Fair: too silty	Good	No unfavorable features.	Moderately rapid permeability.
Frenchtown: FhA, FhB, FvB	Fair to a depth of 20 inches: coarse fragments.	Unsuited: too silty.	Poor: high water table.	High water table; seepage above fragipan; subject to frost action.	High water table.

for selected engineering uses

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

Soil features affecting—Continued						
Ponds—Continued Embankments	Drainage for crops and pasture	Sprinkler irrigation	Terraces and diversions	Grassed waterways	Winter grading	Pipeline construction and maintenance
Low strength; susceptible to piping.	Moderately slow permeability; high water table; subject to ponding; outlets difficult to locate.	High water table; moderately slow permeability.	High water table; moderately slow permeability.	High water table; moderately slow permeability.	High water table; forms large frozen clods; plastic materials.	High water table.
Low strength; susceptible to piping.	Slow permeability; seasonal high water table; seepage above fragipan.	Seasonal high water table; fragipan; slow permeability.	Seasonal high water table; some areas are stony; slow permeability.	Seasonal high water table; some areas are stony; slow permeability.	Seasonal high water table; forms large frozen clods; plastic materials.	Seasonal high water table.
Low strength; susceptible to piping.	Moderately slow permeability; high water table; seepage above fragipan.	Seasonal high water table; fragipan; moderately slow permeability.	Seasonal high water table; moderately slow permeability.	Seasonal high water table; moderately slow permeability.	Seasonal high water table.	Seasonal high water table; walls unstable.
Low strength; susceptible to piping.	Very slow permeability; seasonal high water table; seepage above fragipan.	Seasonal high water table; fragipan; very slow permeability.	Seasonal high water table; very slow permeability; some areas are stony; slope.	Seasonal high water table; very slow permeability; some areas are stony; slope.	Seasonal high water table; some areas are stony.	Seasonal high water table; some areas are stony; slope.
Low strength; poor compaction characteristics.	Very slow permeability; high water table; subject to ponding; outlets difficult to locate.	High water table; very slow permeability.	High water table; very slow permeability.	High water table; very slow permeability.	High water table; plastic materials; forms large frozen clods.	High water table; walls unstable.
Low strength; poor compaction characteristics.	Very slow permeability; seasonal high water table.	Seasonal high water table; very slow permeability.	Seasonal high water table; very slow permeability.	Seasonal high water table; very slow permeability.	Seasonal high water table; plastic materials; forms large frozen clods.	Seasonal high water table; walls unstable.
Organic materials.	High water table; subject to flooding; outlets difficult to locate.	High water table; subject to flooding.	High water table.	High water table.	High water table.	High water table; subject to flooding; walls unstable.
Permeable; susceptible to piping.	Well drained to somewhat excessively drained.	Moderately rapid permeability; slope.	Moderately rapid permeability; slope.	Moderately rapid permeability; slope.	No unfavorable features.	Walls unstable.
Low strength; susceptible to piping.	Slow permeability; high water table; seepage above fragipan.	High water table; fragipan; slow permeability.	High water table; slow permeability; some areas are stony.	High water table; slow permeability; some areas are stony.	High water table; plastic materials; forms large frozen clods; some areas are stony.	High water table; walls unstable; some areas are stony.

TABLE 6.—*Soil interpretations for*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway and road location	Ponds: Reservoir areas
Halsey: Ha	Poor: high water table.	Fair below a depth of 30 inches: too silty.	Poor: high water table.	High water table; subject to frost action.	High water table; pervious substratum in places.
Hanover: HnA, HnB, HnC, HoB, HoD.	Fair to a depth of 25 inches: coarse fragments.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; seepage above fragipan; subject to frost action.	Seasonal high water table.
Haven: HvA, HvB	Fair to a depth of 30 inches: coarse fragments.	Fair to poor below a depth of 30 inches: too silty.	Fair: subject to frost action.	Subject to frost action.	Pervious substratum.
Holly: Hy, Hz	Poor: high water table.	Unsuited: too silty.	Poor: high water table.	High water table; subject to frost action; subject to flooding.	High water table; subject to flooding.
Philo: Ph	Good to a depth of 44 inches.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; subject to frost action; subject to flooding.	Seasonal high water table; subject to flooding.
Platea: PkB	Fair to a depth of 17 inches: coarse fragments.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; seepage above fragipan; subject to frost action.	Seasonal high water table.
Pope: Po	Good to a depth of 57 inches.	Unsuited: too silty.	Fair: subject to frost action.	Subject to frost action; subject to flooding.	Subject to flooding.
Red Hook: Rh	Fair to a depth of 13 inches: coarse fragments.	Fair to poor below a depth of 35 inches: too silty.	Poor: seasonal high water table.	Seasonal high water table: subject to frost action.	Seasonal high water table; pervious substratum in places.
Scio: ScA, ScB	Good to a depth of 65 inches.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; subject to frost action.	Seasonal high water table; pervious substratum in places.

selected engineering uses—Continued

Soil features affecting—Continued						
Ponds—Continued						
Embankments	Drainage for crops and pasture	Sprinkler irrigation	Terraces and diversions	Grassed waterways	Winter grading	Pipeline construction and maintenance
Permeable; susceptible to piping.	High water table; outlets difficult to locate; moderately slow permeability.	High water table; moderately slow permeability.	High water table; moderately slow permeability.	High water table; moderately slow permeability.	High water table; forms large frozen clods.	High water table; walls unstable.
Low strength; susceptible to piping.	Moderately slow permeability; seasonal high water table; seepage above fragipan.	Seasonal high water table; fragipan; moderately slow permeability; slope.	Seasonal high water table; moderately slow permeability; some areas are stony; slope.	Seasonal high water table; moderately slow permeability; some areas are stony; slope.	Seasonal high water table; some areas are stony.	Seasonal high water table; some areas are stony; slope; walls unstable.
Low strength; susceptible to piping; permeable.	Well drained ---	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Walls unstable.
Low strength; susceptible to piping.	Moderate to moderately slow permeability; high water table; subject to flooding; outlets difficult to locate.	High water table; subject to flooding; moderate to moderately slow permeability.	High water table; moderate to moderately slow permeability.	High water table; moderate to moderately slow permeability.	High water table; plastic materials; forms large frozen clods.	High water table; walls unstable; subject to flooding.
Low strength; susceptible to piping.	Moderate to moderately slow permeability; seasonal high water table; subject to flooding.	Seasonal high water table; subject to flooding; moderate to moderately slow permeability.	Seasonal high water table; moderate to moderately slow permeability.	Seasonal high water table; moderate to moderately slow permeability.	Seasonal high water table.	Seasonal high water table; walls unstable; subject to flooding.
Low strength; susceptible to piping.	Very slow permeability; seasonal high water table; seepage above fragipan.	Seasonal high water table; very slow permeability.	Seasonal high water table; very slow permeability.	Seasonal high water table; very slow permeability.	Seasonal high water table.	Seasonal high water table; walls unstable.
Low strength; susceptible to piping.	Well drained; subject to flooding.	Subject to flooding.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Subject to flooding.
Low strength; susceptible to piping.	Moderate permeability; seasonal high water table.	Seasonal high water table; moderate permeability.	Seasonal high water table; moderate permeability.	Seasonal high water table; moderate permeability.	Seasonal high water table.	Seasonal high water table; walls unstable.
Low strength; susceptible to piping.	Seasonal high water table.	Seasonal high water table; fragipan.	Seasonal high water table.	Seasonal high water table.	Seasonal high water table.	Seasonal high water table.

TABLE 6.—*Soil interpretations for*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway and road location	Ponds: Reservoir areas
Sheffield: Sh	Poor: high water table.	Unsuited: too silty.	Poor: high water table.	High water table; seepage above fragipan; subject to frost action.	High water table.
Shelmadine: SmA, SmB	Poor: high water table.	Unsuited: too silty.	Poor: high water table.	High water table; seepage above fragipan; subject to frost action.	High water table.
*Valois: VaB, VaC, VaD, VLF, VmB, VmC. For interpretations of the Cambridge part of VmB and VmC, see the Cambridge series.	Poor: coarse fragments.	Poor below a depth of 23 inches: too silty.	Fair to good: subject to frost action.	Subject to frost action.	Pervious substratum in places; slope.
Venango: VnA, VnB, VnC, VoB, VoC.	Fair to a depth of 20 inches: coarse fragments.	Unsuited: too silty.	Fair: subject to frost action.	Seasonal high water table; seepage above fragipan; subject to frost action.	Seasonal high water table.
Wyoming: WyA, WyB, WyC, WyD.	Poor: coarse fragments.	Fair: too silty.	Good	No unfavorable features.	Rapid permeability.

1. Select potential residential, industrial, commercial, and recreation areas.
2. Evaluate alternate routes for roads, highways, pipelines, underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm 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 for the purpose of predicting performance of structures built 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 5, 6, and 7, which show, respectively, several estimated soil properties significant in engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the general soil map and other parts of this publication, can be used to make interpretations in addition to those given in table 6, 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. Also, sites should be inspected 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 meaning to soil scientists that is not known to all engineers. The Glossary defines many of the terms commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*12*) used by the SCS engineers, the Department of Defense, and others, and the AASHO (*2*) system adopted by the American Association of State Highway Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. 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

selected engineering uses—Continued

Soil features affecting—Continued						
Ponds—Continued	Drainage for crops and pasture	Sprinkler irrigation	Terraces and diversions	Grassed waterways	Winter grading	Pipeline construction and maintenance
Embankments						
Low strength; susceptible to piping.	Very slow permeability; high water table; seepage above fragipan.	High water table; fragipan; very slow permeability.	High water table; very slow permeability.	High water table; very slow permeability.	High water table; plastic materials; forms large frozen clods.	High water table; walls unstable.
Low strength; susceptible to piping.	Slow permeability; high water table; seepage above fragipan.	High water table; fragipan; slow permeability.	High water table; slow permeability; some areas are stony.	High water table; slow permeability. some areas are stony.	High water table; plastic materials; forms large frozen clods; some areas are stony.	High water table; walls unstable.
Low strength; susceptible to piping.	Well drained	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Walls unstable.
Low strength; susceptible to piping.	Very slow permeability; seasonal high water table; seepage above fragipan.	Seasonal high water table; fragipan; very slow permeability.	Seasonal high water table; very slow permeability.	Seasonal high water table; very slow permeability;	Seasonal high water table; plastic materials; forms large frozen clods.	Seasonal high water table; walls unstable; some areas are stony.
Permeable; susceptible to piping.	Somewhat excessively drained.	Rapid permeability.	Rapid permeability.	Rapid permeability.	No unfavorable features.	Walls unstable.

classes are designated by symbols for both classes; for example, CL–ML.

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, 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 7; the estimated classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers 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. All of the soil series mapped in the county are deep to bedrock. Following are explanations of some of the columns in table 5.

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

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is smaller 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 of this soil survey.

Permeability is the quality that enables a soil to transmit water or air. It is estimated on the basis of soil characteristics observed in the field, particularly

TABLE 7.—*Engineering*

[Tests performed by the Pennsylvania Department of Transportation in accordance with standard

Soil name and location	Parent material	Engineering report number	Depth from surface	Moisture density [1]		Mechanical analysis [2]		
				Maximum dry density	Optimum moisture	Percentage passing sieve—		
						3 in	1½ in	¾ in
			Inches	*Pounds per cubic foot*	*Percent*			
Alvira silt loam:								
1.5 miles north of Titusville along Route 20103; Oil Creek Township. (Modal)	Glacial till.	BP–23308	12–25	114	16	--------	--------	100
		BP–23309	51–60	122	10	--------	100	99
Braceville gravelly loam:								
0.2 mile east of Randolph school, in Guys Mills. (Modal)	Water sorted sand, silt, and gravel.	BP–34609	10–16	101	20	100	92	90
		BP–34610	22–27	112	14	100	72	67
Caneadea silt loam:								
1 mile southwest of Conneautville and northwest of the intersection of Route 20038 and township road T–725. (Modal)	Glacial lake deposits.	BP–47221	20–29	103	20	--------	--------	100
		BP–47222	41–70	107	19	--------	--------	100
Chenango gravelly silt loam:								
0.5 mile east of Townville on State Highway 408. (Modal)	Glacial outwash.	BP–23310	17–25	119	12	100	98	89
		BP–23311	50–63	129	9	100	80	70
Hanover silt loam:								
2.5 miles northeast of Titusville, Oil Creek Township, 200 feet north of the intersection of Route 20103 and township road T–920. (Modal)	Glacial till.	BP–21612	18–25	113	15	--------	100	97
		BP–21613	56–71	116	14	--------	--------	100
Haven silt loam:								
3 miles north of Cambridge Springs, Cambridge Springs Township, in a gravel pit at the south end of Mitchell's Lake. (Modal)	Glacial stream deposits.	BP–33992	15–21	118	13	--------	100	98
		BP–33993	30–39	122	12	--------	100	87
Philo silt loam:								
3 miles east of Meadville, West Meade Township, between U.S. Highway 322 and French Creek along Route 20027. (Modal)	Stream deposits.	BP–21604	15–24	103	20	--------	--------	--------
		BP–21605	56–70	114	13	--------	--------	--------
Platea silt loam:								
1 mile west of Beaver Center, Beaver Township, on township road T–779, 0.1 mile east of the intersection of township roads T–779 and T–308. (Modal)	Glacial till.	BP–23316	17–22	116	15	--------	--------	100
		BP–23317	53–66	120	13	--------	--------	100

test data

procedures of the American Association of State Highway Officials (AASHO) (*2*)]

Mechanical analysis —continued								Liquid limit	Plasticity index	Classification [3]	
Percentage passing sieve—Continued				Percentage smaller than—							
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHO [4]	Unified [5]
								Percent			
96	92	89	83	81	63	31	23	33	7	A–4(8)	ML
95	91	84	67	64	44	18	13	21	1	A–4(6)	ML
87	86	84	73	71	51	19	11	37	1	A–4(8)	ML
59	55	50	35	32	21	9	6	27	0	A–2–4(0)	GM
99	99	98	96	96	91	75	59	52	23	A–7–6(16)	MH
100	99	99	97	97	94	75	55	46	18	A–7–6(12)	ML
74	67	59	37	34	22	8	6	21	0	A–4(0)	SM
50	37	22	8	7	5	4	4	19	[6] NP	A–1–a(0)	GM
91	88	84	70	67	55	36	29	31	9	A–4(7)	CL
99	98	96	88	86	67	29	21	25	5	A–4(8)	CL–ML
97	96	91	66	62	43	22	13	21	1	A–4(6)	ML
49	37	23	14	13	10	7	6	29	6	A–1–a(0)	GM
----------	----------	100	98	97	78	40	30	38	10	A–4(8)	ML
----------	100	94	26	22	13	5	5	NP	NP	A–2–4(0)	SM
97	94	90	78	76	60	39	30	31	9	A–4(8)	CL
93	88	81	72	70	55	33	23	29	7	A–4(7)	CL–ML

TABLE 7.—*Engineering*

Soil name and location	Parent material	Engineering report number	Depth from surface	Moisture density [1]		Mechanical analysis [2]		
				Maximum dry density	Optimum moisture	Percentage passing sieve—		
						3 in	1½ in	¾ in
			Inches	*Pounds per cubic foot*	*Percent*			
Pope loam:								
4 miles east of Cambridge Springs along Route 20077 and 600 feet south of French Creek. (Modal)	Stream deposits.	BP–35542	15–30	108	16	--------	--------	--------
		BP–35543	30–45	101	21	--------	--------	--------
Sheffield silt loam:								
3 miles west of Beaver Center and 50 feet west of township road T–508. (Modal)	Glacial till.	BP–55528	16–24	109	17	--------	--------	--------
		BP–55529	28–40	115	15	--------	--------	--------
Valois gravelly silt loam:								
5 miles south of Meadville in Union Township between township roads T–530 and T–393. (Modal)	Glacial till.	BP–21608	23–33	119	12	--------	100	81
		BP–21609	57–70	123	11	--------	100	89
Venango silt loam:								
0.5 mile north of Blystone Corner and 50 feet east of Route 20127. (Modal)	Glacial till.	BP–35548	15–20	117	13	--------	100	99
		BP–35549	35–42	119	13	100	95	93

[1] Based on the Moisture-density Relations of Soils Using 5.5-lb. Rammer and 12-in. Drop, AASHO Designation T 99, Method A (*2*).

[2] Mechanical analyses according to the AASHO Designation T 88 (*2*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine

structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of the soil 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 of water in the soil at the wilting point of most crop plants.

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

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, 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, the maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Shrink-swell potential is the 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 or swells as it gets wet. 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.

Corrosion potential or corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity of the soil material. Ratings of soils for corrosivity for concrete are based mainly on soil texture and acidity. Installations that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* indicates a low probability of soil-induced corrosion damage. A rating of *high* indicates a high probability

test data—Continued

Mechanical analysis [2]—continued								Liquid limit	Plasticity index	Classification [3]	
Percentage passing sieve—Continued				Percentage smaller than—							
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHO [4]	Unified [5]
								Percent			
		100	97	93	65	27	20	30	3	A–4(8)	
		100	99	97	70	34	23	39	8	A–4(8)	ML
											ML
100	99	96	84	82	68	45	35	39	16	A–6(10)	CL
100	99	95	82	80	67	41	29	33	12	A–6(9)	CL
68	47	35	27	26	20	13	11	33	10	A–2–4(0)	SC
77	71	63	49	47	35	18	14	23	4	A–4(3)	SM–SC
92	86	78	62	59	43	18	12	22	1	A–4(5)	ML
86	81	75	61	59	45	23	17	26	6	A–4(5)	CL–ML

material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soil.

[3] Classifications based on material smaller than 3 inches.

[4] Based on AASHO Designation M 145–66I (*2*).

[5] Based on the Unified Soil Classification System (*12*).

[6] NP means nonplastic.

of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations of the soils

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and in others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Crawford County. In table 6, ratings of *good, fair,* and *poor* are used to summarize suitability of the soils as sources of topsoil, sand and gravel, and road fill. For all other listed uses, table 6 gives those soil features not to be overlooked in planning, installation, and maintenance.

Following are explanations of some of the columns in table 6:

Topsoil 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; by natural fertility of the material, or the response of plants when fertilizer is applied; and by absence of substances toxic to plants. The texture of the soil material and its content of stone fragments are other characteristics that affect suitability. Also considered in the ratings is the damage that will result to the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance on 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 6 feet of the soil surface. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, nor do they indicate the quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and (2) the relative ease of excavating the material at borrow areas.

Soil properties that most affect highway and road

location are the 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 also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect the 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 full needed to reach an even grade.

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

Embankments require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. The presence of stones or organic material in a soil are among the unfavorable factors.

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

Irrigation of a soil 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 the 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; available water capacity; 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 material; presence of stones or outcropping rock; and steepness of slope. 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 road building when temperatures are below freezing.

Pipeline construction and other shallow excavations for sewer lines, telephone and power transmission lines, basements, open ditches, and cemeteries generally require digging or trenching to a depth of less than 6 feet. Desirable soil properties for construction and maintenance are good workability, moderate resistance to sloughing, gentle slopes, absence of outcropping rock or big stones, and freedom from flooding or a high water table.

Soil test data

Table 7 contains engineering test data for modal profiles of some of the major soil series in Crawford County. These tests were made to help evaluate the soils for engineering purposes. 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.

Moisture-density (or compaction) data are determined as has been explained for table 5.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the soil material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to a plastic state; the liquid limit is the moisture content at which the soil material changes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index in table 7 are based on tests of soil samples.

Use of the Soils for Town and Country Planning

This section of the soil survey provides information on the properties of soils and their effect on selected uses for town and country planning. It will help community planners, developers, and individual landowners determine the most suitable use for a particular area. Other useful information can be found in other parts of the survey, particularly the sections "Descriptions of the Soils" and "Engineering Uses of the Soils." Although the soil map and tables serve as a guide and can eliminate some sites from further consideration, they do not eliminate the need for detailed onsite investigations when a development is being planned. Not considered in rating the soils are their location in relation to established business centers or transportation lines and other economic factors that are important in determining the ultimate use of an area.

The soil limitations in table 8 are *slight, moderate,* or *severe. Slight* means that soil properties are generally favorable for the rated use, or that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Following are explanations of the columns in table 8:

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 is evaluated from a depth of 18 inches to a depth of 6 feet. 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 the water table or rock, and susceptibility to flooding. 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. The presence of large rocks or boulders hinders construction and thereby increases cost.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet until bacteria can decompose the solids. A lagoon has a nearly level floor and has sides or embankments of compacted soil material. It is assumed that the embankment is compacted to medium density and the pond is protected from flooding. Soil properties that affect the pond floor are permeability, organic-matter content, and slope. If the floor needs to be leveled, depth to and condition of the bedrock are important. Soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification (*12*) and the amount of stones, which influences the ease of excavation and compaction of the embankment material.

Dwellings, as rated in table 8, are homes or other buildings three stories or less in height that have an excavation of no more than 8 feet for basements. Buildings that have foundation loads in excess of those equal to three-story dwellings and that have an excavation deeper than 8 feet for basements are excluded from the ratings. Considered in rating the soils are depth to the water table, shrink-swell potential, depth to and kind of bedrock, soil texture, slope, potential frost action, and the hazard of flooding.

In rating soils for lawns and landscaping used at homesites, it is assumed that enough lime and fertilizer is used to grow lawn grasses and ornamental plants. Suitable soil material is needed in sufficient quantities so that desirable trees and other plants can survive and grow well. Among the important soil properties considered for lawns and landscaping are depth to bedrock or to layers that restrict water and roots, texture, slope, depth to the water table, and the presence of stones or rocks.

Local roads and streets, as rated in table 8, 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. The 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.

Soil properties that most affect design and construction of roads and streets are the load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHO (*2*) and Unified (*12*) classifications of the soil material, and also 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.

Sanitary landfill is a method of disposing 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 most suitable soils have moderately slow permeability, can withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before selections are made.

Use of the Soils for Recreation Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 9 the soils of Crawford County are rated according to limitations that affect their use for camp sites, service buildings, paths and trails, picnic areas, playgrounds, and golf fairways.

In table 9 the soils are rated as having *slight*, *moderate*, or *severe* limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A *slight* limitation means that soil properties are generally favorable, and limitations are so minor that they can be overcome easily. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required other than shaping and leveling for tent areas and parking areas. Camp sites are subject to heavy foot traffic and little 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.

Service buildings and dwellings, as rated in table 9, do not have basements, are not more than three stories high, and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for service buildings are those that relate to 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, content of stones, and outcrops of bedrock.

Paths and trails are used for local and cross-country travel on 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.

TABLE 8.—*Soil limitations for*

Soil series and map symbols	Septic tank absorption fields	Sewage lagoons
Alden: Ad	Severe: high water table; moderately slow permeability.	Slight [2]
Alvira:		
AvA	Severe: seasonal high water table; slow permeability.	Moderate: coarse fragments; inflow hazard.
AvB	Severe: seasonal high water table; slow permeability.	Moderate: coarse fragments; inflow hazard; slope.
Braceville: BrA, BrB	Severe: seasonal high water table; moderately slow permeability.	Severe: permeable substratum
Cambridge:		
CaA	Severe: seasonal high water table; very slow permeability.	Slight
CaB	Severe: seasonal high water table; very slow permeability.	Moderate: slope
CaC	Severe: seasonal high water table; very slow permeability.	Severe: slope
CaD	Severe: seasonal high water table; very slow permeability; slope.	Severe: slope
CbB	Severe: seasonal high water table; very slow permeability.	Moderate: slope
CbD	Severe: seasonal high water table; very slow permeability; slope.	Severe: slope
CcB	Severe: seasonal high water table; very slow permeability.	Moderate: slope
Canadice: Cd	Severe: high water table; very slow permeability.	Slight [2]
Caneadea:		
CeA	Severe: seasonal high water table; very slow permeability.	Slight [2]
CeB	Severe: seasonal high water table; very slow permeability.	Moderate: inflow hazard; slope
Carlisle: CM	Severe: high water table	Severe: organic material
Chenango:		
CoA	Slight [2]	Severe: coarse fragments; moderately rapid permeability; hazard of ground water pollution.
CoB	Slight [2]	Severe: coarse fragments; moderately rapid permeability.
CoC	Moderate: hazard of ground water pollution; slope.	Severe: coarse fragments; moderately rapid permeability; slope.
Frenchtown:		
FhA	Severe: high water table; slow permeability.	Slight [2]
FhB, FvB	Severe: high water table; slow permeability.	Moderate: inflow hazard; slope
Halsey: Ha	Severe: high water table; moderately slow permeability.	Severe: permeable substratum
Hanover:		
HnA	Severe: seasonal high water table; moderately slow permeability.	Slight
HnB	Severe: seasonal high water table; moderately slow permeability.	Moderate: slope
HnC	Severe: seasonal high water table; moderately slow permeability.	Severe: slope
HoB	Severe: seasonal high water table; moderately slow permeability.	Moderate: slope
HoD	Severe: seasonal high water table; moderately slow permeability.	Severe: slope

town and country planning

Dwellings	Lawns and landscaping	Local roads and streets	Sanitary landfill (trench)[1]
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Moderate: seasonal high water table.	Slight	Moderate: subject to frost action.	Severe: seasonal high water table; permeable substratum.
Moderate: seasonal high water table.	Slight	Slight	Severe: seasonal high water table.
Moderate: seasonal high water table.	Slight	Slight	Severe: seasonal high water table.
Moderate: seasonal high water table; slope.	Moderate: slope	Moderate: slope	Severe: seasonal high water table.
Severe: slope	Severe: slope	Severe: slope	Severe: seasonal high water table.
Moderate: seasonal high water table; stony.	Moderate: stony	Slight	Severe: seasonal high water table.
Severe: slope	Severe: slope	Severe: slope	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: high water table; organic material; unstable.	Severe: high water table	Severe: high water table; subject to frost action; organic material.	Severe: seasonal high water table.
Slight	Slight	Slight	Severe: moderately rapid permeability.
Slight	Slight	Slight	Severe: moderately rapid permeability.
Moderate: slope	Moderate: slope	Moderate: slope	Severe: moderately rapid permeability.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Moderate: seasonal high water table.	Slight	Slight	Severe: seasonal high water table.
Moderate: seasonal high water table.	Slight	Slight	Severe: seasonal high water table.
Moderate: seasonal high water table; slope.	Moderate: slope	Moderate: slope	Severe: seasonal high water table.
Moderate: seasonal high water table; stony.	Moderate: stony	Slight	Severe: seasonal high water table.
Severe: slope	Severe: slope	Severe: slope	Severe: seasonal high water table.

TABLE 8.—*Soil limitations for town*

Soil series and map symbols	Septic tank absorption fields	Sewage lagoons
Haven: HvA, HvB	Slight[3]	Severe: permeable substratum
Holly: Hy, Hz	Severe: high water table; hazard of flooding; moderate to moderately slow permeability.	Severe: hazard of flooding
Philo: Ph	Severe: seasonal high water table; hazard of flooding; moderately slow permeability.	Severe: hazard of flooding
Platea: PkB	Severe: seasonal high water table; very slow permeability.	Slight[2]
Pope: Po	Severe: hazard of flooding	Severe: hazard of flooding
Red Hook: Rh	Severe: seasonal high water table	Severe: permeable substratum
Scio:		
ScA	Severe: seasonal high water table	Moderate: moderate permeability.
ScB	Severe: seasonal high water table	Moderate: moderate permeability; slope.
Sheffield: Sh	Severe: high water table; very slow permeability.	Slight[3]
Shelmadine:		
SmA	Severe: high water table; slow permeability.	Slight[2]
SmB	Severe: high water table; slow permeability.	Moderate: inflow hazard; slope
Valois:		
VaB	Slight	Moderate: coarse fragments; slope; moderate permeability.
VaC	Moderate: slope	Severe: slope
VaD	Severe: slope	Severe: slope
VLF	Severe: slope	Severe: slope
VmB	Severe: seasonal high water table; very slow permeability.	Moderate: coarse fragments; slope.
VmC	Severe: seasonal high water table; very slow permeability.	Severe: slope
Venango:		
VnA	Severe: seasonal high water table; very slow permeability.	Slight[3]
VnB	Severe: seasonal high water table; very slow permeability.	Moderate: inflow hazard; slope
VnC	Severe: seasonal high water table; very slow permeability.	Severe: slope
VoB	Severe: seasonal high water table; very slow permeability.	Moderate: inflow hazard; slope
VoC	Severe: seasonal high water table; very slow permeability.	Severe: slope
Wyoming:		
WyA	Slight[3]	Severe: coarse fragments; rapid permeability.
WyB	Slight[3]	Severe: coarse fragments; rapid permeability.
WyC	Moderate: hazard of ground water pollution; slope.	Severe: coarse fragments; rapid permeability; slope.
WyD	Severe: slope	Severe: coarse fragments; rapid permeability; slope.

[1] Onsite deep studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water need to be made for landfills deeper than 5 or 6 feet.

and country planning—Continued

Dwellings	Lawns and landscaping	Local roads and streets	Sanitary landfill (trench)[1]
Slight	Slight	Slight	Severe: permeable substratum.
Severe: high water table; hazard of flooding.	Severe: high water table	Severe: high water table; subject to frost action; hazard of flooding.	Severe: high water table; hazard of flooding.
Severe: hazard of flooding	Moderate: hazard of flooding.	Severe: hazard of flooding	Severe: seasonal high water table; hazard of flooding.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: hazard of flooding	Moderate: hazard of flooding.	Severe: hazard of flooding	Severe: hazard of flooding.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table; permeable substratum.
Moderate: seasonal high water table.	Slight	Moderate: subject to frost action.	Severe: seasonal high water table.
Moderate: seasonal high water table.	Slight	Moderate: subject to frost action.	Severe: seasonal high water table.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Severe: high water table	Severe: high water table	Severe: high water table; subject to frost action.	Severe: high water table.
Slight	Slight	Slight	Slight.
Moderate: slope	Moderate: slope	Moderate: slope	Slight.
Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Moderate: seasonal high water table.	Slight	Slight	Severe: seasonal high water table.
Moderate: seasonal high water table; slope.	Moderate: slope	Moderate: slope	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table; slope.	Moderate: seasonal high water table; subject to frost action; slope.	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table; stony.	Moderate: seasonal high water table; subject to frost action.	Severe: seasonal high water table.
Severe: seasonal high water table.	Moderate: seasonal high water table; stony; slope.	Moderate: seasonal high water table; subject to frost action; slope.	Severe: seasonal high water table.
Slight	Moderate: too sandy	Slight	Severe: rapid permeability.
Slight	Moderate: too sandy	Slight	Severe: rapid permeability.
Moderate: slope	Moderate: too sandy; slope	Moderate: slope	Severe: rapid permeability.
Severe: slope	Severe: slope	Severe: slope	Severe: rapid permeability.

[2] Inflow hazard.
[3] Hazard of ground water pollution.

TABLE 9.—*Soil limitations*

Soil series and map symbols	Camp areas	Service buildings and dwellings without basements
Alden: Ad	Severe: high water table	Severe: high water table
Alvira: AvA, AvB	Moderate: seasonal high water table; slow permeability.	Moderate: seasonal high water table.
Braceville: BrA, BrB	Moderate: gravelly; moderately slow permeability.	Slight
Cambridge:		
CaA	Moderate: very slow permeability	Slight
CaB	Moderate: very slow permeability	Slight
CaC	Moderate: very slow permeability; slope.	Moderate: slope
CaD	Severe: slope	Severe: slope
CbB	Moderate: stony; very slow permeability.	Moderate: stony
CbD	Severe: slope	Severe: slope
CcB	Moderate: seasonal high water table; very slow permeability.	Moderate: seasonal high water table.
Canadice: Cd	Severe: high water table	Severe: high water table
Caneadea: CeA, CeB	Moderate: seasonal high water table; very slow permeability.	Moderate: seasonal high water table.
Carlisle: CM	Severe: high water table; organic material.	Severe: high water table; organic material.
Chenango:		
CoA, CoB	Moderate: gravelly	Slight
CoC	Moderate: gravelly; slope	Moderate: slope
Frenchtown: FhA, FhB, FvB	Severe: high water table	Severe: high water table
Halsey: Ha	Severe: high water table	Severe: high water table
Hanover:		
HnA	Moderate: moderately slow permeability.	Slight
HnB	Moderate: moderately slow permeability.	Slight
HnC	Moderate: moderately slow permeability; slope.	Moderate: slope
HoB	Moderate: moderately slow permeability; stony.	Moderate: slope
HoD	Severe: slope	Severe: slope
Haven:		
HvA	Slight	Slight
HvB	Slight	Slight
Holly: Hy, Hz	Severe: high water table	Severe: high water table; hazard of flooding.
Philo: Ph	Moderate: hazard of flooding; modately slow permeability.	Severe: hazard of flooding
Platea: PkB	Moderate: seasonal high water table; very slow permeability.	Moderate: seasonal high water table.

for recreation development

Paths and trails	Picnic areas	Playgrounds	Golf fairways
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Moderate: seasonal high water table.	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.
Moderate: gravelly	Moderate: gravelly	Severe: gravelly	Moderate: seasonal high water table; gravelly.
Slight	Slight	Moderate: seasonal high water table; very slow permeability.	Slight.
Slight	Slight	Moderate: seasonal high water table; very slow permeability; slope.	Slight.
Slight	Moderate: slope	Severe: slope	Moderate: slope.
Moderate: slope Moderate: stony	Severe: slope Slight	Severe: slope Moderate: seasonal high water table; very slow permeability; stony.	Severe: slope. Moderate: stony.
Moderate: stony; slope Moderate: seasonal high water table.	Severe: slope Moderate: seasonal high water table.	Severe: slope Severe: seasonal high water table.	Severe: slope. Moderate: seasonal high water table.
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Moderate: seasonal high water table.	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.
Severe: high water table; organic material.	Severe: high water table; organic material.	Severe: high water table; organic material.	Severe: high water table; organic material.
Moderate: gravelly Moderate: gravelly	Moderate: gravelly Moderate: gravelly; slope	Severe: gravelly Severe: gravelly; slope	Moderate: gravelly. Moderate: gravelly; slope.
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Slight	Slight	Moderate: seasonal high water table; moderately slow permeability.	Slight.
Slight	Slight	Moderate: seasonal high water table; moderately slow permeability; slope.	Slight.
Slight	Moderate: slope	Severe: slope	Moderate: slope.
Moderate: stony	Slight	Moderate: seasonal high water table; moderately slow permeability; stony; slope.	Moderate: stony.
Moderate: stony; slope	Severe: slope	Severe: slope	Severe: slope.
Slight Slight	Slight Slight	Slight Moderate: slope	Slight. Slight.
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Slight	Moderate: hazard of flooding.	Moderate: seasonal high water table; hazard of flooding; moderately slow permeability.	Moderate: hazard of flooding.
Moderate: seasonal high water table.	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.

TABLE 9.—*Soil limitations for*

Soil series and map symbols	Camp areas	Service buildings and dwellings without basements
Pope: Po	Moderate: hazard of flooding	Severe: hazard of flooding
Red Hook: Rh	Moderate: seasonal high water table	Moderate: seasonal high water table.
Scio:		
ScA	Slight	Slight
ScB	Slight	Slight
Sheffield: Sh	Severe: high water table	Severe: high water table
Shelmadine: SmA, SmB	Severe: high water table	Severe: high water table
Valois:		
VaB	Moderate: gravelly	Slight
VaC	Moderate: gravelly; slope	Moderate: slope
VaD	Severe: slope	Severe: slope
VLF	Severe: slope	Severe: slope
VmB	Moderate: very slow permeability; gravelly.	Slight
VmC	Moderate: very slow permeability; gravelly; slope.	Moderate: slope
Venango:		
VnA, VnB	Moderate: seasonal high water table; very slow permeability.	Moderate: seasonal high water table.
VnC	Moderate: seasonal high water table; very slow permeability; slope.	Moderate: seasonal high water table; slope.
VoB	Moderate: seasonal high water table; very slow permeability; stony.	Moderate: seasonal high water table; stony.
VoC	Moderate: seasonal high water table; very slow permeability; stony; slope.	Moderate: seasonal high water table; stony; slope.
Wyoming:		
WyA, WyB	Moderate: gravelly	Slight
WyC	Moderate: gravelly; slope	Moderate: slope
WyD	Severe: slope	Severe: slope

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most vehicular traffic, however, is confined to access roads. The most suitable soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stones that greatly increase the cost of leveling sites or of building access roads.

Playgrounds are used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand heavy foot traffic. They should 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.

Golf fairways are used intensively and are subject to heavy foot traffic. Most vehicular traffic is confined to hard-surface trails and roads. Suitable soils have good drainage, mild slopes, and a surface that is free of rocks and stones and is firm after rains but not dusty when dry.

Formation, Morphology, and Classification of the Soils

In this section the major factors that affect the formation and morphology of the soils of Crawford County are discussed and the soils are classified by higher categories.

Factors of Soil Formation

Soils form through the interaction of five major factors: climate, plant and animal life, parent material, relief, and time. The relative influence of each factor generally varies from place to place. Local variations in soils are generally the result of differences in the kind of parent material and in relief and drainage. In places one factor can dominate the formation of a soil and determine most of its properties.

Climate

Crawford County has a humid, continental climate marked by extreme changes in seasonal temperatures. It has an annual precipitation of about 42 inches and a mean annual air temperature of about 52° F. Rain-

recreation development—Continued

Paths and trails	Picnic areas	Playgrounds	Golf fairways
Slight	Moderate: hazard of flooding.	Moderate: hazard of flooding.	Moderate: hazard of flooding.
Moderate: seasonal high water table.	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.
Slight	Slight	Moderate: seasonal high water table.	Slight.
Slight	Slight	Moderate: seasonal high water table; slope.	Slight.
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table.
Moderate: gravelly	Moderate: gravelly	Severe: gravelly	Moderate: gravelly.
Moderate: gravelly	Moderate: gravelly; slope	Severe: gravelly; slope	Moderate: gravelly; slope.
Moderate: gravelly; slope	Severe: slope	Severe: gravelly; slope	Severe: slope.
Severe: slope	Severe: slope	Severe: gravelly; slope	Severe: slope.
Moderate: gravelly	Moderate: gravelly	Severe: gravelly	Moderate: gravelly.
Moderate: gravelly	Moderate: gravelly; slope	Severe: gravelly; slope	Moderate: gravelly; slope.
Moderate: seasonal high water table.	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.
Moderate: seasonal high water table.	Moderate: seasonal high water table; slope.	Severe: seasonal high water table; slope.	Moderate: seasonal high water table; slope.
Moderate: seasonal high water table; stony.	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table; stony.
Moderate: seasonal high water table; stony.	Moderate: seasonal high water table; slope.	Severe: seasonal high water table; slope.	Moderate: seasonal high water table; stony; slope.
Moderate: gravelly	Moderate: gravelly	Severe: gravelly	Moderate: gravelly; too sandy.
Moderate: gravelly	Moderate: gravelly; slope	Severe: gravelly; slope	Moderate: gravelly; too sandy; slope.
Moderate: gravelly; slope	Severe: slope	Severe: gravelly; slope	Severe: slope.

fall is nearly uniform during the growing season of May through September and averages about 19 inches. The cool temperature has allowed the accumulation of organic matter in the surface layer of the soils. For more detailed information on climate, see the section "Environmental Factors Affecting Soil Use."

Plant and animal life

All living organisms are important to soil formation. Among these are vegetation, animals, bacteria, and fungi. Vegetation generally determines the amount of organic matter, the color of the surface layer, and the amount of nutrients in the soil. Such animals as earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the organic matter, thus releasing nutrients for plant food.

In Crawford County, the native forests have had more influence on soil formation than any other living organism. Man, however, has greatly affected the surface layer where he has cleared the forests and plowed the soil. He has added fertilizers, has mixed some of the soil horizons, and has moved soil material from place to place.

Parent material

Parent material is the unconsolidated mass from which soils form. It influences the mineralogical and chemical composition of the soil and to a large extent, the rate at which soil-forming processes take place.

In Crawford County, soils formed in glacial till, glacial outwash, recent stream alluvium, and organic materials. Most of the soil materials were left after the glaciers melted about 15,000 years ago. Alluvial and organic materials are of recent origin and are being deposited continually.

Soils that formed in glacial till are the most extensive in the county and have a wide range of characteristics. Examples of soils that formed in glacial till are Frenchtown, Venango, Sheffield, and Alvira soils. Soils that formed in glacial outwash deposits are commonly underlain by stratified sand and gravel. Examples of these soils are Wyoming, Chenango, and Red Hook soils. Soils on the flood plains formed in waterlaid materials called recent alluvium. They have little or no profile development. Examples of these soils are Pope, Philo, and Holly soils. Carlisle soils formed in organic material.

Relief

Crawford County is in the glaciated part of the Allegheny Plateau of Pennsylvania. This region is a dissected plateau mostly within the Allegheny River drainage system. In places, the plateau is dissected to depths of several hundred feet. The walls of French Creek Valley rise to the dissected plateau, and in places elevation differs as much as 250 or 300 feet within a distance of less than a mile. On the plateau itself, elevation can differ as much as 300 feet. Elevation throughout much of the county averages between 1,100 and 1,500 feet above sea level.

Upland slopes are gently rolling in the broad summit areas, and side slopes are generally sloping to steep. About 22 percent of the county is made up of stream terraces or flood plains. The general features of the upland area have been smoothed by glaciation, and the landscape has smooth curves rather than sharp, abrupt features.

The shape of the land surface, slope, and depth to 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, have a bright-colored, unmottled subsoil, and in most places 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 show some evidence of wetness, such as mottling in the subsoil. In level areas or slight depressions where the water table is at or near the surface for long periods, the soils show marked evidence of wetness. They have a dark-colored surface layer and a strongly mottled or grayish subsoil. Some soils, however, are wet because of a high water table. The permeability of the soil, as well as the length, steepness, and configuration of the slopes, influences the kind of soil that is formed from place to place.

Time

The formation of soil generally requires a long time for changes to take place in the parent material. The soils of Crawford County formed in the period since glaciation. Evidence of this relatively short time can be seen in the soil.

Soils that formed on flood plains subject to varying degrees of overflow can receive new sediment with each flooding. These soils have weak soil structure and weak color differences between horizons. An example is the Pope soils. Soils that have well-developed horizons, such as Alvira soils, have been forming for a longer time than the Pope soils.

Morphology of Soils

In this section horizon nomenclature and the processes involved in horizon development are described.

Major soil horizons

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

Most soils have three major horizons, designated as A, B, and C (*9*). These major horizons may be further divided by the use of numbers and letters to indicate changes within one horizon. For example, the B2t horizon is a B horizon that contains an accumulation of clay.

The A horizon is the surface layer of the soil. An A1 horizon is that part of the surface layer that has the greatest accumulation of organic matter. The A horizon is also the layer of maximum leaching or eluviation of clay and iron. If considerable leaching has taken place and organic matter has not darkened the material, the horizon is called an A2 horizon. In some soils in Crawford County, the A1 horizon has been plowed or disturbed and is designated as an Ap horizon.

The B horizon underlies 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 leached from the surface layer. In some soils, the B horizon formed by alteration of the minerals in place rather than by illuviation. The alteration can be caused by oxidation and reduction of iron or by the weathering of clay minerals. The B horizon commonly has blocky or prismatic structure. It generally is firmer and lighter colored than the A1 horizon but darker colored than the C horizon.

The C horizon lies below the B horizon. It consists of materials that are little altered by the soil-forming processes but that may be modified by weathering.

Processes of soil horizon differentiation

In Crawford County several processes are involved in the development of soil horizons. Among these are the accumulation of organic matter, the leaching of soluble salts, the reduction and transfer of iron, the formation of soil structure, and the formation and translocation of clay minerals. These processes are continually taking place and generally occur at the same time throughout the profile. Such processes have been going on for thousands of years.

The accumulation and incorporation of organic matter take place as plant residue decomposes. These additions darken the surface layer and help to form the A1 horizon. Once organic matter is lost, a long time is generally required to replace it. In Crawford County the organic-matter content of the surface layer averages about 5 percent.

In soils that have distinct subsoil horizons, some of the lime and other soluble salts are leached before the translocation of clay minerals. Among the factors that affect this leaching are the kinds of salt 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 Crawford County have a yellowish-brown subsoil. This color is caused mainly by thin coatings of iron oxides on sand and silt grains. Weak to moderate development of subangular blocky structure has taken place, and the subsoil of some well drained and moderately well drained soils contains more clay than the overlying surface horizon.

A fragipan has developed in the subsoil of most of the moderately well drained and somewhat poorly drained soils in the county. This horizon is firm or very firm and brittle when moist. Soil particles are tightly packed so that bulk density is high and there are few

pore spaces. Genesis of this horizon is not fully understood, but studies show that swelling and shrinking take place in alternating wet and dry periods. This may account for the packing of soil particles and for a gross polygonal pattern of cracks in the fragipan. Clay, silica, and oxides of aluminum are the most likely cementing agents that cause the horizon to be brittle and hard.

The reduction and transfer of iron is associated mainly with the wetter, more poorly drained soils. This process is called gleying. Moderately well drained to somewhat poorly drained soils have mottles of yellowish brown and reddish brown that indicate the segregation of iron. In poorly drained to very poorly drained soils, such as the Frenchtown, Sheffield, and Alden soils, the subsoil and underlying materials are grayish, which indicates reduction and transfer of iron by removal in solution.

Classification of Soils

Soils are classified so that their significant characteristics can be more easily remembered. Classification enables us to assemble knowledge about the soils, to recognize their relationship to one another and to the whole environment, and to develop principles that help in understanding their behavior and their response to manipulation. First through classification, and then through use of soil maps, knowledge of soils can be applied to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, provide the means 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.[7] Because this system is under continual study, readers interested in developments of the current system should refer to the latest literature available (*8, 10*).

The current system of classification has six categories. Beginning with the 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 10, the soil series of Crawford County are placed in three 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, which are found 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 divided into suborders that are based primarily on those soil characteristics that seem to produce classes with 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 either the presence or absence of waterlogging or soil differ-

[7] Unpublished working document used in the Soil Conservation Service: "Soil Taxonomy of the National Cooperative Soil Survey." 1970. Copy available in the SCS State office.

TABLE 10.—*Classification of the soils*

Series	Family	Subgroup	Order
Alden	Fine-loamy, mixed, nonacid, mesic	Mollic Haplaquepts	Inceptisols.
Alvira	Fine-loamy, mixed, mesic	Aeric Fragiaquults	Ultisols.
Braceville	Coarse-loamy, mixed, mesic	Typic Fragiochrepts	Inceptisols.
Cambridge	Fine-loamy, mixed, mesic	Ochreptic Fragiudalfs	Alfisols.
Canadice	Fine, illitic, mesic	Typic Ochraqualfs	Alfisols.
Caneadea	Fine, illitic, mesic	Aeric Ochraqualfs	Alfisols.
Carlisle	Euic, mesic	Typic Medisaprist	Histosols.
Chenango	Loamy-skeletal, mixed, mesic	Typic Dystrochrepts	Inceptisols.
Frenchtown	Fine-loamy, mixed, mesic	Typic Fragiaqualfs	Alfisols.
Halsey	Coarse-loamy over sandy or sandy-skeletal, mixed, nonacid, mesic.	Mollic Haplaquepts	Inceptisols.
Hanover	Fine-loamy, mixed, mesic	Typic Fragiudults	Ultisols.
Haven	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Dystrochrepts	Inceptisols.
Holly	Fine-loamy, mixed, nonacid, mesic	Typic Fluvaquents	Entisols.
Philo	Coarse-loamy, mixed, mesic	Fluvaquentic Dystrochrepts	Inceptisols.
Platea	Fine-silty, mixed, mesic	Aeric Fragiaqualfs	Alfisols.
Pope	Coarse-loamy, mixed, mesic	Fluventic Dystrochrepts	Inceptisols.
Red Hook[1]	Coarse-loamy, mixed, acid, mesic	Aeric Haplaquepts	Inceptisols.
Scio	Coarse-silty, mixed, mesic	Aquic Dystrochrepts	Inceptisols.
Sheffield	Fine-silty, mixed, mesic	Typic Fragiaqualfs	Alfisols.
Shelmadine	Fine-loamy, mixed, mesic	Typic Fragiaquults	Ultisols.
Valois[2]	Coarse-loamy, mixed, mesic	Typic Dystrochrepts	Inceptisols.
Venango	Fine-loamy, mixed, mesic	Aeric Fragiaqualfs	Alfisols.
Wyoming	Loamy-skeletal, mixed, mesic	Typic Dystrochrepts	Inceptisols.

[1] These soils are taxadjuncts to the Red Hook series because they are medium acid and slightly acid.
[2] These soils are taxadjuncts to the Valois series because they have a weakly expressed argillic horizon.

ences resulting from the climate or vegetation. The names of suborders have two syllables, the last of which 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 a pan that interferes with growth of roots, movement of water, or both; and those that have a thick, dark-colored surface horizon. The features include 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 of 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).

Subgroup.—Great groups are divided 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 are also 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 such properties as texture and mineralogy that are used to differentiate families (see table 10). An example is the fine, illitic, mesic family of Typic Ochraqualfs.

Laboratory Data[8]

Laboratory soil characterization indentifies properties useful in studying soil formation processes, in interpreting land-use limitations, in classifying soil profiles and series, and in understanding genetic concepts of soils. The factors influencing soil formation vary independently; consequently soils can vary even though their apparent environment is similar. Detailed studies help to clarify these relationships, although there are practical limitations in sampling. The characterization studies in Crawford County add to information previously collected and are particularly applicable to northwestern Pennsylvania, where continued characterization studies are in progress.

Samples from six soil series common in Crawford County were collected at twelve sites. All the soils sampled formed in glacial material; six of the profiles formed in till and six formed in outwash and alluvium. Both kinds of material are typical of the northwestern section of Pennsylvania. The descriptions of similar soil profiles are presented in the section "Descriptions of the Soils."

The detailed laboratory data and methodology are published as a part of the cumulative soil characterization studies of the Department of Agronomy of The Pennsylvania State University (*3*). The following general interpretations are derived from that data.

Coarse fragments

Soils that formed in till and outwash generally contain an appreciable amount of coarse fragments. The coarse fragments measured in the laboratory are larger than 2 millimeters and smaller than 76 millimeters; the particles smaller than 2 millimeters are called fine earth. In profiles 2008 and 2009, Chenango and Valois soils, more than 50 percent of the material smaller than 50 centimeters is coarse fragments. In three profiles, 2004, 2005, and 2011, Alvira, Hanover,

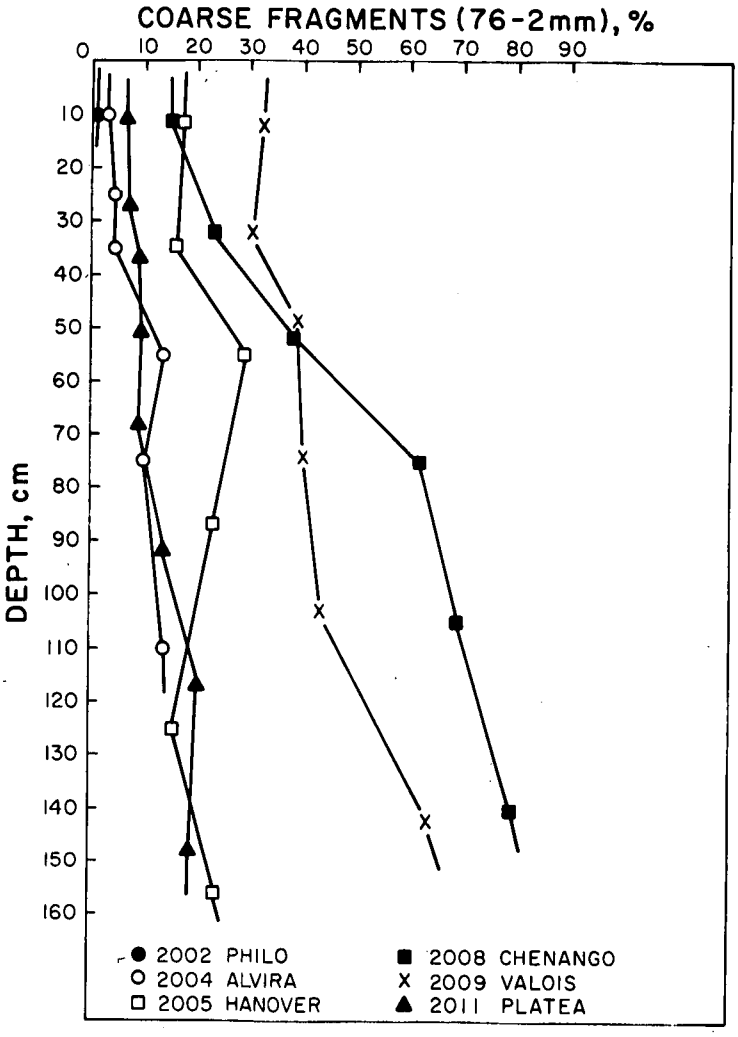

Figure 8.—Distribution of coarse fragments.

[8] By R. L. CUNNINGHAM, R. P. MATELSKI, G. W. PETERSEN, R. PENNOCK, JR., and E. J. CIOLKOSZ, Department of Agronomy, The Pennsylvania State University.

and Platea soils, the amount of coarse fragments tends to increase with depth to a maximum of 20 percent. Profile 2002, Philo soil, has few coarse fragments. The profiles examined have fewer coarse fragments in the surface horizon than in the subsoil because the coarse fragments have been removed or have deteriorated from the more intense weathering at the surface (fig. 8).

The amount of coarse fragments influences the use of soils; for example, they interfere with construction equipment and compaction operations in fills. In cultivated soils, gravel and cobbles interfere with implements and tillage operations, making it necessary for farmers to remove the larger fragments from fields each year.

Coarse fragments dilute the soils and should be considered in interpreting other properties of soils. For example, if a horizon is 50 percent coarse fragments and the fine earth is 20 percent clay, then the clay percentage for the total material in the horizon is 10 percent. Analogous calculations for most physical and all chemical properties can be made using the determinations for the fine earth.

Coarse fragments on the surface dissipate some of the energy of raindrops. Therefore, soils that have a moderate amount of coarse fragments on the surface tend to resist erosion. The percolation rate of water in the soil is commonly higher in soils that have more coarse fragments if other properties are similar.

Clay content

The amount of clay is an indicator of soil plasticity, shrink-swell potential, and cation exchange capacity. The amount of water held in the soil increases with increasing clay content; however, water available to plants does not necessarily increase.

Clay is a mobile component of soils and generally reveals the degree of soil development. Many soils contain a relatively small amount of clay in the surface layer, the largest amount of clay in the 25- to 75-centimeter layer, and a smaller amount below a depth of 100 centimeters. This distribution of clay is associated with an argillic horizon that is an important feature in studies of soil genesis. For further information refer to the section "Formation, Morphology, and Classification of the Soils."

Figure 9 illustrates the clay distribution for one profile of each of the six soil series sampled. Bulges in the clay curves are perceptible in profiles 2004, Alvira soil; 2005, Hanover soil; and 2011, Platea soil. Profile 2005, Hanover soil, has an argillic horizon; the upper horizons of this soil have been depleted of clay and this clay, through illuviation, has accumulated in the Bt horizon. The clay content below the argillic horizon is intermediate between the eluviated A horizon and the illuviated B horizon.

Clay distribution curves of the outwash and alluvial soils, profile 2008, Chenango soils, and 2002, Philo soils, display a low clay content and a general decrease of clay with depth. This observation agrees with the hypothesis that these soils are relatively less developed and formed in younger material than the other three soils.

The clay content of the surface horizon of all the soils ranges from 12 to 27 percent. Four of the soils

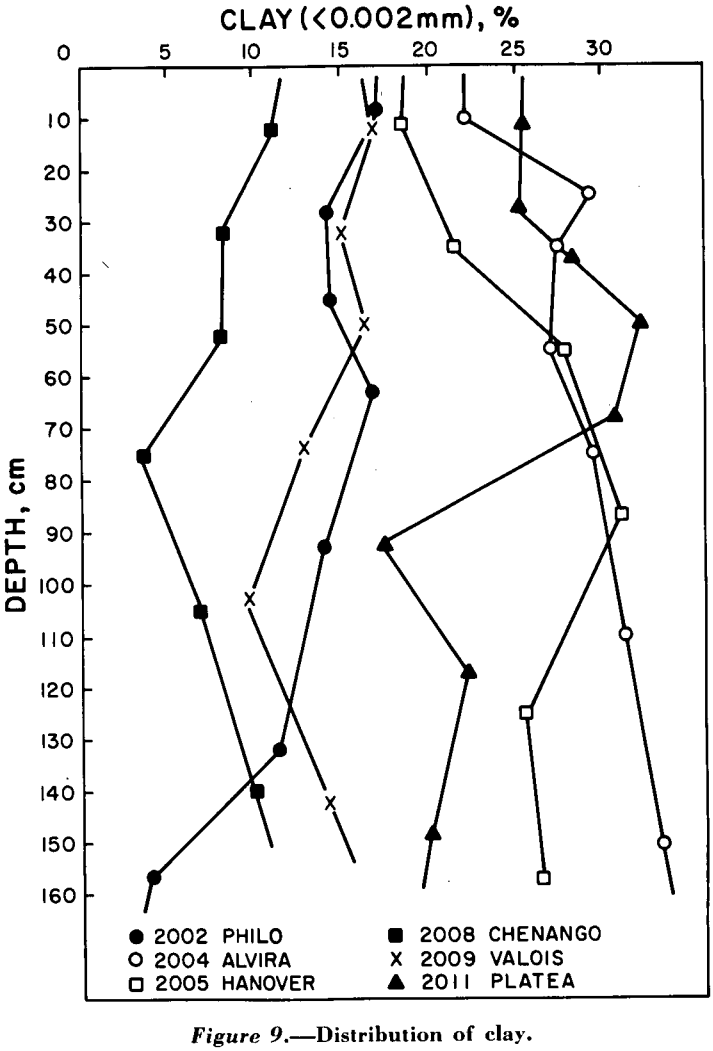

Figure 9.—Distribution of clay.

have a clay content between 17 and 22 percent, which is representative of the average amount of clay in the surface horizon of soils in Crawford County.

Nutrients

Nutrient holding capacity depends on the proportion of clay and organic matter, the history of fertilization, and the chemical content of the parent material.

An indication of nutrient holding capacity is the laboratory-measured cation exchange capacity of the fine earth. Trends in exchange capacity coincide with trends in percentages of organic matter and clay. Measured in milli-equivalents per 100 grams of soil, the surface horizon of soils in Crawford County commonly has 20 to 30 milli-equivalents of cation exchange capacity per 100 grams of fine earth, and the lower horizons have 10 to 20, depending on the clay content.

As an example of a favorable nutrient relationship, if a soil has 20 milli-equivalents per 100 grams cation exchange capacity, then the calcium ion saturation of that complex should be about 80 percent, or 16 milli-equivalents per 100 grams, for most farm crops. Figure 10 illustrates that in all but one soil tested, calcium levels are considerably less than 10 milli-equivalents

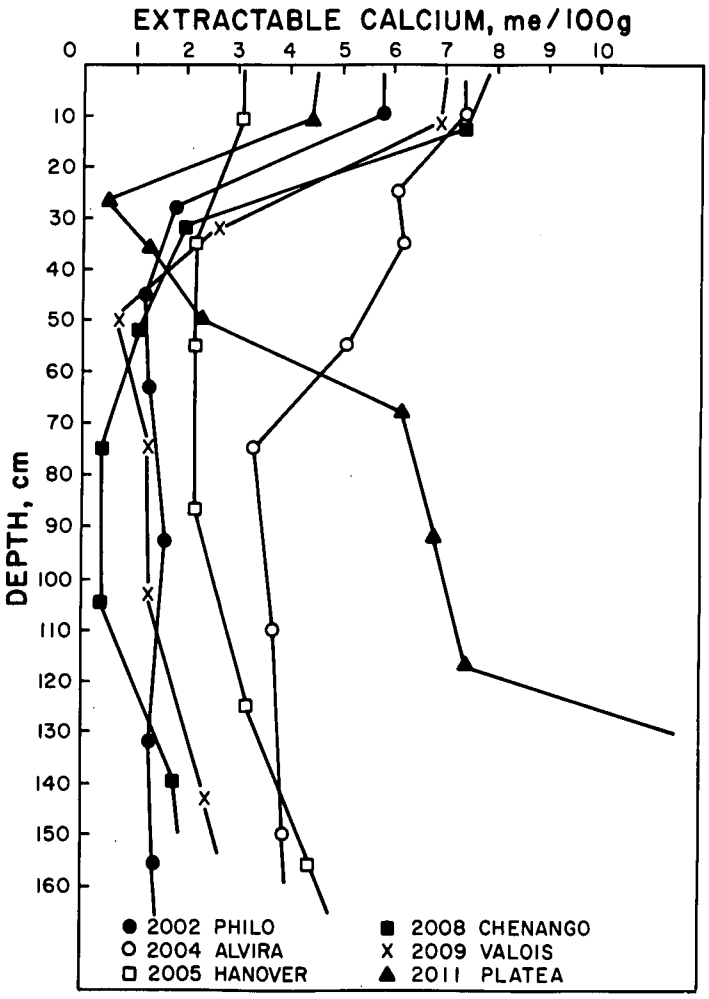

Figure 10.—Level of calcium.

per 100 grams; in most samples the calcium level is about 5 milli-equivalents per 100 grams. Calcium ions apparently were depleted in these soils by cropping and leaching.

The glacial till parent material of profile 2011, Platea soil, is calcareous, has a pH value of 8, and contains a considerable amount of calcium below a depth of 125 centimeters. The wetness of the somewhat poorly drained Platea soil is not conducive to extensive leaching and root feeding but enhances the weathering breakdown of calcium-bearing materials.

The surface horizon of three profiles has been enriched in calcium by additions of lime. The pH value for most other horizons ranges from 5 to 6, except for the lower horizons of the Alvira soil, which have a pH value of less than 5, and the lower horizons of the Platea soil, which have a pH value of more than 8.

The extractable sodium cation occurs in amounts of less than 0.1 milli-equivalents per 100 grams in all horizons analyzed. This amount of sodium is not detrimental to soil structure or plant growth.

Extractable potassium ranges from 0.1 to 0.5 milli-equivalents per 100 grams, an adequate amount for the growth of most plants. A maximum of as much as 0.5 milli-equivalents per 100 grams is generally in the surface layer, and a minimum of less than 0.1 milli-equivalents per 100 grams is commonly at a depth of 50 centimeters.

The magnesium content of the surface horizon of most soils is 1 to 3 milli-equivalents per 100 grams. The content of magnesium in profile 2005, Hanover soil, reaches 5.9 and 4.4 milli-equivalents per 100 grams. The profiles that have a lesser content of magnesium have a fragipan that greatly reduces the uptake of magnesium by limiting root penetration and reducing leaching caused by percolating precipitation. The level of magnesium content, however, generally is adequate for plant growth.

Clay minerals

Clay identification by X-ray shows that illite increases with increasing depth whereas vermiculite decreases with increasing depth in most profiles. The clay in the surface horizon is approximately 30 percent illite and 45 percent vermiculite. The clay in the subsoil is about 50 percent illite and 10 to 20 percent vermiculite. The rest of the clay is kaolinite and vermiculite and illite interstratified with minor amount of chlorite and montmorillonite. Profile 2004, Alvira soil, contains as much as approximately 40 percent montmorillonite but has a correspondingly smaller amount of vermiculite.

The amount of montmorillonite is associated with the wetness and consequent chemical environment in these soils caused by an impermeable fragipan and the humid climate. Montmorillonite and vermiculite clay have more exchange sites and a higher cation holding capacity than other types of clay. The usual high expansion and contraction of clay rich in montmorillonite during wetting and drying is not apparent in these soils because of the relatively small total content of clay.

Percolation rates

Percolation rate at a depth of 90 centimeters in Alvira, Hanover, and Platea soils is less than 2.5 centimeters per hour. The percolation rate in Philo and Valois soils is between 2.5 and 12.5 centimeters per hour. Acceptable filter fields for disposal of septic tank effluent should percolate at a rate between 2.5 and 23 centimeters per hour. Slow rates cause the system to malfunction, and excessively fast rates cause contamination of ground or surface water.

Environmental Factors Affecting Soil Use

The first settlers in what is now Crawford County arrived in the valley of French Creek in 1788, and the town of Meadville was founded in 1794. Crawford County was formed from part of Allegheny County and the town of Meadville was established as the county seat in 1800. The lumber produced locally and the salt brought in from New York was shipped, chiefly by way of French Creek, to market in Pittsburgh, and supplies from Meadville were brought upstream. In 1800 the population of the town was between 200 and 300 persons, and that of the county 2,346 persons. By 1970 the county population had grown to 81,342.

According to the Pennsylvania Crop Reporting Service, in 1972, there were 48,300 cattle and calves, 3,100

hogs, 66,000 chickens, and 2,400 sheep (*5*) on farms in the county. Apples and peaches were the major fruit crops, and 172,000 pounds of apples and 42,288 pounds of peaches were harvested. The honey produced by 3,600 colonies of bees amounted to 92,400 pounds. The acreage of principal field crops harvested in 1972 was, as follows:

Crop:	
Corn for grain	14,900
Corn for silage	13,600
Wheat	2,400
Oats	13,800
Barley	800
Hay (alfalfa)	12,600
Hay (all hay)	59,200
Potatoes	540

Transportation in the county is provided by major railroads, airlines, truckline, and buslines. Interstate Highway 79 provides easy access to the cities of Erie and Pittsburgh; U.S. Highways 19, 6, and 322 as well as a number of State Routes cross the county. All-weather roads are available to all farming areas. The construction of these major highways has resulted in increased numbers of people traveling in the county, and the easy access, in increased activities and in greatly increased demand for recreation land.

Climate[9]

The climate of Crawford County is continental and humid. It is affected by warm air masses that originate in the Gulf of Mexico, mild dry air masses that originate in the western part of the United States, and cold dry air masses that originate in Canada. Late in fall and in winter, the Great Lakes are an important source of moisture.

Winters are generally cold and snowy. Because this

[9] By JAMES J. RAHN, climatologist for Pennsylvania, National Weather Service, U.S. Department of Commerce.

TABLE 11.—*Temperature and precipitation data*

[From records at Meadville, for the period 1941–70]

Month	Temperature				Precipitation					
	Average daily maximum	Average daily minimum	Average extreme maximum	Average extreme minimum	Average monthly total	1 year in 10 will have—		Average monthly snowfall	Average number of days with snow cover of—	
						Less than—	More than—		1 inch or more	6 inches or more
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Inches*		
January	33	16	54	−6	2.8	1.3	4.6	19.6	21	8
February	35	15	55	−6	2.5	1.1	4.2	18.5	21	6
March	44	24	69	5	3.3	1.7	5.2	16.2	13	3
April	58	35	79	19	3.8	2.2	5.6	3.8	2	(1)
May	69	44	85	29	4.2	1.9	6.9	.4	(1)	
June	78	53	91	38	4.2	2.2	6.6			
July	81	57	91	44	4.5	2.2	7.2			
August	80	55	90	42	3.7	1.5	6.3			
September	74	48	89	34	3.1	1.4	5.1	(2)		
October	63	39	81	26	3.7	.9	7.4	.8	(1)	0
November	48	31	69	15	3.5	2.0	5.2	10.8	5	1
December	36	20	58	−1	2.9	1.6	4.4	23.3	19	6
Year	58	36	93	−11	42.1	34.9	49.3	93.4	81	24

[1] Less than one day.
[2] Trace.

TABLE 12.—*Probabilities of low temperatures in spring and fall*

[From records at Meadville]

Probability	Dates for given probability and temperatures				
	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	April 7	April 17	April 30	May 16	May 30
2 years in 10 later than	April 3	April 13	April 26	May 10	May 25
5 years in 10 later than	March 27	April 6	April 18	April 29	May 15
Fall:					
1 year in 10 earlier than	November 14	November 5	October 23	October 5	September 21
2 years in 10 earlier than	November 18	November 10	October 28	October 10	September 26
5 years in 10 earlier than	November 27	November 18	November 7	October 20	October 6

county is in the northwestern snowbelt, it receives some of the heaviest snowfall in Pennsylvania. Summers are generally pleasant, and summer rainfall, which occurs mainly as showers and thunderstorms, is generally adequate for farming. In spring and fall there are wide variations in temperature.

Table 11 gives temperature and precipitation data for Crawford County, and table 12 gives probabilities of low temperatures in spring and fall.

Normal daytime temperatures range from the low 30's to the upper 30's in winter and from the upper 70's to the low 80's in summer. Nighttime temperatures are generally in the teens in winter and in the 50's in summer. The temperature can be expected to be less than 32° on about 150 days each year and below zero on 6 to 12 days each winter. The record low temperatures are in the range from about 20° below zero to about 25° below zero. Temperatures of more than 90° can be expected on about 6 to 12 days in summer. The record high temperatures range from 100° to 110°.

Normal annual precipitation ranges from about 38 inches in the southwestern part of the county to 44 inches in the northwestern part. About 55 percent of this total falls in the period April through September. The record highest annual precipitation ranges from 50 to 55 inches and the lowest from 10 to 15 inches. The most precipitation recorded for any one month was 10 to 15 inches, and the least was less than 0.5 inch.

The total snowfall normally is about 70 inches in the southwestern corner of the county, 90 to 95 inches in the central part, and more than 120 inches in the extreme northeastern part. Much of the snowfall is in the form of showers and squalls, which result when cold air blows over the relatively warm water of Lake Erie. Snow cover of 1 inch or more can be expected on about 75 to 80 days each winter and 6 inches or more on about 20 to 30 days.

Thunderstorms can be expected on about 20 days in the period June through August. Some of these storms are accompanied by strong winds, hail, or both. Since 1854 there have been 10 tornadoes reported in Crawford County.

The growing season averages about 145 to 150 days in the southwestern part of the county and 130 to 135 days in the northeastern part, but it has been as short as 80 to 85 days and as long as 180 to 185 days. In 2 years out of 3, the growing season can be expected to be within about 18 days of the average.

Geology[10]

The soils of Crawford County inherited many of their properties from those of geologic formations in the county. They formed in materials resulting from the effect of glaciation on bedrock. Generally, the glacial drift includes deposits of till, outwash, and lacustrine material.

The Geologic Map of Pennsylvania published in 1960 shows the major bedrock formations, which occur in three bands that cross the county diagonally in a southwest to northeast direction. The rock strata dip about 15 to 20 feet a mile toward the southeast.

In the northwestern part of the county, the oldest bedrock exposed is red, gray, and brown shale, siltstone, and sandstone of the Cattaraugus and Riceville Formations, which are of Devonian age. Also in this geologic group is the sandstone of the Venango Formation that contains oil and is found in the southern and eastern parts of the county.

In the central part of the county there is a broad band of gray, hard, massive sandstone and conglomerate interbedded with shale and limestone. These are in the Pocono Group of Mississippian age. Many springs issue from this sandstone and conglomerate, and wells in it yield moderate amounts of water. At greater depths, the water is likely to be high in iron and somewhat salty. Also this group includes sandstone that contains oil and is of the Big Injun and Berea Grit Formations.

Southeast of the diagonal line joining the southwestern and northeastern corners of the county, the youngest bedrock is conglomerate, sandstone, thin shale, and some minable coal of the Pottsville Group, which is of Pennsylvanian age. The conglomerate commonly has rounded quartz pebbles. In places the water in springs and wells contains large amounts of minerals.

The surface of Crawford County was greatly changed during at least the period that two great glaciers advanced from the north. The ice of the Illinoian glacier covered the entire county, and later the Wisconsin glacier covered all but the southeastern corner between Thompson Creek and Titusville. These glaciers planed off hilltops and ridges, gouged out valleys parallel to the movement of ice, and left a thick deposit of glacial drift in the valleys and a thin mantle on the uplands.

In this county glacial till is a compact mixture of minerals that range from boulders to clay in size of fragments or particles. It contains many fragments of the gray, acid sandstone, siltstones, and shale. The till is made up of materials deposited under advancing ice sheets, moraines pushed ahead of or alongside the moving ice, and ablation material dropped in place as stagnant ice melted. Valois, Hanover, Alvira, Shelmadine, and Alden soils formed in Illinoian till.

Because the later ice sheets reworked much of the Illinoian till, soils that formed in the Wisconsin till are similar to those that formed in Illinoian till. Valois, Cambridge, Venango, Frenchtown, and Alden soils formed in Wisconsin till. In some areas the Wisconsin till is enriched with limestone and fragments of calcareous shale. Platea and Sheffield soils formed in these areas.

Glacial outwash in the county contains strata or lenses of sorted silt, sand, and gravel deposited by water flowing from the glaciers. Among these deposits are the glaciofluvial materials that are in scoured valleys, on the terrace remnants of valley walls, and on hummocky kames and in kettles. They formed when blocks of stagnant ice beside and under the outwash melted, and the kames formed around them. Outwash is the most productive source of ground water in the county. Wyoming, Chenango, Braceville, Red Hook, and Halsey soils formed in outwash.

The lacustrine deposits consist of varied or very thin

[10] R. F. FONNER, geologist, Soil Conservation Service, Upper Darby, Pa., assisted in preparing this section.

layers of silt and clay or of rock flour deposited in the quiet water of glacial ponds, lakes, and other depressions. Caneadea and Canadice soils formed in lacustrine deposits.

Since glacial times, thick deposits of peat and muck have accumulated in many kettles, lakes, bogs, and swamps. Carlisle soils formed in these deposits.

After the Wisconsin glaciers melted, about 15,000 years ago (*7*), land surfaces that had been depressed by great loads of ice began to rise or rebound. Cycles of upland and valley erosion were renewed, as shown by the high position of outwash terraces and two levels of post-glacial alluvial deposits on flood plains. Haven and Scio soils formed in deposits on the older flood plains or high bottoms. Pope, Philo, and Holly soils formed in recent alluvium on the lower bottoms.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but that in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

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.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

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.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Contour stripcropping. Growing crops in strips that follow the contour or are parallel to terraces or diversions. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Eluviation. The movement of material from one place to another within the soil, in either true solution or colloidal suspension. Soil horizons that have lost material through eluviation are said to be eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

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.

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" as applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

High water table. A zone of saturation in the soil which is within 6 inches of the surface in most seasons. It may be caused by a normal ground water table or by a perched water table. The presence of a high water table is indicated by mottling within 6 inches of the soil surface. It is associated with poorly drained and very poorly drained soils.

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.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

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

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, 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.*

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 rection; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

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

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

Seasonal high water table. A zone of saturation in the soil which is within 6 inches of the soil surface during at least part of the year. A seasonal high water table is usually caused by a fluctuating water table that generally is not associated with the normal ground water table. It is indicated by mottling within 6 to 36 inches of the soil surface. It is associated with somewhat poorly drained and moderately well drained soils.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

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 earthly 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.

Stripcropping. Growing crops in a systematic arrangements of strips, or bands, to serve as vegetative barriers to wind and water erosion.

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 grained* (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.

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."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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.

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 it belongs. The system of capability grouping is explained in the section that begins on page 29. Other information is given in tables as follows:

Acreage and extent, table 1, page 7.
Estimated yields, table 2, page 30.
Woodland, table 3, page 32.
Wildlife, table 4, page 38.
Engineering uses, tables 5, 6, and 7, pages 40 to 53.
Town and country planning, table 8, page 56.
Recreation, table 9, page 60.

Map symbol	Mapping unit	Described on page	Capability unit
Ad	Alden silt loam	7	IVw-2
AvA	Alvira silt loam, 0 to 3 percent slopes	8	IIIw-3
AvB	Alvira silt loam, 3 to 8 percent slopes	8	IIIw-2
BrA	Braceville gravelly loam, 0 to 3 percent slopes	9	IIw-2
BrB	Braceville gravelly loam, 3 to 8 percent slopes	9	IIe-2
CaA	Cambridge silt loam, 0 to 3 percent slopes	11	IIw-3
CaB	Cambridge silt loam, 3 to 8 percent slopes	11	IIe-2
CaC	Cambridge silt loam, 8 to 15 percent slopes	11	IIIe-2
CaD	Cambridge silt loam, 15 to 25 percent slopes	11	IVe-1
CbB	Cambridge very stony silt loam, 0 to 8 percent slopes	11	VIs-1
CbD	Cambridge very stony silt loam, 8 to 25 percent slopes	11	VIs-1
CcB	Cambridge-Venango silt loams, 3 to 8 percent slopes	11	IIIw-2
Cd	Canadice silt loam	12	IVw-1
CeA	Caneadea silt loam, 0 to 3 percent slopes	13	IIIw-2
CeB	Caneadea silt loam, 3 to 8 percent slopes	13	IIIw-2
CM	Carlisle muck	14	VIIw-1
CoA	Chenango gravelly silt loam, 0 to 3 percent slopes	15	IIs-1
CoB	Chenango gravelly silt loam, 3 to 8 percent slopes	15	IIs-1
CoC	Chenango gravelly silt loam, 8 to 15 percent slopes	15	IIIe-3
FhA	Frenchtown silt loam, 0 to 3 percent slopes	16	IIIw-3
FhB	Frenchtown silt loam, 3 to 8 percent slopes	16	IIIw-3
FvB	Frenchtown very stony silt loam, 0 to 8 percent slopes	16	VIIs-1
Ha	Halsey silt loam	17	IVw-2
HnA	Hanover silt loam, 0 to 3 percent slopes	17	IIw-2
HnB	Hanover silt loam, 3 to 8 percent slopes	18	IIe-2
HnC	Hanover silt loam, 8 to 15 percent slopes	18	IIIe-2
HoB	Hanover very stony silt loam, 0 to 8 percent slopes	18	VIs-1
HoD	Hanover very stony silt loam, 8 to 25 percent slopes	18	VIs-1
HvA	Haven silt loam, 0 to 3 percent slopes	19	I-2
HvB	Haven silt loam, 3 to 8 percent slopes	19	IIe-1
Hy	Holly silt loam	20	IIIw-1
Hż	Holly silty clay loam	20	VIw-1
Ph	Philo silt loam	21	IIw-1
PkB	Platea silt loam, 3 to 8 percent slopes	21	IIIw-2
Po	Pope loam	22	I-1
Rh	Red Hook loam	22	IIIw-2
ScA	Scio silt loam, 0 to 3 percent slopes	23	IIw-2
ScB	Scio silt loam, 3 to 8 percent slopes	23	IIe-2
Sh	Sheffield silt loam	24	IIIw-3
SmA	Shelmadine silt loam, 0 to 3 percent slopes	24	IVw-1
SmB	Shelmadine silt loam, 3 to 8 percent slopes	25	IVw-1
VaB	Valois gravelly silt loam, 3 to 8 percent slopes	25	IIe-1
VaC	Valois gravelly silt loam, 8 to 15 percent slopes	25	IIIe-1
VaD	Valois gravelly silt loam, 15 to 25 percent slopes	25	IVe-1
VLF	Valois soils, very steep	26	VIe-1
VmB	Valois-Cambridge complex, 3 to 8 percent slopes	26	IIe-2
VmC	Valois-Cambridge complex, 8 to 15 percent slopes	26	IIIe-2
VnA	Venango silt loam, 0 to 3 percent slopes	27	IIIw-2
VnB	Venango silt loam, 3 to 8 percent slopes	27	IIIw-2
VnC	Venango silt loam, 8 to 15 percent slopes	27	IIIe-4
VoB	Venango very stony silt loam, 0 to 8 percent slopes	27	VIs-1

Map symbol	Mapping unit	Described on page	Capability unit
VoC	Venango very stony silt loam, 8 to 15 percent slopes	28	VIs-1
WyA	Wyoming gravelly sandy loam, 0 to 3 percent slopes	28	IIIs-1
WyB	Wyoming gravelly sandy loam, 3 to 8 percent slopes	28	IIIs-1
WyC	Wyoming gravelly sandy loam, 8 to 15 percent slopes	28	IVe-2
WyD	Wyoming gravelly sandy loam, 15 to 25 percent slopes	29	VIe-1

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