SOIL SURVEY OF

Carroll, Gallatin, and Owen Counties, Kentucky

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Kentucky Agricultural Experiment Station

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 1968–71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the Kentucky Agricultural Experiment Station. It is part of the technical assistance furnished to the Carroll, Gallatin, and Owen Counties Soil and Water Conservation Districts.

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 of the soils of Carroll, Gallatin, and Owen Counties 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 counties 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 materials 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, and the section "Use of Soils for Crops and Pasture."

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

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

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

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

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

Newcomers in the area 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 "General Nature of the Counties."

Cover: Corn and burley tobacco on Wheeling silt loam, 0 to 2 percent slopes. In the right background are steep Fairmount soils.

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SOIL SURVEY OF CARROLL, GALLATIN, AND OWEN COUNTIES, KENTUCKY

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KENTUCKY AGRICULTURAL EXPERIMENT STATION

CARROLL, GALLATIN, AND OWEN COUNTIES are in the north-central part of Kentucky (fig. 1). They have a total area of 371,770 acres, or approximately 581 square miles. Carroll County has an area of about 130 square miles, Gallatin County 100 square miles, and Owen County 351 square miles.

The two major rivers of the area are boundaries for parts of the counties. The Ohio River is the northern boundary of Carroll and Gallatin Counties, and the Kentucky River is the western boundary of Owen County. The survey area is in two physiographic regions. The northern part of the area is in the Outer Bluegrass region, and the southern part is in the Hills of the Bluegrass region.

Most of the industry in the survey area is concentrated in the northern part, where the Ohio River and a new highway, Interstate Highway No. 71, provide easy access. Farming is the primary industry in the central part of the area. Burley tobacco, milk, and beef cattle are the main products. In the southern part, farming has declined in recent years because of the difficulty of operating machinery on the steep slopes of the area.

The climate in the survey area is temperate and humid. It is a favorable climate for many types of plants and animals.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the survey area, 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.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Boonesboro and Huntington, 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 on 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, Lowell silt loam, 2 to 6 percent slopes, is one of several phases within the Lowell 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

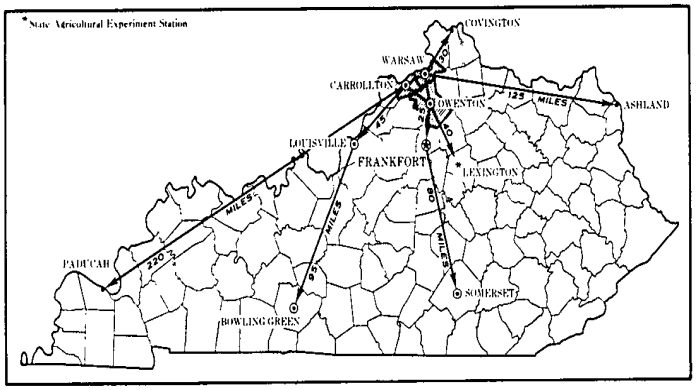

Figure 1.—Location of Carroll, Gallatin, and Owen Counties in Kentucky.

boundaries accurately. The soil map at the back of this survey 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, however, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. One such kind of mapping unit shown on the soil map of the survey area is the soil complex.

A soil complex consists of areas of two or more soils, so intricately intermingled 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. Fairmount-Rock outcrop complex, 30 to 60 percent slopes, is an example.

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

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 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 consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

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

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

The soil survey for Carroll, Gallatin, and Owen Counties is adjacent to the completed soil survey of Boone, Campbell, and Kenton Counties, Kentucky. The soil association boundary lines join between the two surveys on the general soil map, but the soil association names do not join in one association. Lowell soils in the Carroll, Gallatin, and Owen Counties survey join Faywood soils in the Boone, Campbell, and Kenton Counties survey. These two soils formed in similar parent material, but the Lowell soils are slightly deeper to bedrock. The detailed soil maps do not completely join between the two survey areas, because there are differences in the classification of some of the soils and in the combination of some mapping units. These differences are mostly a result of differences in the extent of some soils in the two survey areas.

The soil associations in Carroll, Gallatin, and Owen Counties are discussed in the following pages.

1. Wheeling-Huntington-Alluvial land association

Nearly level to steep soils that have a loamy subsoil; on stream terraces and flood plains

This association is along the Ohio River and extends along the entire northern boundary of the survey area. The stream terraces are mostly broad and nearly level, but the slopes along the breaks between terraces and in dissected areas are moderately steep to steep. The flood plains are narrow and are partly covered by backwater from the Markland Dam.

This association makes up about 10 percent of Carroll County and 9 percent of Gallatin County, or 4 percent of the survey area. Wheeling soils make up about 60 percent of the association, Huntington soils 12 percent, Alluvial land 9 percent, and minor soils the remaining 19 percent (fig. 2).

The Wheeling soils are on stream terraces. They are deep, well-drained, mostly nearly level soils, but some areas along the breaks between terraces are moderately steep.

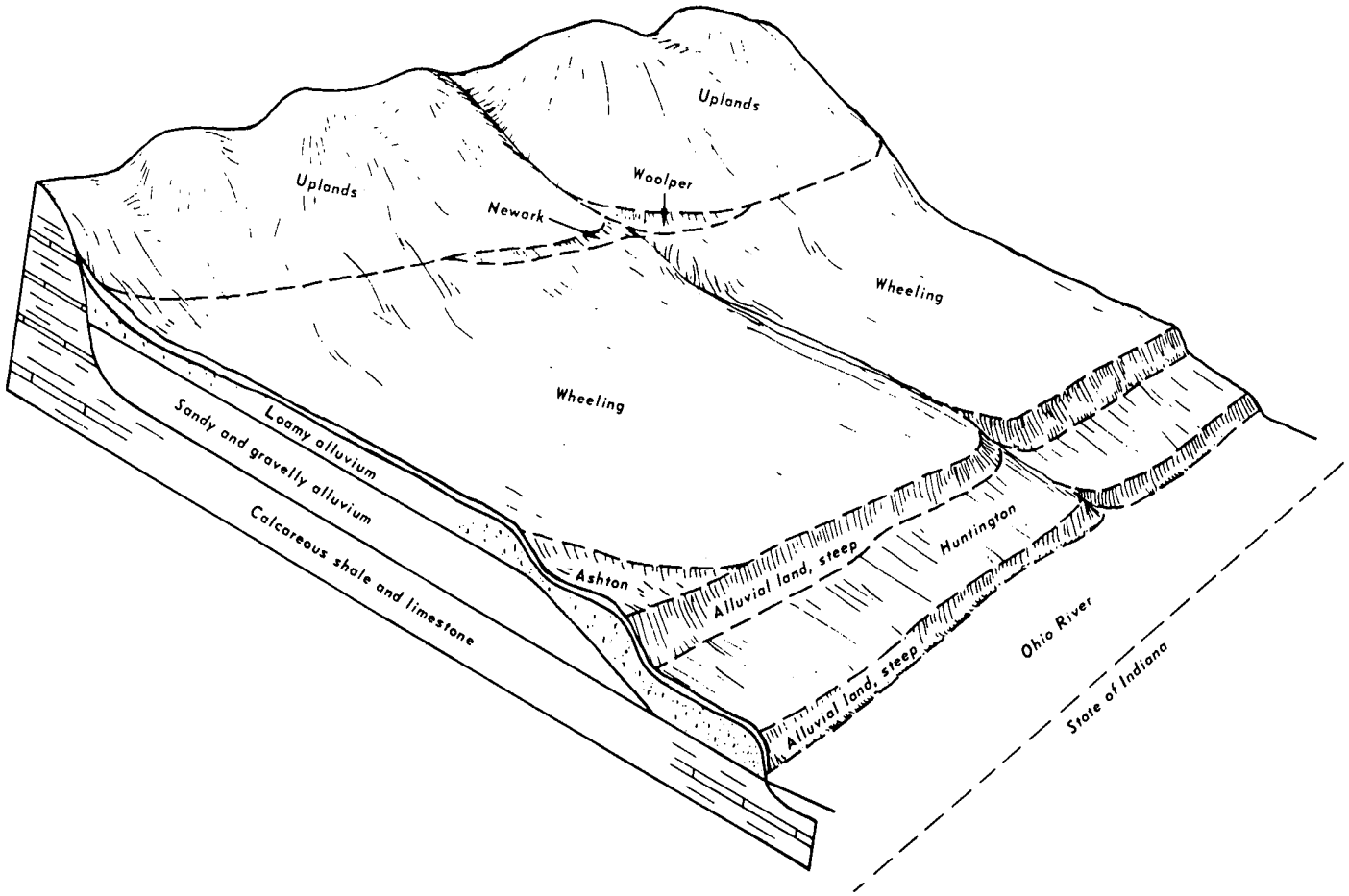

***Figure 2.*—Pattern of soils and underlying material in the Wheeling-Huntington-Alluvial land association.**

The Huntington soils are on flood plains. They are deep, well-drained, nearly level soils.

Alluvial land is mostly on steep breaks between the terraces and flood plains and along the banks of the river.

Minor soils in this association are the Ashton, Otwell, Lawrence, Lakin, McGary, and Markland soils on stream terraces; and the Woolper, Brashear, Newark, and Nolin soils on toe slopes and flood plains.

A substantial part of this association is used for industrial and residential purposes. Several new factories have been erected. The towns of Warsaw and Carrolton are in this association. Areas of this association that are not subject to flooding are well suited to nonfarm uses.

Some areas of this association are used for commercial vegetable gardens, and others are used for corn, tobacco, fruit trees, and ornamental trees or flowers. Most of the soils are well suited to farming and horticulture. Gravel and sand are taken from a few large quarries.

2. *Otwell-Nolin-Markland association*

Nearly level to steep soils that have a loamy and clayey subsoil; on stream terraces and flood plains

This association is in the central part of Carroll County and borders the northern and western parts of Owen County. It consists of soils on stream terraces and flood plains along the Kentucky River and Eagle Creek. The stream terraces generally are fairly narrow and gently sloping to sloping and have steep, locally dissected areas. Near the mouth of the Kentucky River in Carroll County, however, the terraces are broad and nearly level. The flood plains are more narrow in Carroll County than they are upstream in Owen County.

This association makes up about 12 percent of Carroll County, 7 percent of Gallatin County, and 6 percent of Owen County, or 7 percent of the survey area. Otwell soils make up about 24 percent of this association, Nolin soils 20 percent, Markland soils 13 percent, and minor soils the remaining 43 percent (fig. 3).

Otwell soils are nearly level to sloping and are on stream terraces. They are deep, moderately well drained soils that have a loamy subsoil and a fragipan.

Nolin soils are nearly level and are on flood plains. They are deep, well-drained soils that have a loamy subsoil.

Markland soils are gently sloping to steep and are on stream terraces. They are deep, moderately well drained to well drained soils that have a clayey subsoil.

Minor soils in this association are Alluvial land and Elk, Lawrence, McGary, Robertsville, and Zipp soils on the stream terraces; and Brashear, Woolper, and Newark soils on toe slopes and flood plains.

This association is used mainly for farming. Many of the areas are in grass, but many others are used for corn and tobacco. Most of the association is suited to general farming, but a large acreage, especially in the steeper areas, is in deciduous trees or brush. General

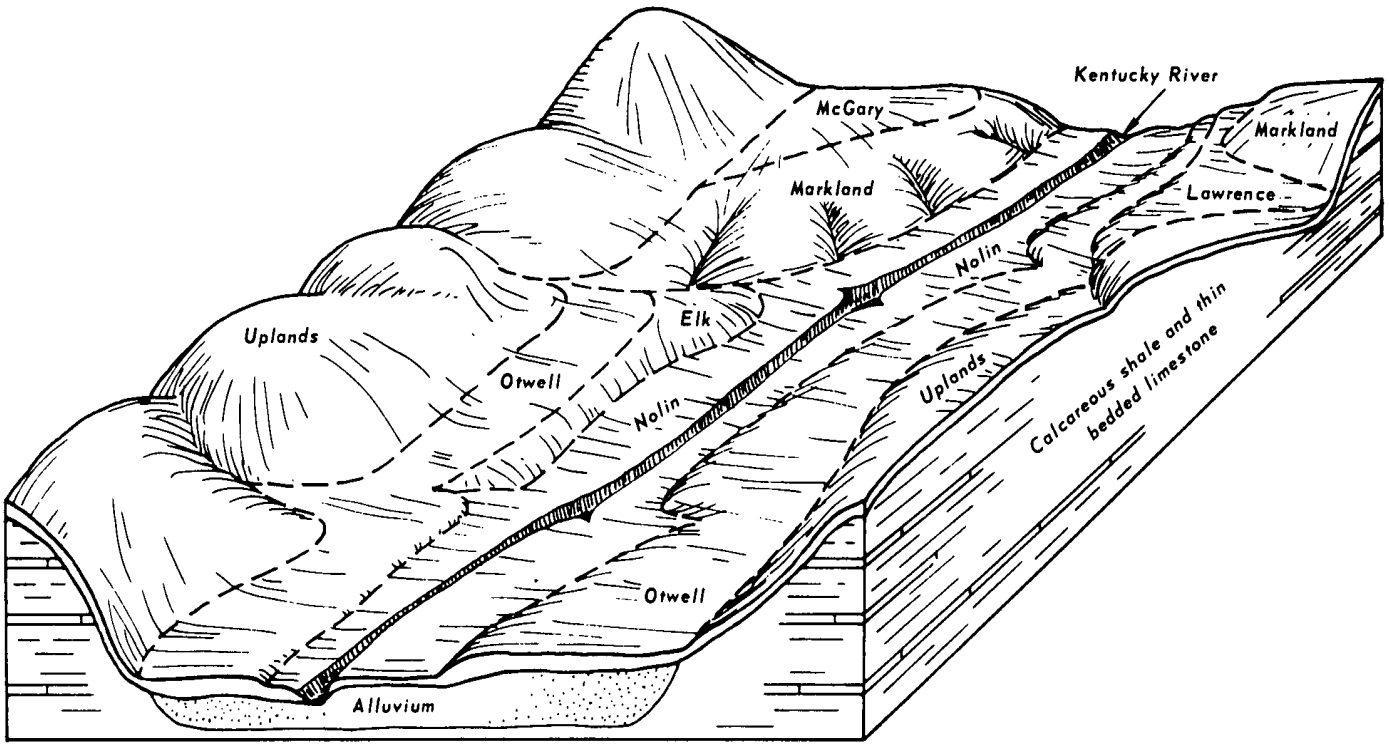

Figure 3.—**Pattern of soils and underlying material in the Otwell-Nolin-Markland association.**

Butler State Park, Perry Park, and a few private recreational parks are located in this association. The soils in this association have severe limitations for septic tank filter fields.

3. *Fairmount-Rock outcrop-Lowell association*

Steep to gently sloping soils that have a clayey subsoil; on hillsides and narrow ridges

This association consists mostly of steep, highly dissected soils on uplands. These soils are underlain by thin-bedded limestone and soft calcareous shale.

Nearly all of this association is in Carroll County, but one small area extends into the western part of Gallatin County. It makes up about 63 percent of Carroll County and less than 1 percent of Gallatin County, or 14 percent of the survey area. Fairmount soils make up about 48 percent of this association, Rock outcrop 21 percent, Lowell soils 12 percent, and minor soils the remaining 19 percent (fig. 4).

The Fairmount soils are strongly sloping to steep, shallow, and somewhat droughty and occur on narrow ridges and upper hillsides. These soils have a flaggy and clayey subsoil. Runoff is rapid. Rock outcrops and rock land occur in many areas of the steeper slopes.

The Lowell soils are gently sloping to strongly sloping and are on upper hillsides and narrow ridgetops. They are deep, well-drained soils that are clayey in the lower part of the subsoil.

Minor soils in this association are Eden soils on lower hillsides; Brassfield and Nicholson soils on upper slopes; and Woolper, Nolin, Boonesboro, and Newark soils in narrow valleys.

Most areas of the soils in this association are in low-quality trees or brush, but the narrow areas on ridgetops are in grass or tobacco. These soils are generally not suited to cultivation, and some farms are now idle. Hillsides generally are too steep for farming, and natural fertility is only moderate. Much of the farming is done by part-time farmers who work off the farm. Most of the soils in this association have low potential for either forestry or farming.

4. *Lowell-Nicholson association*

Strongly sloping to gently sloping soils that have a loamy and clayey subsoil; on upper hillsides and fairly broad ridges.

This association consists of soils that are underlain by limestone, calcareous shale, and beds of siltstone.

This association makes up about 9 percent of Carroll County, 22 percent of Gallatin County, and 17 percent of Owen County, or 16 percent of the survey area. Lowell soils make up about 65 percent of this association, Nicholson soils 24 percent, and minor soils the remaining 11 percent (fig. 5).

Lowell soils are gently sloping or sloping on ridgetops and strongly sloping on hillsides. These soils are deep, are well drained, and are clayey in the lower part of the subsoil.

Nicholson soils are gently sloping and are on fairly broad ridgetops. They are deep, well drained to moderately well drained soils that have a fragipan.

The minor soils of this association are Eden soils on lower hillsides; Markland and Otwell soils on high stream terraces or ridges; and Nolin soils on narrow flood plains.

This association is used mainly for crops. Most of the areas are in grass, but many areas of the more nearly level soils are used for corn and tobacco. Most of this association is suited to several types of farming.

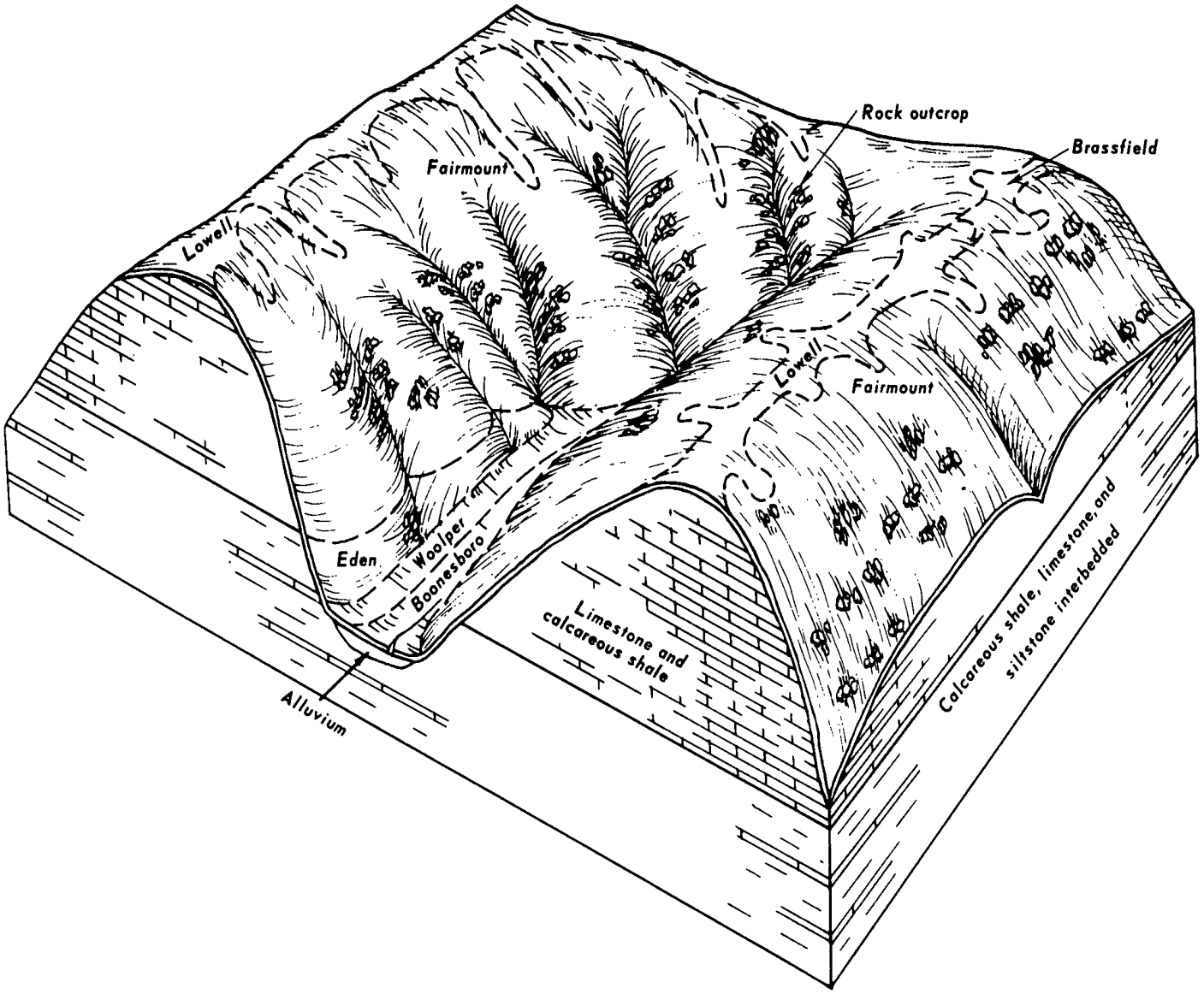

Figure 4.—**Pattern of soils and underlying material in the Fairmount-Rock outcrop-Lowell association.**

5. *Eden association*

Moderately steep and strongly sloping soils that have a clayey subsoil; on hillsides and narrow ridges

This association is on highly dissected uplands that have narrow ridgetops and narrow bottom lands. These soils are underlain by soft calcareous shale that has thin layers of limestone and beds of siltstone.

This association makes up about 6 percent of Carroll County, 62 percent of Gallatin County, and 77 percent of Owen County, or 59 percent of the survey area. Eden soils make up about 90 percent of this association, and minor soils the remaining 10 percent. (fig. 6).

Eden soils are moderately steep on hillsides and strongly sloping on narrow ridgetops. These soils are deep, are somewhat droughty, and have rapid runoff.

The minor soils in this association are Fairmount soils on hillsides; Heitt and Lowell soils on narrow ridgetops; and Brashear, Boonesboro, Nolin, Newark, and Woolper soils on narrow flood plains.

Most areas in this association are in grass, which is used for pasture or hay, but about one-third of the association is in trees or brush. Slopes are generally too steep to be suitable for row crops. Very little of the soils in this association is plowed, except for small gardens and tobacco. There is a potential for range-type grazing, but the farms are generally small. Tobacco is the main crop grown for cash.

Descriptions of the Soils

This section describes the soil series and mapping units in Carroll, Gallatin, and Owen Counties. Each soil series is described in detail, and then, briefly, each mapping unit 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

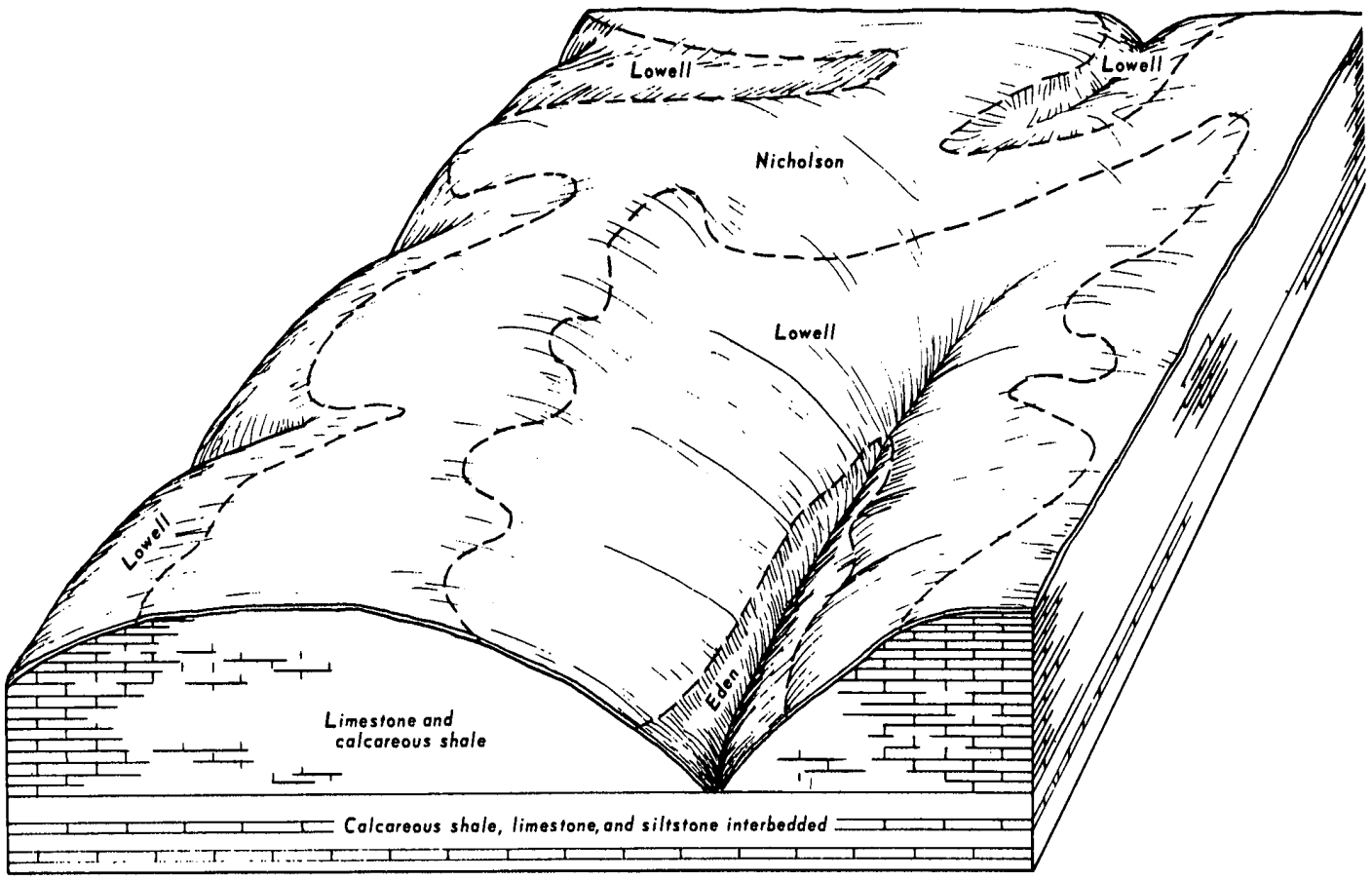

Figure 5.—**Pattern of soils and underlying material in the Lowell-Nicholson association.**

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. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for moist soil unless otherwise stated. The content of coarse fragments is measured by percentage of total volume.

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

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and woodland suitability group in which the mapping unit has been placed. The capability unit or other interpretative group in which each mapping unit has been placed can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

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 (*14*).[1]

Alluvial Land, Steep

Alluvial land, steep, (AlD) consists of soil material mostly along the banks of rivers and the edges of stream terraces. These areas are long and narrow and are as much as 100 acres in size. Slope ranges from 20 to 50 percent. The soil material in these areas is greatly stratified. The texture ranges from sandy loam to silty clay. The material is highly mottled in places. Few interpretations can be made about the land type, because of these extreme differences in the material.

Included with this land type in mapping were areas of steep Wheeling, Elk, and Huntington soils near the Ohio River and small areas of rock land and of Fairmount and Nolin soils near the Kentucky River.

This land type is not suited to crops or hay, because of steepness and the hazard of erosion. It is better suited to Kentucky 31 fescue and sericea lespedeza than to most other kinds of pasture plants. It is suit-

[1] Italic numbers in parentheses refer to Literature Cited, p. 60.

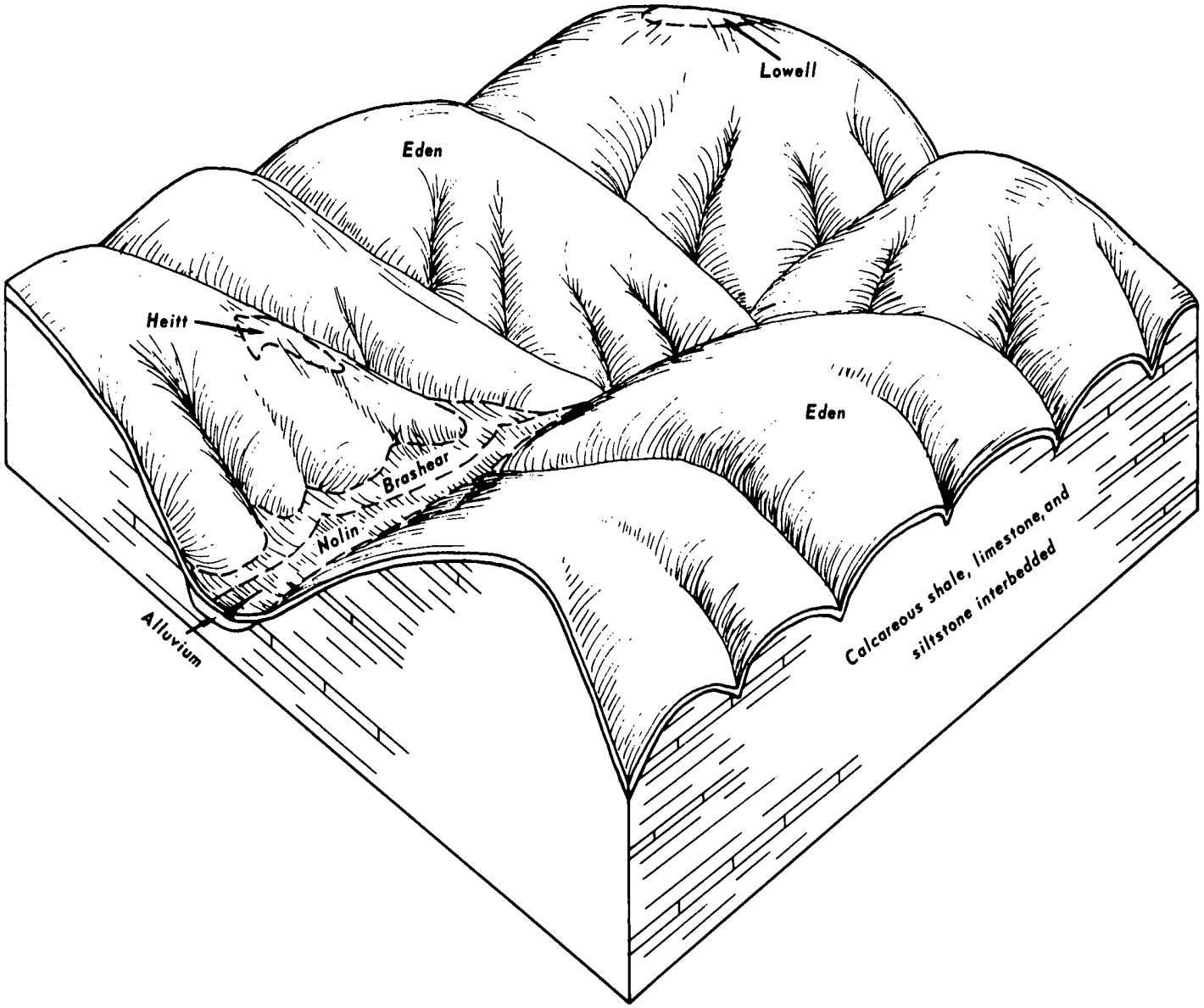

Figure 6.—**Pattern of soils and underlying material in the Eden association.**

able for limited pasture, but it is better suited to use as woodland or wildlife habitat.

Most areas of this land type are in scrub brush, weeds, and trees. Capability unit VIIe–1; not assigned to a woodland suitability group.

Ashton Series

The Ashton series consists of deep, well-drained, nearly level and gently sloping soils on low stream terraces, or second bottoms. These soils formed in alluvium that weathered mostly from limestone and calcareous shale. They are in small scattered areas, mostly along the Ohio River.

In a representative profile the surface layer is dark-brown silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches or more. It is about 8 inches of brown silt loam, 26 inches of brown silty clay loam, and 16 inches of dark yellowish-brown silt loam.

The Ashton soils have a deep rooting zone. Permeability is moderate, and runoff is medium. Available moisture capacity is high, and organic-matter content is medium. Reaction is neutral or slightly acid throughout. Natural fertility is high. The surface layer is easy to till and can be worked through a wide range of moisture content without clodding or crusting. These soils are flooded only when streamflow is uncommonly high. Crops are seldom affected by flooding.

Nearly all areas of these soils are used for burley tobacco, corn, or hay, but a few areas are used for truck crops and orchards.

Representative profile of Ashton silt loam, 0 to 4 percent slopes, in a field, 4 miles west of Warsaw, 400 feet north of U.S. Highway No. 42, 1 mile west of Markland Dam:

Ap—0 to 10 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, fine, granular structure; very friable; many roots; neutral; gradual, smooth boundary.

B1—10 to 18 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; friable; common roots; neutral; gradual, smooth boundary.

B2t—18 to 44 inches, brown (7.5YR 4.4) light silty clay

TABLE 1.—*Approximate acreage and proportionate extent of the soils by county and by survey area*

Soil	Carroll		Gallatin		Owen		Survey Area	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Alluvial land, steep	760	0.9	690	1.1	1,510	0.7	2,960	0.8
Ashton silt loam, 0 to 4 percent slopes	330	.4	140	.2	90	(1)	560	.1
Boonesboro-Alluvial land complex	520	.6	200	.3	1,340	.6	2,060	.6
Brashear silty clay loam, 6 to 12 percent slopes	160	.2	290	.5	1,950	.9	2,400	.6
Brashear silty clay loam, 12 to 20 percent slopes	250	.3	420	.6	900	.4	1,570	.4
Brassfield silt loam, 12 to 25 percent slopes	430	.5	0	0	0	0	430	.1
Eden silty clay loam, 12 to 20 percent slopes	380	.5	2,480	3.9	36,290	16.2	39,150	10.5
Eden flaggy silty clay, 20 to 30 percent slopes, severely eroded	7,330	8.8	35,810	56.0	124,070	55.2	167,210	44.9
Elk silt loam, 0 to 2 percent slopes	20	(1)	240	.4	310	.1	570	.2
Elk silt loam, 2 to 6 percent slopes	30	(1)	40	.1	860	.4	930	.2
Elk silt loam, 6 to 12 percent slopes	40	.1	0	0	920	.4	960	.3
Fairmount flaggy silty clay, 12 to 20 percent slopes	3,820	4.6	10	(1)	680	.3	4,510	1.2
Fairmount-Rock outcrop complex, 30 to 60 percent slopes	36,020	43.3	100	.2	7,780	3.5	43,900	11.8
Heitt silt loam, 6 to 12 percent slopes	0	0	300	.5	3,320	1.5	3,620	1.0
Huntington silt loam	890	1.1	630	1.0	0	0	1,520	.4
Lakin loamy fine sand, 2 to 12 percent slopes	130	.2	60	.1	0	0	190	.1
Lawrence silt loam	1,250	1.5	300	.4	1,130	.5	2,680	.7
Lowell silt loam, 2 to 6 percent slopes	1,080	1.3	330	.5	1,100	.5	2,510	.7
Lowell silt loam, 6 to 12 percent slopes	3,740	4.5	870	1.4	8,950	4.0	13,560	3.0
Lowell silty clay loam, 12 to 20 percent slopes, severely eroded	7,370	8.8	8,120	12.7	14,680	6.5	30,170	8.1
Markland silt loam, 2 to 6 percent slopes	870	1.1	140	.2	20	(1)	1,030	.3
Markland soils, 12 to 35 percent slopes	1,500	1.8	1,170	1.8	160	.1	2,830	.8
McGary silt loam	1,520	1.8	10	(1)	620	.3	2,150	.6
Newark silt loam	580	.7	320	.5	310	.1	1,210	.3
Nicholson silt loam, 2 to 8 percent slopes	1,680	2.0	4,370	6.8	8,250	3.7	14,310	3.8
Nolin silt loam	2,650	3.2	1,050	1.6	5,410	2.3	9,110	2.5
Otwell silt loam, 0 to 2 percent slopes	710	.9	160	.2	900	.4	1,770	.5
Otwell silt loam, 2 to 6 percent slopes	1,000	1.2	1,670	2.6	1,020	.5	3,690	1.0
Otwell silt loam, 6 to 12 percent slopes	560	.7	450	.7	450	.2	1,460	.4
Robertsville silt loam	750	.9	10	(1)	570	.3	1,330	.4
Wheeling silt loam, 0 to 2 percent slopes	3,810	4.6	2,850	4.5	100	(1)	6,760	1.8
Wheeling silt loam, 12 to 20 percent slopes	940	1.1	390	.6	50	(1)	1,380	.4
Woolper silty clay loam, 0 to 2 percent slopes	790	.9	210	.3	370	.2	1,370	.4
Woolper silty clay loam, 6 to 12 percent slopes	90	.1	70	.1	250	.1	410	.1
Woolper silty clay loam, 12 to 20 percent slopes	1,110	1.3	100	.2	90	(1)	1,300	.3
Zipp silty clay loam	80	.1	0	0	130	.1	210	.1
Total	83,190	100.0	64,000	100.0	224,580	100.0	371,770	100.0

[1] Less than 0.05 percent.

loam; moderate, fine, subangular blocky structure; friable; few fine roots; few thin clay films; neutral; gradual, smooth boundary.

B3—44 to 60 inches +, dark yellowish-brown (10YR 4/4) silt loam; weak, fine, subangular blocky structure; friable; neutral.

The solum ranges from 40 to 60 inches in thickness. The B1 horizon is brown (10YR 4/3 and 7.5YR 4/2 to 4/4) or dark yellowish brown (10YR 4/4). The B2 and B3 horizons are brown (7.5YR 4/4), dark yellowish-brown (10YR 4/4), or yellowish-brown (10YR 5/4) silt loam or silty clay loam. The C horizon ranges from silty clay loam to sand.

Ashton soils are near Wheeling, Elk, Woolper, Huntington, and Nolin soils. They are at lower elevations on the stream terraces than Wheeling, Elk, and Woolper soils. They have a darker Ap horizon than Wheeling or Elk soils, and they have a coarser textured B horizon than Woolper soils. Ashton soils are at slightly higher elevations, are less frequently flooded, and have more distinct horizons than Huntington and Nolin soils.

Ashton silt loam, 0 to 4 percent slopes (AsA).—This soil is mostly on low stream terraces or second bottoms. The areas range from 5 to 30 acres in size. Slopes are mostly about 2 percent.

Included with this soil in mapping were areas of a soil that has more clay in the subsoil than is typical for the Ashton series, but use and management of this soil are not significantly different. Areas of this soil make up about one-fourth of the acreage mapped. Also included were a few narrow areas of a soil that is steeper than 4 percent, an area of a soil that has a brown surface layer and a strongly acid subsoil, and areas of a soil that is dark brown and dark grayish brown in the upper part of the subsoil.

This soil is not subject to erosion.

This soil can be cropped year after year and productivity maintained if the soil is properly fertilized, practices are used to help to maintain organic-matter content, and good tillage practices are followed. It is well suited to all pasture and hay plants that are commonly grown in the area and to truck crops, orchards,

vineyards, and nursery stock plants. Capability unit I–5; woodland suitability group 1o2.

Boonesboro Series

The Boonesboro series consists of moderately deep, well-drained, nearly level and gently sloping soils in narrow stream valleys. These soils formed in recent alluvium, mostly weathered from limestone and calcareous shale. They are subject to rapid flooding.

In a representative profile the surface layer is dark-brown silty clay loam about 18 inches thick. This layer is about 15 percent coarse limestone fragments in the lower 10 inches. The subsoil is brown very gravelly silty clay loam about 6 inches thick. It is about 45 percent limestone fragments. The underlying material is limestone bedrock.

The rooting zone is moderately deep. Permeability is moderate in the upper 18 inches of these soils and rapid in the lower part. Runoff is medium. Crops may be damaged by flooding during the growing season. The available moisture capacity is moderate, and organic-matter content is medium. Reaction generally is neutral to mildly alkaline throughout the profile. Natural fertility is moderately high.

Most areas of these soils are in pasture, but some areas are used for burley tobacco, home gardens, or hay. A few areas are in brush, native bluegrass, weeds, and scattered deciduous trees.

Representative profile of Boonesboro silty clay loam in an area of Boonesboro-Alluvial land complex, 4 to 5 miles south of Carrollton, 100 feet southeast of State Highway No. 55, along Mellins Branch:

Ap—0 to 8 inches, dark-brown (10YR 3/3 when rubbed) light silty clay loam; moderate, fine, granular structure; friable; many roots; neutral or mildly alkaline; gradual, wavy boundary.

A1—8 to 18 inches, dark-brown (10YR 3/3) silty clay loam; weak, fine, granular structure; friable; many roots; coarse limestone fragments make up about 15 percent of the horizon; mildly alkaline; gradual, wavy boundary.

B—18 to 24 inches, brown (10YR 4/3) very gravelly silty clay loam; weak, fine, granular structure; friable; few roots; coarse limestone fragments make up about 45 percent of the horizon; mildly alkaline; abrupt, smooth boundary.

R—24 inches +, limestone.

The solum is 20 to 40 inches thick over bedrock. The Ap and A1 horizons are dark-brown (10YR 3/3) or very dark grayish-brown (10YR 3/2) silt loam to silty clay loam. Coarse fragments make up about 0 to 20 percent of these horizons. The B horizon is brown (10YR 4/3, 7.5YR 4/2, or 7.5YR 4/4) or dark grayish-brown (10YR 4/2) silt loam to silty clay loam. Coarse fragments make up about 15 to 60 percent in this horizon.

Boonesboro soils are in narrow valleys near Nolin, Woolper, and Brashear soils. They are shallower to bedrock and are flooded more often than those soils.

Boonesboro-Alluvial land complex (0 to 4 percent slopes) (Bo).—This complex is on long, narrow bottom lands. The areas are 10 to 60 acres in size. The soils in this complex are subject to deposition and scouring as a result of rapid flooding. The areas are so intricately intermingled that they could not be separated at the scale mapped.

Boonesboro silty clay loam makes up about 50 percent of this complex; areas that are mostly stones, gravel, or flagstones, or a mixture of these, and that have silty alluvium between the coarse fragments, make up 15 percent; a shallow, rocky stream channel that is 25 to 100 feet wide makes up 10 percent; and areas of Nolin, Brashear, Woolper, and Newark soils make up the remaining 25 percent.

Included with the complex in mapping were areas of soils that have a dark grayish-brown surface layer and subsoil.

Most areas of this complex are not suited to cultivation, because they are subject to flooding. If the areas are leveled and protected from flooding, however, they are suitable for crops. A small part of the complex is suitable for most plants commonly grown in the area. This complex is suited to trees, pasture, and hay. Some of the better suited pasture and hay plants are tall fescue, reed canarygrass, sericea lespedeza, red clover, and annual lespedeza.

Management of plants for ground cover and protection of the soils is very important because of the rapid flooding. Plants used for pasture should be mixes that provide satisfactory forage production, produce adequate ground cover, and require the least frequent renovation. The soils need to be rested to permit pasture plants to regrow. Capability unit Vw–1; woodland suitability group 1o1.

Brashear Series

The Brashear series consists of deep, well drained to moderately well drained soils on foot slopes and alluvial fans, in narrow valleys, and at the base of steep hills. These soils formed in colluvium or local alluvium that washed mostly from Eden soils.

In a representative profile the surface layer is brown silty clay loam about 6 inches thick. The subsoil is yellowish brown and extends to a depth of about 44 inches. It is silty clay loam in the upper 6 inches; silty clay in the next 6 inches; and silty clay that has gray mottles in the lower 26 inches. The underlying material is light olive-brown clay that extends to a depth of 60 inches or more.

The depth of the rooting zone is somewhat restricted by the clayey subsoil. Permeability is moderately slow, and runoff is medium to rapid. Available moisture capacity is moderate, and organic-matter content is low. Reaction ranges from slightly acid to strongly acid, and natural fertility is moderately high.

Much of the acreage of these soils is in pasture, but many areas are used for burley tobacco. A few areas are in deciduous trees, and a few areas are in brush, native bluegrass, and weeds.

Representative profile of Brashear silty clay loam, 12 to 20 percent slopes, 7 miles south of Warsaw, 1 mile east of Sparta, on the north side of State Highway No. 1132:

Ap—0 to 6 inches, brown (10YR 4/3) silty clay loam; weak, fine, granular structure; friable; many roots; coarse flags that are 4 to 10 inches wide make up about 2 percent of the horizon; strongly acid; clear, wavy boundary.

B1t—6 to 12 inches, yellowish-brown (10YR 5/4) silty clay loam; moderate, fine and medium, angular blocky struc-

ture; firm, sticky and plastic; many roots; common thin clay films; coarse fragments make up about 3 percent of the horizon; strongly acid; gradual, smooth boundary.

B21t—12 to 18 inches, yellowish-brown (10YR 5/4) silty clay; strong, medium, angular blocky structure; very firm, sticky and plastic; few roots; common moderately thick clay films; coarse fragments make up about 3 percent of the horizon; strongly acid; gradual, wavy boundary.

B22t—18 to 26 inches, yellowish-brown (10YR 5/4) silty clay; few, fine, distinct, light brownish-gray (2.5Y 6/2) mottles, common, medium, faint, brown (7.5YR 5/4) mottles, and common, fine, faint, light olive-brown (2.5Y 5/4) mottles; strong, medium, angular blocky structure; very firm, sticky and plastic; few roots; common moderately thick clay films; few, very small, brown concretions; coarse fragments make up about 4 percent of the horizon; strongly acid; clear, wavy boundary.

B31t—26 to 36 inches, mottled yellowish-brown (10YR 5/4), light-gray (2.5Y 7/2), and pale-yellow (2.5Y 7/4) silty clay; moderate, coarse, angular blocky structure; very firm, sticky and plastic; common moderately thick clay films; siltstone fragments make up about 5 percent and limestone flags make up about 2 percent of the horizon; strongly acid; gradual, wavy boundary.

B32t—36 to 44 inches, yellowish-brown (10YR 5/6) silty clay; common, fine, faint, light olive-gray (5Y 6/2) mottles; weak, coarse, blocky structure; firm, sticky and plastic; few thin clay films; soft brown concretions make up about 3 percent and limestone flags make up about 4 percent of the horizon; medium acid; gradual, wavy boundary.

C—44 to 60 inches +, light olive-brown (2.5Y 5/4) clay; few, medium, distinct, light olive-gray (5Y 6/2) mottles; massive; very firm, sticky and plastic; small black concretions make up about 5 percent and coarse fragments make up about 5 percent of the horizon; neutral.

The solum ranges from 38 to 55 inches in thickness. Bedrock is at a depth of 4 feet to more than 10 feet. Gray mottles begin at a depth of 16 to 22 inches. Content of coarse limestone and siltstone flags and smaller fragments ranges from 2 to 10 percent, and they occur on the surface and throughout the profile. The Ap horizon is brown (10YR 4/3) or dark grayish-brown (10YR 4/2 or 2.5Y 4/2) silt loam to silty clay loam. The B1 horizon is yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4), or olive brown (2.5Y 4/4). The B2 and B3 horizons are 10YR and 2.5Y in hue, 4 and 5 in value, and 4 or 6 in chroma. They are silty clay to clay in texture. The C horizon is light olive-brown (2.5Y 5/4) or olive-brown (2.5Y 4/4) silty clay to clay.

Brashear soils are near Eden, Woolper, Boonesboro, Nolin, McGary, and Markland soils. They have a thicker B horizon than Eden soils and are generally more acid. They have a lighter colored A horizon than Woolper or Boonesboro soils and a finer textured B horizon than Nolin soils. Brashear soils are better drained than McGary soils. They have more coarse fragments than McGary and Markland soils but do not have the lime nodules of those soils.

Brashear silty clay loam, 6 to 12 percent slopes (BrC).—This soil is mostly in small, narrow areas on the low-lying toe slopes that are below Eden soils. The areas range from 3 to 20 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is silt loam 6 to 9 inches thick.

Included with this soil in mapping were long, narrow areas of Nolin soils, small areas of Otwell and Eden soils, and areas of soils near Monterey that have a surface layer of gravelly loam 6 to 10 inches thick. Also included were a few small seepy spots and areas of soils that have slopes of less than 6 percent.

This soil is somewhat difficult to till, because of the silty clay loam texture. If this soil is cultivated, the hazard of erosion is severe, and cropping systems and other conservation practices must be used to slow runoff and keep soil losses to a minimum.

This soil is suited to crops that are commonly grown in the area, such as corn, tobacco, and small grain. Some of the better suited pasture and hay plants are tall fescue, orchardgrass, timothy, alfalfa, red clover, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIIe–2; woodland suitability group 2c1.

Brashear silty clay loam, 12 to 20 percent slopes (BrD).—This soil is on narrow toe slopes that are below Eden soils. The areas are rarely more than 300 feet wide, and they range from 10 to 50 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were a few flaggy areas of soils that have a very dark grayish-brown surface layer 4 to 6 inches thick, small areas of soils that have a silt loam surface layer, a few areas of soils that have deep gullies, a few small seepy spots, and small areas of Nolin, Otwell, and Eden soils. Also included was a small acreage of severely eroded soils.

This soil is somewhat difficult to till, because of the silty clay loam texture. If this soil is cultivated, the hazard of erosion is very severe, and cropping systems and other conservation practices must be used to slow runoff and keep soil losses to a minimum.

This soil is suited to row crops that are commonly grown in the area, such as corn and tobacco. Some of the better suited pasture and hay plants are orchardgrass, tall fescue, alfalfa, red clover, white clover, sericea lespedeza, and annual lespedeza. Capability unit IVe–2; woodland suitability group 2c1.

Brassfield Series

The Brassfield series consists of moderately deep, well-drained, strongly sloping to moderately steep soils on upper hillsides and very narrow ridges, mostly in the western part of Carroll County. These soils formed in residual material that weathered from interbedded calcareous sandstone, limestone, and shale.

In a representative profile the surface layer is dark grayish-brown silt loam, about 5 inches thick, that has light olive-brown mottles. The subsoil is light olive-brown loam about 7 inches thick. The underlying material is olive loam that extends to a depth of about 26 inches. It is underlain by layers of soft calcareous shale and calcareous sandstone.

The rooting zone is shallow to moderately deep. Permeability is moderate, and runoff is medium. Available moisture capacity is low, and organic-matter content generally is low. Reaction generally is mildly alkaline to strongly alkaline, and the profile is calcareous throughout. Natural fertility is low.

Most areas of these soils have been cleared and are used for pasture. Some areas have reverted to brush or second-growth deciduous trees.

Representative profile of Brassfield silt loam, 12 to 25 percent slopes, 4 miles west-southwest of Carrollton, and 0.3 mile northeast of the Trimble County line; or 1,000 feet northeast of Mt. Herman Church:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) silt loam; common, medium, distinct, light olive-brown (2.5Y 5/4) mottles; moderate, fine, angular block structure; friable; many roots; siltstone fragments make up about 2 percent of the horizon; mildly alkaline, calcareous; abrupt, wavy boundary.

B—5 to 12 inches, light olive-brown (2.5Y 5/4) loam; moderate, fine, angular blocky structure; friable; common roots; soft siltstone fragments make up about 10 percent of the horizon; moderately alkaline, calcareous; gradual, wavy boundary.

C—12 to 26 inches, olive (5Y 5/3) loam; few, coarse, distinct, light olive-gray (5Y 6/2) mottles (color is from parent material rather than wetness) and few, fine, faint, light olive-brown (2.5Y 5/6) mottles; moderate, thin, platy and moderate, fine, angular blocky structure; friable; few roots; very soft weathered shale and sandstone fragments make up about 18 percent of the horizon; strongly alkaline; calcareous.

R—26 inches +, olive (5Y 5/4) calcareous shale and calcareous sandstone.

The solum ranges from 10 to 20 inches in thickness. Bedrock is at a depth of 20 to 36 inches. The A1 horizon, if present, is very dark grayish brown (10YR 3/2) and is less than 6 inches thick. The Ap horizon is 10YR and 2.5Y in hue, 4 or 5 in value, and 1 or 2 in chroma. It is loam to silty clay loam. Coarse fragments make up about 1 to 10 percent of this horizon. The B horizon ranges from yellowish-brown (10YR 5/6) to olive (5Y 5/4) loam to silty clay loam. Coarse fragments make up about 5 to 20 percent of this horizon. The C horizon is 5Y and 2.5Y in hue, 5 or 6 in value, and 1 to 4 in chroma. Coarse fragments make up about 10 to 50 percent of this horizon.

The Brassfield soils are on uplands near Lowell, Eden, and Fairmount soils. They have a coarser textured B horizon than any of those soils.

Brassfield silt loam, 12 to 25 percent slopes (BsD).—This soil is on upper hillsides. The areas range from 10 to 20 acres in size.

Included with this soil in mapping were areas of soils that have a discontinuous, strong-brown or reddish-yellow subsoil less than 12 inches thick. Also included were a few very severely eroded areas of soils that have fairly deep gullies.

This soil is fairly easy to till but is not suitable for cultivation, because of steepness, the effects of past erosion, and the hazard of additional erosion.

This soil is suited to pasture or hay crops commonly grown in the area, such as tall fescue and sericea lespedeza. Plants that provide continuous ground cover are needed to protect the soil from erosion. Seeding mixtures should include plants that provide satisfactory forage production, produce adequate ground cover, and require the least frequent pasture renovation. This soil needs rest between grazing periods to permit the regrowth of plants. Grazing should be controlled to leave vegetation at least 3 inches high. Capability unit VIe–4; woodland suitability group 4d1.

Eden Series

The Eden series consists of deep, well-drained, strongly sloping to moderately steep soils on very narrow ridges and side slopes in hilly areas. These soils are somewhat droughty. They formed in residual material that weathered from soft calcareous shale that has thin layers of limestone and beds of siltstone.

In a representative profile the surface layer is brown silty clay loam about 4 inches thick. The subsoil is silty clay that extends to a depth of about 20 inches. It is olive brown in the upper 4 inches and light olive brown in the lower 12 inches. The lower part of this layer is about 15 percent coarse fragments. The underlying material is olive silty clay that is about 50 percent coarse fragments and extends to a depth of about 50 inches to thin layers of unweathered shale and limestone.

The depth of the rooting zone is somewhat restricted by the silty clay subsoil. Runoff is rapid. Permeability is slow. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is slightly acid to moderately alkaline throughout the profile. Natural fertility is moderately high.

These soils were cleared and used for corn for many years, but very little corn is now grown. Most of the more nearly level areas are used for pasture and hay, but many of the steeper areas have reverted to redcedar, deciduous trees, or brush pasture. Some very small areas are used for burley tobacco and garden crops.

Representative profile of Eden silty clay loam, 12 to 20 percent slopes, 5.5 miles east-northeast of Owenton, on the University of Kentucky Experimental Farm:

Ap—0 to 4 inches, brown (10YR 4/3) heavy silty clay loam; moderate, very fine, angular blocky structure; firm, slightly sticky and plastic; many roots; coarse limestone and siltstone fragments make up about 5 percent of the horizon; neutral; clear, smooth boundary.

B21t—4 to 8 inches, olive-brown (2.5Y 4/4) silty clay; moderate, fine angular blocky structure; very firm, sticky and plastic; few roots; common thick clay films; coarse fragments make up about 15 percent of the horizon; neutral; gradual, wavy boundary.

B22t—8 to 14 inches, light olive-brown (2.5Y 5/4) silty clay; moderate, fine, angular blocky structure; very firm, sticky and plastic; few roots; common thick clay films; coarse limestone and siltstone fragments make up about 15 percent of the horizon; neutral; gradual, wavy boundary.

B3—14 to 20 inches, light olive-brown (2.5Y 5/4) silty clay; weak, medium, angular blocky structure; very firm, sticky and plastic; few roots; few clay films; soft yellowish-brown (10YR 5/4) pieces of siltstone make up about 5 percent of the horizon, and coarse limestone and siltstone fragments make up about 15 percent; neutral; gradual, wavy boundary.

C&R—20 to 50 inches, olive (5Y 5/3) silty clay; pale-olive (5Y 6/3) coatings and yellowish-brown (10YR 5/6) mottles; relict platy structure; very firm; calcareous shale makes up about 30 percent of the horizon, and coarse limestone fragments make up about 20 percent; mildly alkaline, gradual, wavy boundary.

R—50 inches +, soft, unweathered, olive-gray, calcareous shale, some siltstone, and interbedded thin layers of limestone.

The solum ranges from 14 to 26 inches in thickness. Unweathered shale is at a depth of 40 to 60 inches. The Ap horizon is brown (10YR 4/3), dark grayish-brown (10YR 4/2 or 2.5Y 4/2), or grayish-brown (10YR 5/2) light silty clay loam to silty clay. Coarse fragments make up about 2 to 15 percent of this horizon. The B horizon is 10YR to 5Y in hue, 4 or 5 in value, and 4 or 6 in chroma. It is silty clay to clay in texture. Coarse fragments make up about 10 to 30 percent of this horizon. The C&R horizon is olive (5Y 5/3), olive gray (5Y 5/2), pale olive (5Y 6/3), and light olive brown (2.5Y 5/4). Coarse fragments make up about 25 to 75 percent of this horizon.

Eden soils are near Brashear, Markland, Lowell, Heitt, and Fairmount soils. They have a thinner solum than Brashear and Markland soils, and they have a thinner, more olive B horizon than Lowell or Heitt soils. Eden soils

have a lighter colored A horizon and are deeper to bedrock and less flaggy than Fairmount soils.

Eden silty clay loam, 12 to 20 percent slopes (EdD).—This soil is on narrow ridges and upper hillsides above areas of steeper Eden soils. The areas range from 30 to 200 acres in size. This soil has the profile described as representative for the series. The surface layer generally is 2 to 12 percent thin limestone and siltstone flags, which have been removed in some areas.

Included with this soil in mapping were small areas of soils that have a thin, discontinuous, yellowish-brown to yellowish-red, strongly acid subsoil; areas of soils that are uneroded; areas of soils that are severely eroded; areas of soils that have less than 10 percent coarse fragments in the subsoil; and areas of soils that have a surface layer and subsoil as thin as 8 inches. Also included were areas of soils that have a surface layer of silt loam 4 to 6 inches thick; areas of soils that are underlain by siltstone; small areas of soils that are 35 percent limestone and siltstone flags in the plow layer; and areas of soils that have bedrock at a depth of less than 40 inches.

This soil is somewhat difficult to till, because of coarse fragments and the high content of clay in the plow layer. It is generally not suited to cultivation, because of steepness, the effects of past erosion, and the hazard of additional erosion.

Most areas of this soil are used for hay and pasture, but a few areas are used for tobacco and corn. Some of the better suited pasture (fig. 7) and hay plants are tall fescue and sericea lespedeza; annual lespedeza is suited only if it is grown with a mixture of grasses. Plants that provide continuous ground cover are needed to protect the soil from erosion. Seeding mixtures should include plants that provide satisfactory forage production, produce adequate ground cover, and require the least frequent renovation. This soil needs rest between grazing periods to permit the regrowth of plants. Grazing should be controlled to leave vegetation at least 3 inches high. Capability unit VIe–3; woodland suitability group 3c2.

Eden flaggy silty clay, 20 to 30 percent slopes, severely eroded (EfE3).—This soil is on hillsides. The areas are several hundred acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer generally is more clayey and is 15 to 25 percent thin limestone and siltstone flags. In a few areas the flags have been removed and placed in gullies or stacked in ricks.

Included with this soil in mapping were small areas of soils that have a silt loam surface layer 2 to 4 inches thick, small areas of soils that have a surface layer and subsoil less than 8 inches thick combined, small areas of uneroded soils, a few areas of gullied land, and small areas of soils that are more than 50 percent flags. Also included were areas of soils that have unweathered shale at a depth of less than 40 inches. In wooded areas there are spots of Brashear soils, less than one-tenth acre in size, that are more acid and have fragments that are not so coarse as those in Eden soils.

This soil generally is not suited to cultivation, because of flags, steepness, the effects of past erosion, and the hazard of additional erosion. It is limited for

Figure 7.—**Pasture on an Eden silty clay loam.**

hay. Pasture plants have fair growth, but seedbed preparation and mowing to control weeds are very difficult because of steep slopes, flags, numerous shallow gullies, brush, and small trees.

Most areas of this soil are used for limited pasture, but many areas are now idle or in poor stands of second-growth trees. Tall fescue and annual lespedeza are more drought resistant than most other pasture plants, but Kentucky bluegrass commonly grows naturally in areas that are kept mowed. Seeding mixtures should include long-lived plants that seldom require renovation. Fertilizers, except for nitrogen, are not needed. This soil needs rest between grazing periods to permit the regrowth of plants. Grazing should be controlled to leave vegetation at least 3 inches high. Capability unit VIIe–2; woodland suitability group 3c2.

Elk Series

The Elk series consists of deep, well-drained, nearly level to sloping soils on stream terraces, mainly along Eagle Creek and the Kentucky River. These soils formed in alluvium weathered mostly from limestone and calcareous shale.

In a representative profile the surface layer is brown silt loam about 8 inches thick. The subsoil is brown and strong-brown silty clay loam about 32 inches thick. The underlying material, which reaches a depth of 60 inches or more is strong-brown silty clay loam.

Runoff is slow to medium. Permeability is moderate. Available moisture capacity is high, and organic-matter content is low. The rooting zone is deep. Reaction generally is strongly acid or medium acid, but if the surface layer is limed, it is less acid. Natural fertility is moderately high. The surface layer is easy to till. It can be worked over a wide range of moisture content without clodding or crusting.

Most areas of these soils are used for such crops as burley tobacco, corn, and hay.

Representative profile of Elk silt loam, 2 to 6 percent slopes, 7 miles southwest of Owenton, on State Highway No. 355, 1.2 miles southwest of Gratz, 300 feet north of the highway:

Ap—0 to 8 inches, brown (10YR 4/3) silt loam; moderate, fine, granular structure; very friable; many roots; strongly acid; clear, smooth boundary.

B1t—8 to 18 inches, brown (7.5YR 4/4) light silty clay loam; moderate, medium, subangular blocky structure; friable; common roots; few thin clay films; few very small concretions; few very small pieces of gravel; strongly acid, clear, smooth boundary.

B21t—18 to 24 inches, brown (7.5YR 5/4) silty clay loam; moderate, medium, angular blocky structure; friable; few roots; common, moderately thick clay films; few small concretions; few very small pieces of gravel; strongly acid, clear, smooth boundary.

B22t—24 to 40 inches, strong-brown (7.5Y 5/6) silty clay loam; few, fine, faint, pale-brown (10YR 6/3) mottles; moderate, medium, angular blocky structure; friable; common, moderately thick clay films; many, very small, hard, brown and black concretions; strongly acid; gradual, smooth boundary.

C—40 to 60 inches +, strong-brown (7.5YR 5/6) silty clay loam; few, fine, faint, pale-brown (10YR 6/3) mottles; massive; friable; many, common, soft, dark concretions; few small patches of sand and small pebbles; strongly acid.

The solum ranges from 36 to 48 inches in thickness. Bedrock is at a depth of 4 feet to more than 10 feet. Some profiles have small beds of chert and gravel. Gravel and chert fragments (less than 1 inch in diameter) make up 0 to 3 percent of the profile and occur throughout. The Ap horizon is brown (10YR 4/3), dark grayish brown (10YR 4/2), or dark yellowish brown (10YR 4/4). Structure is moderate or weak. The B horizon ranges from strong brown (7.5YR 5/6) to dark yellowish-brown (10YR 4/4) silt loam to silty clay loam. The C horizon is strong brown (7.5YR 5/6) or yellowish brown (10YR 5/6), and in places mottles are absent. This horizon ranges from loam to silty clay, and it contains stratified layers of silt, clay, and sand.

Elk soils are near Otwell, Lawrence, Robertsville, Ashton, and Wheeling soils on stream terraces. Elk soils are better drained than Otwell, Lawrence, or Robertsville soils, and they have a lighter colored Ap horizon than Ashton soils. They have less sand and more clay in the B horizon than Wheeling soils. Elk soils are at higher elevations, are less susceptible to flooding, and have more distinct horizons than Nolin soils.

Elk silt loam, 0 to 2 percent slopes (ElA).—This soil is mainly on low stream terraces or second bottoms. The areas range from 10 to 30 acres in size. They are flooded occasionally when streamflow is unusually high, but damage to crops is slight.

Included with this soil in mapping were small, narrow areas of soils that have slopes as steep as 5 percent, areas of soils that have a dark-brown surface layer, and a few small areas of soils that have a slightly compacted subsoil at a depth below 21 inches. Also included were small areas of soils that have pale-brown mottles at a depth of less than 24 inches.

Erosion is not a hazard on this soil.

This soil can be cropped year after year and productivity maintained if the soil is properly fertilized, practices are used to help maintain organic-matter content, and good tillage practices are followed. It is well suited to all pasture and hay plants commonly grown in the survey area and to truck crops, orchards, vineyards, and nursery stock plants. Capability unit I–5; woodland suitability group 2o1.

Elk silt loam, 2 to 6 percent slopes (ElB).—This soil is on regular stream terraces. The areas are variable in size but range from 5 to 50 acres. Some areas are flooded when streamflow is unusually high. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of soils that have slopes of less than 2 percent, a few eroded spots, areas of soils that have gray mottles below a depth of about 24 inches, small areas of soils that have silty clay in the lower part of the subsoil, small areas of soils that have bedrock at a depth of 3 to 4 feet, and small areas of cherty soils.

This soil is suited to crops commonly grown in the survey area, such as corn, tobacco, and small grain, and to all pasture and hay crops grown in the area. In addition, it is well suited to truck crops, orchards, vineyards, and nursery stock plants. If this soil is cultivated, the hazard of erosion is moderate. Consequently, a suitable cropping system and other conservation practices are needed to slow runoff and to keep soil losses to a minimum. Capability unit IIe–1; woodland suitability group 2o1.

Elk silt loam, 6 to 12 percent slopes (ElC).—This soil is in fairly large areas, but the total acreage is small.

The areas range from 5 to 50 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is less than 7 inches thick. Some areas are flooded when streamflow is unusually high.

Included with this soil in mapping were small areas of soils that are cherty, small narrow areas of soils that have slopes of up to 15 percent, and small areas of severely eroded soils. Also included were areas of soils that have pockets of sand in the lower part of the subsoil and a few areas of soils that have bedrock at a depth of less than 40 inches.

The hazard of erosion is severe. Consequently, if this soil is cultivated, suitable cropping systems and other conservation practices must be used to slow runoff and keep soil loss to a minimum.

This soil is suited to crops commonly grown in the area, such as corn and small grain. It is well suited to all of the pasture and hay plants that are commonly grown in the area and to orchards, vineyards, and nursery stock plants. Capability unit IIIe–1; woodland suitability group 2o1.

Fairmount Series

The Fairmount series consists of shallow, well-drained, strongly sloping to steep soils in hilly areas, mostly in the western part of Carroll County and the southern part of Owen County. These soils are somewhat droughty and have rapid runoff. They formed in residual material that weathered from thin-bedded limestone that has thin layers of calcareous shale.

In a representative profile the surface layer is very dark grayish-brown flaggy silty clay about 6 inches thick. The subsoil is olive-brown flaggy silty clay, about 4 inches thick, and that is about 20 percent coarse fragments. The underlying material is light olive-brown flaggy silty clay that extends to a depth of about 16 inches and rests on rubbly, or rippable, limestone. This layer is about 40 percent coarse fragments (fig. 8).

The rooting zone is shallow. Permeability is moderately slow. Available moisture capacity is low, and organic-matter content is medium. Reaction generally is neutral to moderately alkaline, and the subsoil is calcareous in some places. Natural fertility is moderate.

Most areas of these soils are in redcedar and second-growth deciduous trees. The more nearly level areas have been cleared and are used mostly for pasture and small patches of tobacco, but many of the steeper areas have reverted to trees and brush (fig. 9). Much of the wooded acreage of these soils has been burned, grazed, or cut over, causing the trees to have little commercial value.

Representative profile of a Fairmount flaggy silty clay in an area of Fairmount-Rock outcrop complex, 30 to 60 percent slopes, 2 to 3 miles west of Carrollton, 0.5 mile northwest of junction of a county road and U.S. Highway No. 42, 200 feet north of a point on the county road; 1 mile west of junction of U.S. Highway No. 42 and State Highway No. 36:

Figure 8.—**Profile of Fairmount flaggy silty clay.**

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2 when rubbed) flaggy silty clay; moderate, medium, granular and strong, fine, angular blocky structure; firm, slightly sticky and plastic; many roots; coarse limestone fragments make up about 18 percent of the horizon; neutral; clear, wavy boundary.

B—6 to 10 inches, olive-brown (2.5Y 4/4) flaggy silty clay; ped surfaces are brown (10YR 4/3); strong, medium, angular blocky structure; firm, sticky and plastic; many roots; coarse limestone fragments make up about 20 percent of the horizon; mildly alkaline; clear, wavy boundary.

C—10 to 16 inches, light olive-brown (2.5Y 5/4) flaggy silty clay; massive; firm, slightly sticky and plastic; common roots; coarse limestone fragments make up about 40 percent of the horizon; moderately alkaline; abrupt, wavy boundary.

R&C—16 inches +, rubbly, or rippable, limestone interbedded with 1- to 6-inch layers of soft, calcareous shale.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2 or 2.5Y 3/2). Structure is moderate or strong, medium, granular and fine, angular blocky. Coarse fragments are mostly limestone flags that cover 5 to 25 percent of the surface and make up 10 to 25 percent of the Ap horizon. The B horizon is olive-brown (2.5Y 4/4), brown (10YR 4/3), dark yellowish-brown (10YR 4/4), or yellowish-brown (10YR 5/4) silty clay to clay. Coarse fragments make up 15 to 25 percent of the B horizon. The C horizon is silty clay or clay. Coarse fragments make up 30 to 50 percent of this horizon. The R&C horizon is at a depth of 10 to 20 inches.

Fairmount soils are near Brassfield, Lowell, Eden, and Woolper soils. They are flaggy and are finer textured than Brassfield soils, and they are shallower to bedrock than the other soils. Fairmount soils have a darker A horizon than Eden soils.

Fairmount flaggy silty clay, 12 to 20 percent slopes (FaD).—This soil is on high, narrow ridges and upper

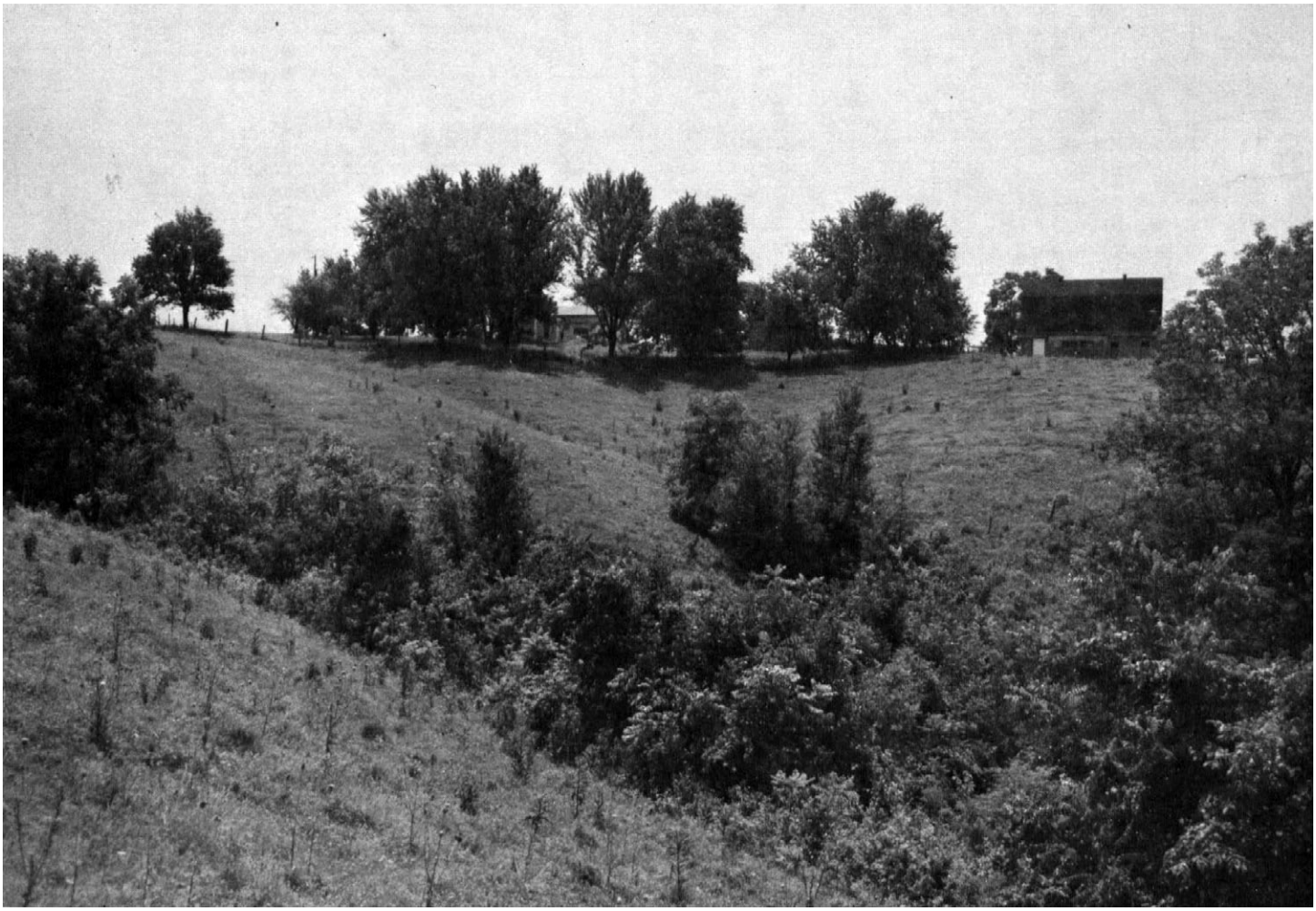

Figure 9.—**Area of Fairmount flaggy silty clay. The more nearly level areas are in pasture, and the steeper areas are reverting to trees and brush.**

hillsides, mostly in Carroll County. The areas are 10 to 30 acres in size.

Included with this soil in mapping were a few small areas of rock outcrop, small areas of soils that have slopes as steep as 30 percent, small areas of soils that have a surface layer of dark grayish-brown silty clay loam, and small areas of soils that have a dark-brown surface layer less than 4 inches thick. Also included were areas of soils that have a surface layer of gravelly loam alluvium 2 to 10 inches thick.

This soil generally is not suited to cultivation, because of steepness, the effects of past erosion, and the hazard of additional erosion. It is suitable for pasture and hay. Some of the better suited grasses and legumes that are common to the areas are fescue and sericea lespedeza. Plants that provide continuous ground cover are needed to protect the soil from erosion. Seeding mixtures should include plants that provide satisfactory forage production, give adequate ground cover, and require the least frequent renovation. This soil needs rest between grazing periods to permit the regrowth of plants. Grazing should be controlled to leave vegetation at least 3 inches high. Capability unit VIe–4; woodland suitability group 4d1.

Fairmount-Rock outcrop complex, 30 to 60 percent slopes (FrF).—This complex is mainly on steep bluffs along the Ohio and Kentucky Rivers and on steep hillsides in the western part of Carroll County. The areas are several hundred acres in size. Fairmount soils make up 60 percent of this complex, Rock outcrop 30 percent, and minor soils 10 percent. A Fairmount soil in this complex has the profile described as representative for the Fairmount series.

Included with this complex in mapping were areas of soils, near the Ohio and Kentucky Rivers, that have slopes as steep as 85 percent; narrow areas of soils that have slopes of less than 30 percent; areas of soils that are uneroded; and small bands of Woolper soils. Also included were areas of soils that have a dark grayish-brown surface layer; small areas of soils that are more than 20 inches deep; small areas of soils that have bedrock at a depth of less than 10 inches; and small areas of Lowell soils.

This complex is not suited to cultivation or to hay crops, because of steepness and the presence of rock outcrop. It can be used for limited pasture, but it is better suited to trees and to wildlife habitat. Pasture plants are short lived, and pasture renovation is difficult. Tall fescue and sericea lespedeza are better suited than other pasture plants. The use of fertilizer generally is not economically feasible. Grazing periods should be short and recovery periods long to allow for

regrowth of the plants. Capability unit VIIs–2; woodland suitability group 4x1.

Heitt Series

The Heitt series consists of deep, well-drained, sloping soils on low-lying ridges that appear to be old stream terraces. These soils formed in residual material that weathered from soft, calcareous shale that has thin layers of limestone. Most of the acreage is in the southern part of Owen County.

In a representative profile the surface layer is brown silt loam about 6 inches thick. The subsoil extends to a depth of about 36 inches. In sequence from the top, it is reddish-brown silty clay about 11 inches thick; yellowish-red clay that is about 6 inches thick and has light yellowish-brown and strong-brown variegations; and yellowish-brown clay that is about 13 inches thick and has gray to yellowish-red mottles. The underlying material is variegated light olive-brown, light brownish-gray, and yellowish-brown clay that extends to a depth of about 56 inches to layers of unweathered olive-gray shale and limestone.

The depth of the rooting zone is somewhat restricted by the silty clay subsoil. Permeability is moderately slow, and runoff is medium. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is medium acid or strongly acid, but the surface is less acid if it is limed. The underlying material ranges from neutral to moderately alkaline and is calcareous in places. Natural fertility is moderate. These soils are easy to cultivate in most places.

Much of the acreage of these soils is used for burley tobacco or corn, but some areas are used for hay and pasture. A few areas are in second-growth deciduous trees.

Representative profile of Heitt silt loam, 6 to 12 percent slopes, on west side of University of Kentucky Experimental Farm, 5 miles east-northeast of Owenton, 100 feet east of a side road:

Ap—0 to 6 inches, brown (10YR 5/3) silt loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

B21t—6 to 17 inches, reddish-brown (5YR 5/4) silty clay; strong, medium, subangular blocky structure; firm, sticky and plastic; many roots; common moderately thick clay films; strongly acid; gradual, smooth boundary.

B22t—17 to 23 inches, yellowish-red (5YR 5/6) clay; variegations of light yellowish brown (2.5Y 6/4) and strong brown (7.5YR 5/6); moderate, medium, angular blocky structure; very firm, sticky and plastic; few roots; common thick clay films; few, very small, black concretions; strongly acid; gradual, smooth boundary.

B3t—23 to 36 inches, yellowish-brown (10YR 5/4) clay; common, medium, distinct, light brownish-gray (2.5Y 6/2) and light yellowish-brown (2.5Y 6/4) mottles and few, fine, distinct, yellowish-red (5YR 5/6) mottles; weak, medium, angular blocky structure; very firm, sticky and plastic; few fine roots; few thin clay films; very few, small, brown concretions; strongly acid; gradual, wavy boundary.

C—36 to 56 inches, variegated light olive-brown (2.5Y 5/4), light yellowish-brown (2.5Y 6/4), light brownish-gray (2.5Y 6/2), and yellowish-brown (10YR 5/6) clay; weak, medium, platy structure; firm, sticky and plastic; common dark concretionary material from roots; thin (1 to 2 inches) layer of limestone at a depth of 48 inches; neutral in the upper part and calcareous in the lower part; gradual, wavy boundary.

R—56 inches +, soft, unweathered, olive-gray shale with patches of siltstone interbedded with thin layers of limestone.

The solum ranges from 24 to 40 inches in thickness. Unweathered shale is at a depth of 40 to 72 inches. The Ap horizon ranges from dark grayish-brown (10YR 4/2) to brown (10YR 5/3) in color and from silt loam to silty clay loam in texture. The B21t horizon ranges from yellowish red (5YR 5/6) to brown (7.5YR 4/4), and the B22t horizon ranges from yellowish red (5YR 5/6) to yellowish brown (10YR 5/6). The B horizon is silty clay or clay in texture.

Heitt soils are near Eden, Lowell, Markland, Elk, Otwell, and Nicholson soils. Heitt soils have a redder B horizon than Eden, Lowell, or Markland soils. They have a finer textured B horizon than Elk soils, and they lack the fragipan that is present in Otwell and Nicholson soils.

Heitt silt loam, 6 to 12 percent slopes (HeC).—This soil is mostly at the end of long, narrow ridges. The areas range from 5 to 20 acres in size.

Included with this soil in mapping were areas of soils that have slopes of less than 6 percent; small uneroded areas of soils, small areas of soils that have a yellowish-brown or olive-brown subsoil, and areas of Eden soils.

If this soil is cultivated, the hazard of erosion is severe. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep soil losses to a minimum.

This soil is suited to crops commonly grown in the area, such as corn, tobacco, and small grain. Some of the better suited pasture and hay plants are tall fescue, orchardgrass, timothy, alfalfa, red clover, white clover, sericea lespedeza, and annual lespedeza. Capability unit IIIe–2; woodland suitability group 3c1.

Huntington Series

The Huntington series consists of deep, well-drained, nearly level to gently sloping soils on flood plains along the Ohio River. A large acreage of these soils is covered by water from the Markland Dam. These soils formed in alluvium that weathered mostly from limestone and calcareous shale.

In a representative profile the surface layer is silt loam about 16 inches thick. It is very dark grayish brown in the upper 9 inches and dark brown in the lower 7 inches. The subsoil is brown silt loam about 56 inches thick. The underlying material is brown silt loam that extends to a depth of 80 inches or more.

The rooting zone is deep. Permeability is moderate, and runoff is slow. These soils are often flooded in winter, but crops are seldom damaged during the growing season. Available moisture capacity and organic-matter content are high. Reaction generally is slightly acid to mildly alkaline throughout the profile. Natural fertility is high. The surface layer is easy to till. It can be worked over a wide range of moisture content without clodding or crusting.

Most areas of these soils are used for corn, garden crops, or hay.

Representative profile of Huntington silt loam on bottom lands along the Ohio River, near the mouth of Steele Creek, 6 miles northeast of Warsaw:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2 when rubbed) silt loam; weak, fine, granular structure; very friable; many roots; mildly alkaline; clear, smooth boundary.

A3—9 to 16 inches, dark brown (10YR 3/3) silt loam; weak, fine, subangular blocky structure; very friable; many roots; mildly alkaline; gradual, smooth boundary.

B2—16 to 72 inches, brown (10YR 4/3) silt loam; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; friable; few roots; dark-brown (10YR 3/3) silt coatings on prisms; mildly alkaline; gradual, wavy boundary.

C—72 to 80 inches +, brown (10YR 4/3) silt loam; massive; very friable; pockets of sand; mildly alkaline.

Rock is at a depth of more than 5 feet and generally is at a depth of more than 10 feet. Coarse fragments range from 0 to 5 percent throughout the profile. The Ap horizon is very dark grayish-brown (10YR 3/2) or dark brown (10YR 3/3 or 7.5YR 3/2) loam to silty clay loam. The B horizon is brown (10YR 4/3 or 7.5YR 4/4) silt loam to light silty clay loam. The C horizon has stratified layers of sand, silt, and gravel.

Huntington soils are near Newark, Zipp, Nolin, and Woolper soils. Huntington soils are better drained than Newark and Zipp soils. They have a darker A horizon than Nolin soils and a coarser textured B horizon than Woolper soils. The Huntington soils are on lower elevations than Ashton and Wheeling soils and are therefore flooded more often; also, they have less distinct horizons than those soils.

Huntington silt loam (Hu).—The areas of this soil are generally more than 50 acres in size. Slopes are 0 to 4 percent.

Included with this soil in mapping were small areas of soils that have slopes of more than 4 percent, areas of soils that have patches of sand 2 to 6 inches thick on the surface, a few small seepy spots of soils, small areas of soils that have gray mottles within 24 inches of the surface, and areas of soils that have moderate, medium, prismatic structure in the subsoil. Also included were areas of soils that have a surface layer and subsoil of fine sandy loam and a few areas of soils that have a dark grayish-brown surface layer.

Erosion is not a hazard on this soil.

This soil can be cropped year after year and productivity maintained if the soil is properly fertilized, practices are used to maintain organic-matter content, and good tillage practices are followed. Small grain and alfalfa are subject to damage by flooding in some places. Some of the better suited pasture and hay plants are Kentucky bluegrass, smooth bromegrass, tall fescue, orchardgrass, ladino clover, and annual lespedeza. Capability unit I–1; woodland suitability group 1o1.

Lakin Series

The Lakin series consists of deep, excessively drained, gently sloping to sloping soils in hummocky areas on stream terraces, mostly along the Ohio River. These soils formed in sandy material deposited by wind or water.

In a representative profile the surface layer is brown loamy fine sand about 7 inches thick. The subsurface layer is yellowish-brown loamy fine sand about 10 inches thick. The subsoil is loamy fine sand about 33 inches thick. It is dark brown in the upper 7 inches and brown in the lower 26 inches. The underlying material is fine sand that extends to a depth of 60 inches or more.

The rooting zone is deep. Permeability is rapid, and runoff is slow. Available moisture capacity and organic-matter content are low. Reaction generally is slightly acid to strongly acid throughout the profile. Natural fertility is low.

Most areas of these soils are in pasture, but some areas are used for corn and truck crops. These soils are very easy to till.

Representative profile of Lakin loamy fine sand, 2 to 12 percent slopes, 6.5 miles west-southwest of Warsaw, 200 feet west of county road, 1,600 feet southwest of U.S. Highway No. 42, 1,700 feet northeast of the Carroll County line:

Ap—0 to 7 inches, brown (10YR 4/3) loamy fine sand; weak, very fine, granular structure; very friable to loose; common roots; slightly acid; gradual, wavy boundary.

A2—7 to 17 inches, yellowish-brown (10YR 5/4) loamy fine sand; very weak, very fine, granular structure; very friable; common roots; slightly acid; gradual, smooth boundary.

B1—17 to 24 inches, dark-brown (7.5YR 4/4) loamy fine sand, very weak, very fine, granular structure; very friable; few roots; slightly acid; gradual, wavy boundary.

C&B—24 to 50 inches, brown (7.5YR 5/4) loamy fine sand, content of sand is slightly higher than the B1 horizon; brown (10YR 4/3 to 7.5YR 4/2) bands 1/2 to 1 inch thick that are slightly higher in content of clay; single grained; loose; slightly acid; abrupt, smooth boundary.

C—50 to 60 inches +, brown (10YR 4/3) fine sand; single grained; loose; slightly acid.

Bedrock is at a depth of more than 10 feet. The Ap horizon is brown (10YR 4/3), dark yellowish-brown (10YR 4/4), or dark-brown (10YR 3/3) loamy sand to fine sand. The B horizon ranges from yellowish brown (10YR 5/6) to brown (7.5YR 4/4). In some profiles the B1 horizon has bands ½ to 1 inch thick that are slightly higher in content of clay. The C horizon ranges from light sandy loam to gravelly coarse sand.

Lakin soils are near Wheeling, Otwell, and Lawrence soils on Ohio River terraces. Lakin soils are sandier than those soils. They lack the fragipan that is present in Otwell and Lawrence soils.

Lakin loamy fine sand, 2 to 12 percent slopes (LaC).—This soil is in fairly large, hummocky areas along the Ohio River. The areas are 20 to 50 acres in size.

Included with this soil in mapping were small areas of soils that have a surface layer of coarse loamy sand and lower areas of soils that have no bands in the subsoil. Also included were small areas of soils that have slopes of more than 12 percent and areas of soils that have slopes of less than 2 percent.

If this soil is used for row crops, droughtiness and low fertility are the main limitations. This soil is suited to truck crops, especially melons, if it is irrigated. If the steeper areas are cultivated, some measures are needed to control erosion to prevent the soils from gullying.

Corn is generally the only field crop grown on this soil. The best suited pasture and hay plants are tall fescue and sericea lespedeza. Proper application of fertilizer, maintenance of organic-matter content, and use of good tillage practices are important in the management of this soil. Capability unit IIIs–1; woodland suitability group 3s1.

Lawrence Series

The Lawrence series consists of deep, somewhat poorly drained, nearly level to gently sloping soils that have a fragipan. These soils formed in mixed alluvium that weathered mostly from limestone and calcareous shale. They are on stream terraces, mostly along Eagle Creek, the Little Kentucky River, and the Kentucky River.

In a representative profile the surface layer is brown silt loam about 10 inches thick. The subsoil extends to a depth of about 62 inches. In sequence from the top, it is yellowish-brown silty clay loam that has light brownish-gray mottles and is about 15 inches thick; a firm, brittle and compact silty clay loam fragipan about 25 inches thick; and brown silty clay loam that has mottles and is about 12 inches thick. The underlying material is mottled silty clay that extends to a depth of 75 inches or more.

The depth of the rooting zone is restricted by the fragipan, which slows the movement of water and the growth of roots. Permeability is slow in the fragipan. Runoff is slow. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is strongly acid or very strongly acid, but the surface layer is less acid if it is limed. Natural fertility is moderate. The surface layer is easy to till and can be worked over a wide range of moisture content without clodding or crusting. These soils are flooded in some areas when streamflow is unusually high.

Most of the cleared areas of these soils are used for pasture, but some areas are in water-tolerant deciduous trees.

Representative profile of Lawrence silt loam, 2 miles southeast of Carrollton, near the Kentucky River, 100 feet north of a point on State Highway No. 389, 1.3 miles east of intersection of State Highways No. 389 and 55:

Ap—0 to 10 inches, brown (10YR 4/3) silt loam; moderate, fine and medium, granular structure; very friable; common fine roots; common very fine pores; strongly acid; abrupt, smooth boundary.

B21t—10 to 19 inches, yellowish-brown (10YR 5/6) light silty clay loam; common, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; moderate, medium, subangular blocky structure; friable; few fine roots; nearly continuous, thin, light yellowish-brown clay films; very strongly acid; clear, smooth boundary.

B22t—19 to 25 inches, yellowish-brown (10YR 5/4) light silty clay loam; many, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; friable; few fine roots; nearly continuous thin clay films; few thin silt coatings on prisms; very strongly acid; clear, smooth boundary.

Bx1—25 to 36 inches, mottled yellowish-brown (10YR 5/6) and light brownish-gray (2.5Y 6/2) light silty clay loam; moderate, very coarse, prismatic structure parting to moderate, medium, angular and subangular blocky; very firm, brittle and compact; few fine roots between prisms; continuous light brownish-gray (2.5Y 6/2) clay films and a few, thin, discontinuous silt coatings on prisms; common thin clay films on blocks; few, small, black concretions; very strongly acid; gradual, wavy boundary.

Bx2—36 to 50 inches, mottled strong-brown (7.5YR 5/6) and light brownish-gray (2.5Y 6/2) silty clay loam; moderate, very coarse, prismatic structure parting to moderate, medium, angular blocky; very firm, compact and brittle; continuous light brownish-gray (2.5Y 6/2) clay films and a few silt and sand grains on prisms; common thin clay films on blocks; few, small, black concretions; very strongly acid; gradual, wavy boundary.

B3t—50 to 62 inches, brown (7.5YR 4/4) silty clay loam; common, fine, distinct, light brownish-gray (10YR 6/2) mottles; moderate, medium, angular blocky structure; firm; nearly continuous light-gray (10YR 6/1) clay films; few, small, black concretions; very strongly acid; gradual, wavy boundary.

IIC—62 to 75 inches +, mottled light brownish-gray (10YR 6/2), strong-brown (7.5YR 5/8), and brown (7.5YR 4/4) silty clay; massive; firm; few, small, black concretions; strongly acid.

Bedrock is at a depth of more than 10 feet. The Ap horizon is brown (10YR 4/3) or dark grayish brown (10YR 4/2). The 21t and B22t horizons are yellowish brown (10YR 5/4 or 10YR 5/6), light yellowish brown (2.5Y 6/4 or 10YR 6/4), pale brown (10YR 6/3), or light olive brown (2.5YR 5/6) in color and have mottles in shades of gray. They are silt loam or silty clay loam in texture. The fragipan starts at a depth of 18 to 28 inches and is 12 to 30 inches thick.

Lawrence soils are near Elk, Otwell, Robertsville, Zipp, and McGary soils on stream terraces. They are more poorly drained than Elk and Otwell soils and are better drained than the Robertsville and Zipp soils. Lawrence soils have a coarser textured B horizon than Zipp and McGary soils, and they have a fragipan that those soils do not.

Lawrence silt loam (Lc).—This soil is in fairly large areas, mostly along main streams. Slopes are 0 to 4 percent.

Included with this soil in mapping were small areas of soils that have a silty clay layer, instead of a fragipan, that restricts drainage. Also included are areas of soils along the Ohio River that are underlain by sandy and gravelly material.

Wetness and shallowness to the fragipan are the main limitations to the use of this soil. The slowly permeable fragipan restricts root growth and causes a perched water table to remain near the surface for long periods after heavy rainfall.

Unless this soil is drained, it is poorly suited to most crops and to many hay and pasture plants. This soil can be cropped year after year if it is properly drained, but crops are damaged by wetness in some years. Open-ditch drainage, in combination with grassed waterways, is generally the best drainage system to correct the wetness limitation of this soil. Tobacco and small grain generally are not grown on this soil. Some of the better suited wetness-tolerant plants are tall fescue, redtop, reed canarygrass, red clover, alsike clover, ladino clover, and annual lespedeza. Capability unit IIIw–3; woodland suitability group 2w1.

Lowell Series

The Lowell series consists of deep, well-drained, gently sloping to strongly sloping soils on ridges and upper hillsides in the northern part of the survey area. These soils formed in residual material weathered from limestone and thin layers of calcareous shale.

In a representative profile the surface layer is brown silt loam about 8 inches thick. The subsoil extends to a depth of about 38 inches. It is brown silty clay loam in the upper 6 inches and yellowish-brown silty clay in the lower 24 inches. The underlying mate-

rial is variegated light olive-brown and light brownish-gray clay that extends to a depth of about 47 inches and rests on rubbly, or rippable, limestone.

The rooting zone is somewhat restricted by the clayey lower part of the subsoil. Permeability is moderately slow, and runoff is medium. The available moisture capacity is moderate, and in most places the organic-matter content is low. Reaction generally is medium acid or strongly acid, but the surface layer is less acid if it is limed; the underlying material ranges from medium acid to neutral. Natural fertility is moderate.

Most areas of these soils are in grass, but some of the more nearly level areas are used for corn and tobacco. The plow layer is easy to till in most places.

Representative profile of Lowell silt loam, 2 to 6 percent slopes, 3.5 miles north of Owenton, 0.5 mile southwest of a point on U.S. Highway No. 127 that is 1.0 mile west of intersection of State Highway No. 36 and U.S. Highway No. 127:

Ap—0 to 8 inches, brown (10YR 4/3) silt loam; moderate, medium, granular structure; friable; many roots; slightly acid; clear, smooth boundary.

B1t—8 to 14 inches, silty clay loam that is brown (7.5YR 5/4) inside of peds and dark brown (7.5YR 4/4) on ped surfaces; moderate, medium, subangular blocky structure; firm; common roots; common thin clay films; slightly acid; gradual, smooth boundary.

B2t—14 to 22 inches, yellowish-brown (10YR 5/6) silty clay; moderate, medium, subangular blocky structure; firm, sticky and plastic; few roots; common moderately thick clay films; medium acid; clear, smooth boundary.

B3t—22 to 38 inches, yellowish-brown (10YR 5/6) silty clay; common, fine, faint, strong-brown (7.5YR 5/6) mottles and few, fine, faint, pale-brown (10YR 6/3) mottles; weak to moderate, medium, subangular blocky structure; firm; very sticky and very plastic; few roots; common moderately thick clay films; slightly acid; abrupt, wavy boundary.

C—38 to 47 inches, variegated light olive-brown (2.5Y 5/4) and light brownish-gray (2.5Y 6/2) clay; massive; very firm, very sticky and very plastic; few roots; many, soft, dark concretions; neutral; gradual, wavy boundary.

R—47 inches +, rubbly, or rippable, limestone interbedded with layers of soft, olive-gray, calcareous shale 1 to 6 inches thick.

The solum ranges from 30 to 40 inches in thickness. Bedrock is at a depth of 40 to 60 inches. The A1 horizon is very dark grayish brown (10YR 3/2) and is less than 6 inches thick. The Ap horizon is brown (10YR 4/3) or dark grayish brown (10YR 4/2). The B1t horizon is brown (7.5YR 5/4) or yellowish-brown (10YR 5/4) silty clay loam to silty clay. The B2t horizon is yellowish-brown (10YR 5/6), brown (7.5YR 5/4), or strong-brown (7.5YR 5/6) silty clay or clay. The B3t horizon is yellowish-brown (10YR 5/6) or light olive-brown (2.5Y 5/6) silty clay or clay. Concretionary material in the B3t and C horizons ranges from less than 1 percent to 3 percent.

Lowell soils are near Nicholson, Eden, Heitt, Fairmount, and Markland soils. Lowell soils lack the fragipan of Nicholson soils, and they have a thicker and redder B horizon than Eden soils. They are not so red in the B horizon as Heitt soils. They are deeper to bedrock than Fairmount soils, but they are shallower than Markland soils. Lowell soils lack the lime nodules that are present in Markland soils.

Lowell silt loam, 2 to 6 percent slopes (LlB).—This soil is on fairly narrow ridges. The areas range from 5 to 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were a few areas of soils that were slightly less than 40 inches deep to bedrock and a few very small areas of soils that have a dark-brown surface layer that is 7 to 8 inches thick. Also included were areas of soils that have common, medium, light brownish-gray mottles at a depth of more than 22 inches.

This soil is suited to corn, tobacco, small grain, and other crops commonly grown in the area. Some of the better suited hay and pasture plants are Kentucky bluegrass, tall fescue, smooth bromegrass, orchardgrass, timothy, red clover, alfalfa, ladino clover, sericea lespedeza, and annual lespedeza. The hazard of erosion is moderate. Consequently, if this soil is cultivated, a suitable cropping system and other conservation practices must be used to slow runoff and keep soil losses to a minimum. Capability unit IIe–2; woodland suitability group 2c1.

Lowell silt loam, 6 to 12 percent slopes (LlC).—This soil is on fairly narrow ridges. The areas range from 5 to 20 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer commonly is 4 to 7 inches thick.

Included with this soil in mapping were small areas of soils that have a surface layer more than 7 inches thick and areas of soils that formed in glacial till. Also included were narrow areas of soils that have slopes of less than 6 percent; a few areas of soils that are heavy silty clay loam in the upper part of the subsoil; a few areas of soils that are slightly less than 40 inches deep to bedrock; a few, very small, seepy spots; and a few areas of soils that have gray mottles at a depth of 16 to 22 inches.

This soil is suited to corn, tobacco, small grain, and other crops commonly grown in the area. Some of the better suited hay and pasture plants are orchardgrass, tall fescue, timothy, alfalfa, red clover, white clover, and annual lespedeza. The hazard of erosion is severe. Consequently, if this soil is cultivated, a suitable cropping system and other conservation practices must be used to slow runoff and keep soil loss to a minimum. Capability unit IIIe–2; woodland suitability group 2c1.

Lowell silty clay loam, 12 to 20 percent slopes, severely eroded (LoD3).—This soil is mostly on upper hillsides in areas that are below Nicholson soils. The areas are narrow and long and range from 20 acres to several hundred acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is dark-brown silty clay loam, 3 to 7 inches thick, that is variegated with dark yellowish brown and dark grayish brown and has weak, fine, subangular blocky structure.

Included with this soil in mapping were areas of soils that are less than 40 inches deep to bedrock and small areas of soils that have a silty clay surface layer. Also included were narrow areas of soils that have slopes of less than 12 percent; a few areas of soils that are underlain by glacial till or slack-water alluvium; and a few small areas of rock outcrop.

The hazard of erosion is too severe for this soil to be suitable for cultivation. This soil is better suited to pasture and hay plants commonly grown in the area,

such as tall fescue and sericea lespedeza. Plants that provide continuous ground cover are needed to protect the soil from erosion. Seeding mixtures should include plants that provide satisfactory forage production, give adequate ground cover, and require the least frequent pasture renovation. Grazing should be controlled to leave vegetation at least 3 inches high. Capability unit VIe–10; woodland suitability Group 2c1.

Markland Series

The Markland series consists of deep, moderately well drained to well drained, gently sloping to steep soils on stream terraces. These soils formed in a thin layer of loess and the underlying calcareous lacustrine alluvium.

In a representative profile the surface layer is brown silt loam about 6 inches thick. The subsoil extends to a depth of about 30 inches. In sequence from the top, it is yellowish-brown silty clay loam about 5 inches thick; yellowish-brown silty clay about 13 inches thick; and yellowish-brown clay that is about 6 inches thick and has light brownish-gray mottles. The underlying material is brown clay that extends to a depth of 60 inches or more.

The depth of the rooting zone is somewhat restricted by the clayey subsoil. Permeability is moderately slow in the upper part of the subsoil and slow in the lower part. Runoff is medium. Available moisture capacity is moderate, and organic-matter content is low. Reaction is generally medium acid or strongly acid, but it is less acid if the surface layer is limed. The underlying material is normally calcareous. Natural fertility is moderate. These soils are flooded in some areas when streamflow is unusually high.

Large areas of this soil, especially the steeper areas, are in deciduous trees or brush. Some areas have been cleared and are used for pasture, and a few areas are used for corn or burley tobacco. The surface layer is easy to till in most places.

Representative profile of Markland silt loam, 2 to 6 percent slopes, 6 miles southwest of Warsaw, 300 feet east of a point on State Highway No. 184, 4 miles south of intersection of U.S. Highways No. 42 and 184:

Ap—0 to 6 inches, brown (10YR 4/3) silt loam; weak, very fine, granular structure; friable; many roots; slightly acid; abrupt boundary.

B1—6 to 11 inches, yellowish-brown (10YR 5/6) silty clay loam; moderate, medium, subangular blocky structure; firm; common roots; medium acid; gradual, smooth boundary.

IIB21t—11 to 15 inches, yellowish-brown (10YR 5/6) silty clay; moderate, medium, angular blocky structure; firm, slightly sticky and plastic; few roots; common, moderately thick, yellowish-brown (10YR 5/4) clay films on peds; strongly acid; gradual, smooth boundary.

IIB22t—15 to 24 inches, yellowish-brown (10YR 5/4) silty clay; common, medium, yellowish-brown (10YR 5/6) mottles; moderate, medium and fine, angular blocky structure; firm, sticky and plastic; few roots; common clay films; strongly acid; gradual, wavy boundary.

IIB3t—24 to 30 inches, yellowish-brown (10YR 5/4) clay; common, medium, faint, light brownish-gray (10YR 6/2) mottles; moderate, fine, angular blocky and thin, platy structure; firm, sticky and plastic; few moderately thick clay films; few dark specks from decayed roots; many small lime nodules; slightly acid; gradual, smooth boundary.

IIC1—30 to 46 inches, brown (10YR 5/3) clay; moderate, thin, platy structure; firm, sticky and plastic; few fine roots; common lime nodules; moderately alkaline; gradual, wavy boundary.

IIC2—46 to 60 inches +, brown (7.5YR 5/4) clay with light gray (5Y 6/1) between plates; strong, thin, platy structure; very firm, sticky and plastic; calcareous.

The solum ranges from 24 to 36 inches in thickness. The loess cap ranges from 0 to 15 inches in thickness. Bedrock is at a depth of more than 10 feet. The Ap horizon is brown (10YR 4/3), dark grayish brown (10YR 4/2), or grayish brown (10YR 5/2). The B horizon is dark yellowish brown (10YR 4/4), brown (10YR 5/3 or 7.5YR 5/4), or yellowish brown (10YR 5/6 or 10YR 5/4). The B1 horizon is absent in many profiles. The IIBt horizon is silty clay or clay. Mottles in the IIB3t horizon are light brownish gray (10YR 6/2) or pale brown (10YR 6/3). The C horizon has thin stratified layers of very fine sand and silt. The IIC1 horizon is brown (10YR 5/3) or light olive brown (2.5Y 5/4).

Markland soils are near McGary, Otwell, Wheeling, Lowell, Eden, and Brashear soils. They are better drained than McGary soils, lack the fragipan of Otwell soils, are finer textured than Wheeling soils, and are deeper to bedrock than Lowell, Eden, or Brashear soils. Markland soils have lime nodules, which Otwell, Wheeling, Lowell, Eden, and Brashear soils lack. They lack the flags and coarse fragments that are in the Eden and Brashear soils.

Markland silt loam, 2 to 6 percent slopes (MaB).—This moderately well drained soil is along stream terraces. The areas are 5 to 25 acres in size. This soil has the profile described as representative for the series.

This soil is suited to crops commonly grown in the area, such as corn, tobacco, and small grain, but production is below average in wet years. It is better suited to soybeans, tall fescue, reed canarygrass, redtop, red clover, alsike clover, annual lespedeza, and other pasture and hay plants that tolerate slight wetness. Open-ditch drainage, in combination with grassed waterways, is generally the best drainage system used to correct the slight wetness limitation of this soil. The surface layer is easy to till in most places, but there is a severe hazard of erosion if it is cultivated. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep soil losses to a minimum. Capability unit IIIe–13; woodland suitability group 2c1.

Markland soils, 12 to 35 percent slopes (MbD).—This well-drained soil is mostly on steep breaks along the edge of the more nearly level areas of Markland and McGary soils. The breaks are 20 to 40 feet high. This soil has a profile similar to the one described as representative for the series, but in places the original surface layer and part of the subsoil have been removed by erosion and lime nodules are scattered over the surface. The present surface layer ranges from silt loam to silty clay. Some areas of this soil have deep gullies.

Included with this soil in mapping were areas of soils underlain by glacial till; areas of soils that are strongly acid in the upper part of the underlying material; and small areas of soils that have a surface layer of silt loam 12 to 16 inches thick. Also included were a few areas of soils that have slopes of less than 12 percent and slopes of more than 35 percent and small areas of Nolin, Zipp, and Newark soils.

This soil is not suited to cultivation or to hay crops, because of steepness and the hazard of erosion. It is suited to limited pasture, but it is better suited to woodland or wildlife habitat. Tall fescue and sericea lespedeza are better suited than most other pasture plants. The use of fertilizer is not economically feasible. Grazing periods should be short and recovery periods long to allow for regrowth of plants. Capability unit VIIe–3; woodland suitability group 2c1.

McGary Series

The McGary series consists of deep, somewhat poorly drained, nearly level soils on stream terraces. These soils formed mostly in calcareous lacustrine alluvium.

In a representative profile the surface layer is grayish-brown silt loam about 6 inches thick. The subsoil extends to a depth of about 46 inches. In sequence from the top, it is yellowish-brown silty clay loam that has gray mottles and is about 12 inches thick; light brownish-gray silty clay that has mottles and is about 14 inches thick; and gray silty clay that has mottles and is about 14 inches thick. The underlying material is brown clay that extends to a depth of 60 inches or more.

The depth of the rooting zone is restricted by the silty clay subsoil. Permeability and runoff are slow. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is neutral or slightly acid in the surface layer and slightly acid or medium acid in the subsoil. In some places the lower part of the subsoil is mildly alkaline. These soils generally are calcareous in the underlying material. Natural fertility is moderate. These soils are easy to till and can be worked over a wide range of moisture content without clodding or crusting. They are flooded in some areas when streamflow is unusually high.

Most areas of these soils have been cleared and are used for pasture, but a few areas are used for crops. Some areas are in water-tolerant deciduous trees.

Representative profile of McGary silt loam, 2 to 3 miles southeast of Carrollton, 300 feet east of a point on U.S. Highway No. 227, 0.2 mile southeast of the entrance to General Butler State Park.

Ap—0 to 6 inches, grayish-brown (2.5Y 5/2) silt loam; weak, fine, granular structure; friable; many roots; neutral in reaction; clear, smooth boundary.

B21t—6 to 18 inches, yellowish-brown (10YR 5/4) silty clay loam; ped surfaces are grayish brown (2.5Y 5/2); common, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; moderate, medium, subangular blocky structure; firm; common roots; common moderately thick clay films; medium acid; gradual, wavy boundary.

B22gt—18 to 32 inches, light brownish-gray (2.5Y 6/2) silty clay; common, medium, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; moderate, coarse, angular blocky and moderate, medium, prismatic structure; very firm, slightly sticky and slightly plastic; few roots; continuous, thick, gray (10YR 5/1) clay films on ped surfaces; slightly acid; gradual, wavy boundary.

B3g—32 to 46 inches, gray (10YR 5/1) silty clay; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, prismatic structure; very firm, very sticky and plastic; many lime nodules; mildly alkaline; gradual, irregular boundary.

C—46 to 60 inches +, brown (10YR 5/3) clay; moderate, thin, platy structure; very firm, sticky and plastic; thin, light-gray (5Y 6/1) films between plates; calcareous.

The solum ranges from 26 to 50 inches or more in thickness. The loess mantle is 6 to 12 inches thick. Bedrock is at a depth of more than 5 feet, and generally it is at a depth of more than 10 feet. The Ap horizon is dark grayish brown (10YR 4/2), brown (10YR 4/3), and grayish brown (10YR 5/2 or 2.5Y 5/2). The Bg horizon ranges from gray (10YR 5/1) to light brownish gray (2.5Y 6/2). The B horizon ranges from light silty clay loam in the upper part to silty clay and clay below a depth of 18 inches. The C horizon is brown (10YR 5/3 or 7.5YR 5/4). It has thin stratified layers of very fine sand and silt.

McGary soils are near Markland, Brashear, Otwell, Robertsville, Zipp, and Lawrence soils. McGary soils are not so well drained as Markland, Brashear, and Otwell soils, but they are better drained than Robertsville and Zipp soils. They have a finer textured B horizon than Lawrence and Robertsville soils and lack the fragipan of those soils.

McGary silt loam (Mc).—This soil is on broad, smooth stream terraces. Most areas are more than 100 acres in size. Slopes are 0 to 2 percent.

The slowly permeable subsoil restricts root growth and causes a seasonal water table to remain near the surface after heavy rainfall.

If this soil is drained, it is suited to some row crops and to hay. It is better suited to tall fescue, redtop, reed canarygrass, red clover, alsike clover, ladino clover, annual lespedeza, and other plants that tolerate excessive moisture. This soil can be cropped year after year if it is properly drained, but crops are damaged by wetness in some years. Open-ditch drainage, used in combination with grassed waterways, is generally the best drainage system to correct the wetness of this soil. Tobacco and small grain are often damaged by wetness. Capability unit IIIw–2; woodland suitability group 3w2.

Newark Series

The Newark series consists of deep, somewhat poorly drained, nearly level soils on flood plains along many streams in the survey area. These soils formed in alluvium weathered mostly from limestone and calcareous shale.

In a representative profile the surface layer is dark grayish-brown silt loam about 6 inches thick. The subsoil extends to a depth of about 40 inches. The upper 11 inches is dark grayish-brown silt loam that has grayish-brown mottles, and the lower 23 inches is grayish-brown silt loam that has brown mottles. The underlying material is light olive-gray silt loam that has grayish-brown mottles and extends to a depth of 60 inches or more.

The rooting zone is deep. Permeability is moderate, and runoff is very slow. These soils are often flooded during winter, and crops may be damaged by flooding during the growing season. Available moisture capacity is high, and organic-matter content is low. Reaction is slightly acid to mildly alkaline throughout the profile. Natural fertility is moderately high. The plow layer is easy to till and can be worked over a

wide range of moisture content without clodding or crusting.

Most areas of these soils are in pasture. A few areas are used for corn, and a few areas are in deciduous trees.

Representative profile of Newark silt loam, 3 to 4 miles southeast of Carrollton, on bottom lands of the Kentucky River, 1,600 feet southwest of a point on U.S. Highway No. 227, 0.2 mile northwest of Interstate Highway No. 71:

Ap—0 to 6 inches, dark grayish-brown (2.5Y 4/2) silt loam; common, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, granular structure; very friable; many roots; slightly acid; gradual, wavy boundary.

B1—6 to 17 inches, dark grayish-brown (10YR 4/2) silt loam; common, medium, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, granular structure; very friable; common roots; slightly acid; clear, smooth boundary.

B2g—17 to 40 inches, grayish-brown (2.5Y 5/2) silt loam; common, fine, distinct, brown (7.5YR 4/4) mottles; weak, fine, granular structure; very friable; few roots; slightly acid; gradual, wavy boundary.

Cg—40 to 60 inches +, light olive-gray (5Y 6/2) silt loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; massive; friable; few dark concretions; slightly acid.

The solum ranges from 20 to 40 inches in thickness. Bedrock is at a depth of 4 feet to more than 10 feet. The Ap horizon is dark grayish brown (2.5Y 4/2 or 10YR 4/2) or brown (10YR 4/3). The B1 horizon is dark grayish brown (10YR 4/2 or 2.5Y 4/2), dark yellowish brown (10YR 4/4), or olive brown (2.5Y 4/4). The B2g horizon ranges from grayish brown (2.5Y 5/2) to light brownish gray (10YR 6/2). The B and C horizons have mottles in shades of brown or gray, and they are silt loam or light silty clay loam in texture.

The Newark soils are near Nolin, Huntington, Woolper, and Zipp soils. They are not so well drained as Nolin, Huntington, and Woolper soils, but they are better drained than Zipp soils. Newark soils are coarser textured than Woolper and Zipp soils.

Newark silt loam (Ne).—The areas of this soil are mostly long and narrow and range from 5 to 10 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping were small areas of poorly drained soils and areas of soils that have a heavy silty clay loam subsoil.

This soil can be cropped year after year if it is drained and properly fertilized, practices are used to maintain organic-matter content, and good tillage practices are followed. It is better suited to tall fescue, reed canarygrass, redtop, red clover, alsike clover, ladino clover, annual lespedeza, and other pasture and hay plants that tolerate slight wetness. Tile drainage or open-ditch drainage, or both, in combination with grassed waterways generally corrects the wetness limitation of this soil. Capability unit IIw–1; woodland suitability group 1w1.

Nicholson Series

The Nicholson series consists of deep, well drained to moderately well drained soils that have a fragipan. These soils are gently sloping to sloping and occur on broad ridges of uplands. The upper layers of these soils formed in loess or silty material, the lower layers formed in residual material that weathered from interbedded limestone and calcareous shale.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil extends to a depth of about 36 inches. In sequence from the top, it is brown silt loam about 8 inches thick, yellowish-brown silty clay loam about 8 inches thick, a firm, brittle, compact, yellowish-brown silty clay loam fragipan about 12 inches thick, and brown silty clay about 4 inches thick. The underlying material is yellowish-brown silty clay that has gray mottles and extends to a depth of 60 inches or more.

The depth of the rooting zone is somewhat restricted by the fragipan, which slows water movement and restricts the growth of roots. Permeability is moderate above the fragipan but slow through the fragipan. This causes a perched water table to form after heavy rainfall. Runoff is medium. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is slightly acid to strongly acid in the upper 36 to 42 inches of these soils and medium acid to mildly alkaline in the lower part. Natural fertility is moderate. The surface layer is easy to till and can be worked over a wide range of moisture content without clodding or crusting.

These soils are used mainly for burley tobacco, corn, truck crops, or fruit crops. Some areas are used for pasture, and some are used for urban purposes.

Representative profile of Nicholson silt loam, 2 to 8 percent slopes, near Bromley, 7.5 miles north of Owenton, 100 feet west of U.S. Highway No. 127:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable; many roots; slightly acid; clear, smooth boundary.

B21t—8 to 16 inches, brown (7.5YR 4/4) heavy silt loam; moderate, fine, subangular blocky structure; friable; common roots; few thin clay films; slightly acid; clear, smooth boundary.

B22t—16 to 24 inches, yellowish-brown (10YR 5/6) light silty clay loam; moderate, fine and medium, subangular blocky structure; friable; common roots; common, moderately thick films; slightly acid; gradual, smooth boundary.

Bx—24 to 36 inches, yellowish-brown (10YR 5/6) light silty clay loam; common, fine, distinct, very pale brown (10YR 7/3) mottles; weak, very coarse, prismatic structure parting to moderate, thick, platy; brittle and compact in places, friable when disturbed; few roots; light brownish-gray (10YR 6/2) coatings 1 to 4 millimeters thick between the prisms; few thin clay films or blocks inside prisms; medium acid; abrupt, smooth boundary.

IIB3—36 to 40 inches, brown (7.5YR 4/4) silty clay; few, coarse, distinct, light-gray (10YR 7/2) mottles; weak, coarse, blocky structure; firm, sticky and plastic; medium acid; clear, smooth boundary.

IIC—40 to 60 inches, mottled yellowish-brown (10YR 5/4 to 5/6), light brownish-gray (2.5Y 6/2), and light olive-brown (2.5Y 5/4) silty clay; weak, coarse, blocky structure; very firm, very sticky and plastic; many small black concretions; neutral.

The solum is 40 to 72 inches in thickness. Bedrock is is generally at a depth of 5 to 8 feet. The fragipan starts at a depth of 20 to 28 inches and is 7 to 20 inches in thickness. The loess layers range from 30 to 40 inches in thickness. The Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The B21t horizon ranges from strong brown (7.5YR 5/6) to dark yellowish brown (10YR 4/4) in color, weak to moderate in structure, and silt loam to silty clay loam in texture. The B22t horizon is yellowish brown (10YR 5/6) or strong brown (7.5YR 5/6), and some profiles have pale-brown (10YR 6/3) mottles in the lower

part of this horizon. The Bx horizon is yellowish brown (10YR 5/6), dark yellowish brown (10YR 4/4), or strong brown (7.5Y 5/6) and has few to many mottles in chromas of 2 or less. The prismatic structure ranges from moderate to weak and parts to platy or blocky. The IIB3 horizon is brown (7.5YR 4/4), yellowish brown (10YR 5/4), or dark yellowish brown (10YR 4/4) and has mottles in shades of gray and brown.

Nicholson soils are near Otwell, Lowell, Heitt, and Eden soils. They are slightly better drained, have a thinner fragipan, and are shallower to bedrock than Otwell soils, and they have a fragipan that is not present in Lowell, Heitt, and Eden soils.

Nicholson silt loam, 2 to 8 percent slopes (NfB).—This soil is on many of the ridgetops in the area. The areas are fairly narrow, but they are very long and are several hundred acres in size.

Included with this soil in mapping were small narrow areas of soils that have slopes of less than 2 percent, a few areas of soils that have slopes as steep as 10 percent, a few areas of soils underlain by soft calcareous sandstone, and areas of soils that have silty (loess) material more than 40 inches thick over underlying clayey material. Also included were small areas of eroded soils that have a surface layer less than 6 inches thick and areas of soils that have a slight compact fragipan or in which the fragipan is less than 7 inches thick.

This soil is suited to corn, tobacco, small grain, and other crops commonly grown in the area. Some of the better suited pasture and hay plants are Kentucky bluegrass, smooth bromegrass, tall fescue, orchardgrass, timothy, red clover, ladino clover, white clover, sericea lespedeza, and annual lespedeza. If this soil is cultivated, it is subject to a moderate hazard of erosion. Consequently, cropping systems and other conservation practices are needed to slow surface runoff and keep soil losses to a minimum. Capability unit IIe–5; woodland suitability group 2o1.

Nolin Series

The Nolin series consists of deep, well-drained, nearly level to gently sloping soils on flood plains along all of the streams in the area, except the Ohio River. These soils formed in alluvium that weathered mostly from limestone and calcareous shale.

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil is brown silt loam that extends to a depth of 60 inches or more.

The rooting zone is deep. Permeability is moderate, and runoff is slow. These soils are often flooded during winter, but crops are seldom damaged. Available moisture capacity is high, and organic-matter content is medium. Reaction is neutral to mildly alkaline throughout the profile. Natural fertility is high. The surface layer is easy to till and it can be worked over a wide range of moisture content without clodding or crusting.

Much of the acreage of these soils is used for burley tobacco, corn, or garden crops, but many areas are used for hay or pasture.

Representative profile of Nolin silt loam, 3 to 4 miles southeast of Carrollton, 200 feet from the Kentucky River, 0.3 mile northwest of Interstate Highway No. 71:

Ap—0 to 7 inches, dark grayish-brown (2.5Y 4/2 when rubbed) silt loam; weak, fine, granular structure; very friable; many roots; mildly alkaline; gradual, smooth boundary.

B21—7 to 22 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; very friable; many roots; neutral; gradual, smooth boundary.

B22—22 to 60 inches +, brown (10YR 4/3) silt loam; weak, fine and medium, granular structure; very friable; common roots; neutral.

The solum is more than 40 inches thick. Bedrock is at a depth of 4 feet to more than 10 feet. The Ap horizon is 2.5Y or 10YR in hue, 4 or 5 in value, and 2 or 3 in chroma. The B2 horizon is 10YR or 2.5Y in hue, 4 or 5 in value, and 3 or 4 in chroma. A few gray mottles are below a depth of 24 inches in some places. This horizon is silt loam or light silty clay loam in texture. Its structure is weak, fine and medium, granular; weak, fine, subangular blocky; or weak, medium, prismatic.

Nolin soils are near Boonesboro, Newark, Brashear, Woolper, and Zipp soils on narrow flood plains. They are similar in drainage to Elk and Huntington soils. Nolin soils are deeper to bedrock than Boonesboro soils, coarser textured than Brashear, Woolper, and Zipp soils, and better drained than Newark and Zipp soils. They are in lower positions and have less distinct horizons than Elk soils and they have a lighter colored A horizon than Huntington soils.

Nolin silt loam (No).—This soil is on long, narrow flood plains along many of the creeks and rivers in the area. The areas range from 10 to 50 acres in size. Slopes are 0 to 4 percent.

Included with this soil in mapping were narrow areas of soils that have slopes of more than 4 percent, areas of soils that have a yellowish-brown silty clay loam subsoil, and areas of soils that have patches of sand on the surface that are less than 6 inches thick. Also included were a few, small, seepy spots, small areas of moderately well drained soils that have gray mottles at a depth of less than 24 inches, and a few areas of gravelly soils.

Erosion is not a hazard on this soil.

This soil can be cropped year after year and productivity maintained if it is properly fertilized, practices are used to help maintain organic-matter content, and good tillage practices are followed. Small grain and alfalfa are subject to damage from flooding in some areas. Some of the better suited pasture and hay plants are Kentucky bluegrass, smooth bromegrass, tall fescue, orchardgrass, ladino clover, and annual lespedeza. Capability unit I–1; woodland suitability group 1o1.

Otwell Series

The Otwell series consists of deep, moderately well-drained soils that have a fragipan. These soils are nearly level to sloping and occur on stream terraces and low ridges. The soils formed in mixed alluvium derived mostly from limestone and calcareous shale.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is silty clay loam that extends to a depth of about 46 inches. The upper 8 inches is dark yellowish brown, the next 5 inches is yellowish brown, and the lower 25 inches is a firm, brittle, compact, pale-brown and light

brownish-gray fragipan. The underlying material is light brownish-gray silty clay loam that has gray and dark yellowish-brown mottles and extends to a depth of 63 inches or more.

The depth of the rooting zone is somewhat restricted by the fragipan, which slows the movement of water, restricts root growth, and causes a perched water table to form in the subsoil. Permeability is moderate above the fragipan but slow in the fragipan. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is strongly acid or very strongly acid throughout the profile, but it is less acid if the surface layer is limed. Natural fertility is moderate. The plow layer is easy to till and can be worked over a wide range of moisture content without clodding or crusting.

Much of the acreage of these soils is used for burley tobacco, corn, or hay. Some areas are used for pasture, a few areas are idle, and some small areas are in trees.

Representative profile of Otwell silt loam, 0 to 2 percent slopes, 7 miles southeast of Carrollton, near the Kentucky River, 1,100 feet northeast of a point on State Highway No. 389, about 0.6 mile north of the Henry County line;

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, very fine, granular structure; friable; many roots; strongly acid; clear, smooth boundary.

B21t—8 to 16 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; few, medium, faint, yellowish-brown (10YR 5/4) mottles, few, medium, faint, brown (7.5YR 4/4) mottles, and few, fine, faint, pale-brown (10YR 6/3) mottles; moderate, fine and medium, subangular blocky structure; friable; many roots; common, thin, dark yellowish-brown clay films; few, dark, soft concretions; strongly acid; gradual smooth boundary.

B22t—16 to 21 inches, yellowish-brown (10YR 5/4) light silty clay loam; common, medium, distinct, pale-brown (10YR 6/3) mottles and common, medium, faint, dark yellowish-brown (10YR 4/4) mottles; moderate, medium, subangular blocky structure; firm; many roots; common moderately thick clay films on peds; strongly acid; clear, smooth boundary.

Bx1—21 to 34 inches, pale-brown (10YR 6/3) light silty clay loam; common, medium, faint, light yellowish-brown (2.5Y 6/4) mottles, and common, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, very coarse, prismatic structure parting to moderate, medium, angular blocky; firm, somewhat compact in places, friable when disturbed; roots are common between prisms, but they are not inside prisms; prisms have pale-brown silt coatings less than 1 millimeter thick; few thin clay films on peds inside prisms; few dark concretions; very strongly acid; gradual, wavy boundary.

Bx2—34 to 46 inches, light brownish-gray (10YR 6/2) light silty clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, very coarse, prismatic structure; massive inside prisms; firm, brittle, and compact in place, friable when disturbed; no roots; light brownish-gray silt coatings 2 to 3 millimeters thick between prisms; few dark concretions; very strongly acid; gradual, wavy boundary.

C—46 to 63 inches +, light brownish-gray (10YR 6/2) light silty clay loam; common, fine, faint, light-gray (10YR 6/1) mottles and common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; massive; slightly compact and brittle in place, friable when disturbed; no roots; few, dark, soft concretions; very strongly acid.

The solum ranges from 40 to 60 inches in thickness. Bedrock is at a depth of more than 5 feet, and it is generally at a depth of more than 10 feet. Gray mottles are in the upper 10 inches of the Bt horizon in some profiles, but they are more than 16 inches from the surface. The B2t horizon ranges from 7.5YR to 2.5Y in hue, 4 or 5 in value, and 3 to 6 in chroma. Texture is silt loam or silty clay loam above and immediately below the fragipan. The fragipan starts at a depth of 18 to 26 inches and is 24 to 36 inches thick. In places the Bx horizon is slightly compact and does not have prismatic structure. The C horizon is dominantly silty clay loam, but it ranges from stratified layers of silt loam to clay.

Otwell soils are near Nicholson soils on high terrace positions and near Elk, Wheeling, McGary, Markland, Lawrence and Robertsville soils on stream terraces. They are less well drained, are on lower elevations, and have a thicker fragipan than Nicholson soils. They have a fragipan, which is not present in Elk, Wheeling, McGary, and Markland soils. The Otwell soils are more poorly drained than Elk, Wheeling, and Markland soils, but they are better drained than McGary, Lawrence, and Robertsville soils.

Otwell silt loam, 0 to 2 percent slopes (O+A).—This soil is mostly in broad, smooth areas along the main streams. The areas range from 20 to 40 acres in size. This soil has the profile described as representative for the series. Runoff is slow. This soil is flooded infrequently during periods of unusually high streamflow.

Included with this soil in mapping were small areas of soils that have slopes of more than 2 percent and areas of soils that have a weakly expressed fragipan less than 12 inches thick.

This soil is suited to some row crops commonly grown in the area, such as corn or tobacco, but the crops are damaged by wetness in some years. It is better suited to tall fescue, reed canarygrass, redtop, red clover, alsike clover, ladino clover, annual lespedeza, and other pasture and hay plants that tolerate slight wetness. If this soil is cultivated, open-ditch drainage, in combination with grassed waterways, is generally the best drainage system to correct the wetness limitation of this soil. Capability unit IIw–3; woodland suitability group 3w1.

Otwell silt loam, 2 to 6 percent slopes (O+B).—This soil is in widely scattered areas 5 to 20 acres in size. Runoff is medium to slow. Some areas of this soil are subject to flooding.

Included with this soil in mapping were many small narrow areas of soils that have slopes of more than 6 percent; small areas of soils that have a surface layer 4 to 7 inches thick; and areas of soils that are underlain by clayey material formed from glacial till and slack-water alluvium.

This soil is suited to crops commonly grown in the area, such as corn, tobacco, and small grain. In addition, it is suited to Kentucky bluegrass, smooth bromegrass, tall fescue, orchardgrass, timothy, red clover, ladino clover, white clover, sericea lespedeza, and annual lespedeza, and other pasture and hay plants. If this soil is cultivated, there is a moderate hazard of erosion. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep soil losses to a minimum. Capability unit IIe–4; woodland suitability group 3w1.

Otwell silt loam, 6 to 12 percent slopes (O+C).—This soil is in scattered areas 5 to 10 acres in size. It has a profile similar to the one described as representative for the series, but the surface layer is less than 6

inches thick. Runoff is medium. Some areas of this soil are subject to flooding.

Included with this soil in mapping were many small areas of soils that have slopes of less than 6 percent and areas of soils that are underlain by glacial till or slack-water alluvium.

This soil is suited to crops commonly grown in the area, such as corn, tobacco, and small grain. Some of the better suited pasture and hay plants are Kentucky bluegrass, smooth bromegrass, tall fescue, orchardgrass, timothy, red clover, ladino clover, white clover, sericea lespedeza, and annual lespedeza. The fragipan in this soil restricts the growth of roots and causes wetness during seasons of heavy rainfall; as a result, alfalfa dies out in 2 or 3 years. If this soil is cultivated, there is a severe hazard of erosion. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep soil losses to a minimum. Capability unit IIIe–4; woodland suitability group 3w1.

Robertsville Series

The Robertsville series consists of deep, poorly drained, nearly level soils that have a fragipan. These soils formed in mixed alluvium mostly weathered from limestone and calcareous shale. They are on stream terraces.

In a representative profile the surface layer is about 8 inches of grayish-brown silt loam that has light brownish-gray mottles. The upper 10 inches of the subsoil is light brownish-gray silt loam that has yellowish-brown and brown mottles, and the lower 28 inches is a firm, brittle, compact, light-gray silty clay loam fragipan. The underlying material is mottled, light olive-gray silty clay loam that extends to a depth of 60 inches or more.

The depth of the rooting zone is restricted by the fragipan, which also restricts water movement. Permeability is slow, and runoff is very slow. Available moisture capacity is moderate, and organic-matter content is low. Reaction generally is strongly acid or very strongly acid throughout the profile, but the surface layer is less acid if it is limed. Natural fertility is low. The plow layer is easy to till and can be worked over a wide range of moisture content without clodding or crusting. These soils are flooded when streamflow is unusually high.

Much of the acreage of these soils is cleared and used for pasture. A few small areas are cultivated, but a few large areas are in water-tolerant deciduous trees.

Representative profile of Robertsville silt loam, 1 to 2 miles south of Carrollton, 1,600 feet southwest of State Highway No. 320, 1,000 feet north of the Kentucky River:

Ap—0 to 8 inches, grayish-brown (2.5Y 5/2) silt loam; common, fine, faint, light brownish-gray (2.5Y 6/2) mottles; weak, fine, granular structure; friable; many roots; slightly acid; clear, smooth boundary.

Bg—8 to 18 inches, light brownish-gray (2.5Y 6/2) silt loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, distinct yellowish-brown (10YR 5/4) and brown (7.5YR 4/4) mottles; moderate, medium, subangular blocky structure; friable; few roots; very strongly acid; gradual, smooth boundary.

Bx—18 to 46 inches, light-gray (2.5Y 7/2) light silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, very coarse, prismatic structure; firm, compact, and brittle in place. friable when disturbed; few roots; light-gray (10YR 7/2) silt coatings 2 to 5 millimeters thick between prisms; common thin clay films inside prisms; many dark-brown concretions; very strongly acid; gradual, wavy boundary.

Cg—46 to 60 inches +, light olive-gray (5Y 6/2) heavy silty clay loam; common, medium, distinct, light olive-brown (2.5Y 5/4) mottles and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, thin, platy structure; firm, slightly sticky and plastic; many black concretions; strongly acid.

The solum ranges from 40 to 50 inches in thickness. Bedrock is at a depth of more than 5 feet, and it is generally at a depth of more than 10 feet. The A horizon ranges from light brownish-gray (2.5Y 6/2) to dark grayish-brown (10YR 4/2). The B horizon ranges from light brownish gray (2.5Y 6/2) to light gray (10YR 7/1) in color and has mottles in shades of brown. It is silt loam or silty clay loam in texture. The fragipan starts at a depth of 16 to 30 inches and is generally 20 to 30 inches thick. The Bx horizon is weak or moderate, very coarse, prismatic and breaks to fine and medium blocky in some places. The C horizon is in shades of gray and has mottles in shades of brown, or it is evenly mottled. It is silt loam to silty clay in texture.

Robertsville soils are near Elk, Otwell, Lawrence, McGary, and Zipp soils on stream terraces. They are more poorly drained than Elk, Otwell, Lawrence, and McGary soils and are coarser textured than Zipp soils.

Robertsville silt loam (Ro).—This soil is in large, smooth areas. Slopes are mostly about 1 percent but range from 0 to 4 percent.

Included with this soil in mapping were small areas of soils that are underlain by silty clay instead of a fragipan; areas of soils in which the fragipan is only slightly compact or is less than 20 inches in thickness, or both; and areas of soils that have a combined surface layer and subsoil that are less than 40 inches thick.

Wetness and shallowness to the fragipan are the main limitations to the use of this soil. The slowly permeable fragipan restricts root growth and causes a perched water table to remain at the surface for long periods after heavy rainfall.

This soil has limited use for corn or tobacco, because adequate drainage is difficult to achieve (fig. 10). It is not suited to small grain that is seeded in the fall. This soil is better suited to tall fescue, reed canarygrass, redtop, ladino clover, annual lespedeza, and other pasture and hay plants. Tile drainage systems are generally not suitable for this soil, because of the fragipan and the lack of suitable outlets. Consequently, surface drainage ditches in combination with constructed grassed waterways is generally the best drainage system used to correct the wetness limitation of this soil. Capability unit IVw–1; woodland suitability group 1w2.

Rock Outcrop

Rock outcrop consists of limestone or of a layer of soil material that is 1 to 3 inches thick over thin layers of limestone that have soft shale partings. Rock

Figure 10.—**Area of Robertsville silt loam where corn has been ruined by wetness.**

outcrop is mapped only in a complex with Fairmount soils. It is so intricately intermingled with Fairmount soils that it could not be separated at the scale mapped.

Rock outcrop supports very little plant growth, but clumps of grass, brush, or stunted trees grow in cracks and crevices.

Wheeling Series

The Wheeling series consists of deep, well-drained, nearly level and strongly sloping soils on stream terraces along the Ohio River. These soils formed in alluvium of mixed origin. They are underlain by sand and gravel at a depth of 3 to 6 feet.

In a representative profile the surface layer is brown silt loam about 9 inches thick. The subsoil is mostly brown and extends to a depth of about 60 inches. In sequence from the top, it is about 5 inches of silt loam; about 16 inches of silt clay loam; about 8 inches of clay loam; about 16 inches of dark yellowish-brown fine sandy loam; and about 6 inches of brown gravelly sandy loam. The underlying material is stratified layers of sand, gravel, and silt

The rooting zone is deep. Permeability is moderate. Runoff is slow or medium. Available moisture capacity is high, and organic-matter content is low. Reaction generally is slightly acid to strongly acid throughout the profile, but the surface layer is less acid if it is limed. Natural fertility is moderate. The surface layer is easy to till and can be worked over a wide range of moisture content without clodding or crusting. These soils are flooded in some places when streamflow is unusually high.

Large areas of the towns of Warsaw and Carrollton are on these soils, and many of these areas are used for industrial and residential sites. Burley tobacco, corn, truck crops, and peach or apple orchards are grown on these soils.

Representative profile of Wheeling silt loam, 0 to 2 percent slopes, 4 miles west of Warsaw, 0.7 mile west of Markland Dam, 100 feet south of U.S. Highway No. 42:

Ap—0 to 9 inches, brown (10YR 4/3) silt loam; moderate, fine, granular structure; very friable; many roots; neutral; clear, smooth boundary.

B1t—9 to 14 inches, brown (7.5YR 4/4) silt loam; moderate, fine, subangular blocky structure; friable; many roots; few thin clay films; neutral; gradual, smooth boundary.

B21t—14 to 30 inches, brown (7.5YR 5/4) light silty clay loam; moderate, medium, subangular blocky structure; friable; common roots; common thin clay films; slightly acid; gradual, smooth boundary.

B22t—30 to 38 inches, brown (7.5YR 5/4) clay loam; moderate, medium, subangular blocky structure; friable; few roots, common moderately thick clay films; medium acid; clear, smooth boundary.

B31—38 to 54 inches, dark yellowish-brown (10YR 4/4) very fine sandy loam; weak, medium, subangular blocky structure; friable; few thin clay films; strongly acid; gradual, wavy boundary.

IIB32—54 to 60 inches, brown (7.5YR 4/2) gravelly sandy loam; very weak, coarse, subangular blocky structure; very friable; a few sand grains are coated and bridged with clay; strongly acid; diffuse boundary.

IIC—60 inches +, stratified layers of loose sand, gravel, and silt.

The solum ranges from 40 to 60 inches in thickness. Bedrock is at a depth of more than 10 feet. The Ap horizon is brown (10YR 4/3) or dark grayish-brown (10YR 4/2) fine sandy loam to silt loam. The B horizon is 10YR or 7.5YR in hue, 4 or 5 in value, and 3 to 6 in chroma. The B1 and B2 horizons range from loam to light silty clay loam. The B3 horizon ranges from very fine sandy loam to gravelly sandy loam. The C horizon is stratified layers that range from very fine sand to gravel.

Wheeling soils are near Ashton, Elk, Otwell, Lakin, and Markland soils on stream terraces. They have a lighter colored A horizon than Ashton soils and a coarser textured B horizon than Elk soils. Wheeling soils are better drained than Otwell soils and lack the fragipan that is present in those soils. They are finer textured than Lakin soils and coarser textured than Markland soils.

Wheeling silt loam, 0 to 2 percent slopes (WhA).—This soil is in large smooth areas. It has the profile described as representative for the series.

Included with this soil in mapping were a few narrow areas of soils that have slopes of more than 2 percent, many small areas of soils that have a surface layer of fine sandy loam, and small areas of soils that have a subsoil of reddish-brown gravelly sandy clay below a depth of 18 to 24 inches. Also included were areas of soils that have a yellowish-brown or dark-brown surface layer.

Erosion is not a hazard on this soil.

This soil can be cropped year after year and productivity maintained if it is properly fertilized, practices are used to help maintain organic-matter content, and good tillage practices are followed. It is suited to all pasture and hay plants that are commonly grown in the area and to corn, tobacco, and small grain. In addition, it is well suited to truck crops, orchards, vineyards, and nursery stock plants (fig. 11). Capability unit I–5; woodland suitability group 2o1.

Wheeling silt loam, 12 to 20 percent slopes (WhD).—This soil is commonly in areas that are away from the Ohio River. It is in toe-slope positions at the base of the steep hills that border the river valley and in fairly long narrow areas that border the more nearly level areas of Wheeling soils. The areas range from 10 to 40 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is generally 4 to 7 inches thick.

Included with this soil in mapping were a few small

Figure 11.—Nursery stock on Wheeling silt loam.

areas of soils that have slopes of less than 12 percent, a few areas of soils that have slopes of more than 20 percent, and small areas of soils that have a fine sandy loam surface layer. Also included were small areas of soils on uplands; these soils are underlain by gravel and sand at a depth of less than 24 inches.

This soil is suited to row crops commonly grown in the area, such as corn and tobacco. It is better suited to all of the pasture and hay plants that are commonly grown in this area and to orchards, vineyards, and nursery stock plants. If this soil is cultivated, there is a very severe hazard of erosion. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep soil losses to a minimum. Capability unit IVe–1; woodland suitability group 2o1.

Woolper Series

The Woolper series consists of well-drained, nearly level to strongly sloping soils or foot slopes of alluvial fans at the base of steep hills. These soils formed in colluvium or local alluvium that washed mostly from Fairmount soils.

In a representative profile the surface layer is dark-brown silty clay about 6 inches thick. The subsoil is silty clay that extends to a depth of about 54 inches. It is dark brown in the upper 9 inches, dark yellowish brown in the next 27 inches, and yellowish brown in the lower 12 inches. The underlying material is yellowish-brown silty clay that reaches to a depth of 65 inches or more.

The rooting zone is deep. Permeability is moderately slow, and runoff is medium to rapid. Available moisture capacity and organic-matter content are high. Reaction generally is slightly acid to mildly alkaline throughout the profile. Natural fertility is moderately high. The plow layer is somewhat difficult to till because of the high content of clay.

Most areas of these soils are used for hay or pasture, but some areas are used for burley tobacco or corn.

Representative profile of Woolper silty clay loam, 12 to 20 percent slopes, about 2 miles south of Carrollton, 25 yards west of State Highway No. 55, 0.25 mile south of State Highway No. 389:

Ap—0 to 6 inches, dark-brown (10YR 3/3) silty clay loam; moderate, fine and medium, granular structure; firm; common fine roots; very dark grayish-brown (10YR 3/2) ped coatings; mildly alkaline; clear, smooth boundary.

B21t—6 to 15 inches, dark-brown (10YR 3/3) silty clay; moderate, medium, angular blocky structure; firm; few fine roots; nearly continuous, very dark grayish-brown (10YR 3/2) clay films; few, small, soft, brown sandstone and shale fragments; mildly alkaline, clear, smooth boundary.

B22t—15 to 42 inches, dark yellowish-brown (10YR 4/4) silty clay; moderate, fine and medium, angular blocky structure; very firm; few fine roots; many clay films; mildly alkaline; gradual, smooth boundary.

B23t—42 to 54 inches, yellowish-brown (10YR 5/4) silty clay; weak, fine and medium, angular blocky structure; very firm; few clay films; mildly alkaline; clear, smooth boundary.

C—54 to 65 inches +, yellowish-brown (10YR 5/4) silty clay; many, medium, faint, brown (10YR 4/3) and grayish-brown (2.5Y 5/2) mottles; massive; very firm; few, small, dark-brown concretions; few pressure faces; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. Bedrock is at a depth of 4 feet to more than 10 feet. Coarse fragments range from 0 to 10 percent throughout the profile. The Ap horizon is dark-brown (10YR 3/3) or very dark grayish-brown (10YR 3/2 or 2.5Y 3/2) silty clay loam or silt loam. The B21t horizon has the same color range as the Ap horizon, and its texture is heavy silty clay loam or silty clay. The B22t and B3t horizons range from brown (7.5YR 4/4 or 10YR 4/3) to light olive brown (2.5Y 5/6) silty clay or clay. Some profiles have gray mottles below a depth of about 2 feet. The matrix and mottles of the C horizon are in shades of brown, gray, or olive. The C horizon is silty clay or clay in texture.

Woolper soils are near Brashear, Eden, Fairmount, Boonesboro, Huntington, Nolin, Newark, and Zipp soils. They are darker colored than Brashear and Eden soils and deeper to bedrock than Fairmount or Boonesboro soils. Woolper soils are finer textured than Huntington, Nolin, and Newark soils and are better drained than Zipp soils.

Woolper silty clay loam, 0 to 2 percent slopes (WoA).—This soil is in long, narrow areas on low-lying stream terraces and alluvial fans. The areas range from 10 to 30 acres in size. Areas of this soil are often flooded during winter, but damage to crops is slight during the growing season. This soil has a profile similar to the one described as representative for the series, but gray mottles are commonly at a depth of 24 to 36 inches.

Included with this soil in mapping were small areas of soils that have slopes of more than 2 percent; a few, small, poorly drained areas of soils; and small areas of soils that have a surface layer of dark grayish-brown silt loam 4 to 10 inches thick. Also included were areas of soils that have rock at a depth of less than 4 feet.

Erosion is not a hazard on this soil. This soil is somewhat difficult to till, because of the moderately fine-textured plow layer.

This soil can be cropped year after year and productivity maintained if the soil is properly fertilized, practices are used to help maintain organic-matter content, and good tillage practices are followed. Such crops as alfalfa and small grain may be damaged by flooding in winter and early in spring. Some of the better suited pasture and hay plants are tall fescue, orchardgrass, smooth bromegrass, timothy, ladino clover, annual lespedeza, and sericea lespedeza. Capability unit IIs–2; woodland suitability group 2c1.

Woolper silty clay loam, 6 to 12 percent slopes (WoC)—This soil is in narrow bands below Fairmount soils at the base of hills. The areas range from 10 to 40 acres in size.

Included with this soil in mapping were a few, small, seepy areas and small areas of soils that have slopes of less than 6 percent.

This soil is suited to crops commonly grown in the area, such as corn, tobacco (fig. 12), and small grain. Among the better suited pasture and hay plants are orchardgrass, tall fescue, timothy, alfalfa, red clover, white clover, sericea lespedeza, and annual lespedeza. If this soil is cultivated, there is a severe hazard of erosion. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep

Figure 12.—Tobacco on Woolper silty clay loam.

soil losses to a minimum. Capability unit IIIe–2; woodland suitability group 2c1.

Woolper silty clay loam, 12 to 20 percent slopes (WoD).—This soil is in bands below Fairmount soils at the base of steep hills. The areas range from 5 to 60 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of soils that are flaggy; a few, small, seepy areas; and small areas of Eden and Fairmount soils.

This soil is suited to row crops commonly grown in the area, such as corn and tobacco. Among the better suited pasture and hay plants are orchardgrass, tall fescue, alfalfa, red clover, white clover, sericea lespedeza, and annual lespedeza. If this soil is cultivated, there is a very severe hazard of erosion. Consequently, cropping systems and other conservation practices are needed to slow runoff and keep soil losses to a minimum. Capability unit IVe–2; woodland suitability group 2c1.

Zipp Series

The Zipp series consists of deep, very poorly drained, nearly level soils in depressional areas on stream terraces. These soils formed in slack-water alluvium, mostly of limestone origin.

In a representative profile the surface layer is 10 inches thick. The upper part is dark grayish-brown silty clay loam about 5 inches thick, and the lower part is dark grayish-brown silty clay about 5 inches thick. The subsoil is gray and light-gray silty clay that has mottles in shades of brown and reaches to a depth of about 38 inches. The underlying material is gray silty clay that has yellowish-brown mottles and extends to a depth of 60 inches or more.

The rooting zone is restricted by the clayey subsoil. Permeability is slow, and runoff is very slow. Crops may be damaged by flooding during the growing season. Available moisture capacity is moderate, and organic-matter content is medium. Reaction generally is neutral to mildly alkaline. Natural fertility is moderate. These soils are somewhat difficult to till, because of the fine-textured plow layer.

Most areas of these soils are used for pasture.

Representative profile of Zipp silty clay loam, about 10 miles south of Owenton, about 1.8 miles south of Monterey:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) silty clay loam; dark-brown (10YR 3/3) on exterior of peds; moderate, fine, subangular blocky structure; firm; many roots; mildly alkaline; clear, smooth boundary.

A1—5 to 10 inches, dark grayish-brown (10YR 4/2) silty clay; moderate, coarse, subangular blocky structure;

very firm; few fine roots; mildly alkaline; gradual, smooth boundary.

B2g—10 to 28 inches, gray (10YR 5/1) silty clay; common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure parting to medium and fine, angular blocky; very firm, very sticky and plastic; few fine roots; few, very small, dark concretions; mildly alkaline; gradual, wavy boundary.

B3g—28 to 38 inches, light-gray (5Y 6/1) silty clay; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; very weak, fine, subangular blocky structure; very firm, very sticky and plastic; mildly alkaline; gradual, wavy boundary.

C—38 to 60 inches +, gray (5Y 5/1) silty clay; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; very firm, very sticky and plastic; mildly alkaline.

The solum ranges from 30 to 40 inches in thickness. Bedrock is at a depth of more than 10 feet. The Ap horizon is grayish-brown (10YR 5/2), very dark grayish-brown (10YR 3/2), or dark grayish-brown (2.5YR 4/2) or 10YR 4/2) silty clay loam or silty clay. The Bg horizon is dark-gray (10YR 4/1), gray (10YR 5/1 or N 5/0), or light-gray (5Y 6/1) silty clay or clay and has few to many mottles in shades of brown and olive.

Zipp soils are near Huntington, Nolin, Woolper, Newark, and Robertsville soils. They are more poorly drained than Huntington, Nolin, Woolper, or Newark soils. Zipp soils have a finer textured B horizon than Robertsville soils and lack the fragipan of those soils.

Zipp silty clay loam (Zp).—This soil is in a few scattered areas that appear to be old abandoned stream channels. The areas range from about 10 to 50 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping were small areas of soils that have a buried former surface layer, areas of soils that have an olive-brown subsoil, and areas of soils that have a grayish-brown or olive-gray subsoil.

The slowly permeable clay causes a seasonal high water table to remain near the surface for several days after heavy rainfall.

This soil is not suited to corn, tobacco, or fall-seeded small grain, because of the wetness limitation. It is better suited to tall fescue, reed canarygrass, redtop, ladino clover, annual lespedeza, and other water-tolerant plants. Tile drainage systems are generally not feasible, because of the fine-textured subsoil and the lack of suitable outlets. Surface drainage in combination with ditches and constructed grassed waterways generally helps to correct the wetness limitation of the soil. Capability unit IVw–1; woodland suitability group 1w2.

Use and Management of the Soils

In this section the use and management of the soils for crops and pasture, woodland, wildlife, engineering, and town and country planning are discussed.

Use of Soils for Crops and Pasture [2]

This section is a guide to the suitability and management of the soils for crops and pasture. Specific management practices are not suggested for each soil. Suggestions for the use of each soil are given in the section "Descriptions of the Soils."

This section has three parts. In this first part, some general principles of soil management are discussed. In the second part, the capability grouping is explained, and a descriptive list of the capability classes, subclasses, and units used in this survey is given. In the third part, estimated yields of specific crops under two levels of management are given for each of the soils.

General principles of soil management

Some principles of management are general enough to apply to all of the soils suitable for crops and pasture throughout the survey area, although individual soils or groups of soils require specific kinds of management. The general principles of management are discussed in the following paragraphs.

Many soils in the survey area need lime or fertilizer, or both. The amount needed depends on the natural content of lime and plant nutrients, determined by laboratory analyses of soil samples; on the needs of crops; and on the level of yield desired. Only general suggestions for applications of lime and fertilizer are given in this publication.

Most of the soils in this survey area were never high in organic-matter content, and it is not economically feasible to build up the content to a high level. It is important, however, to return organic matter to the soil by adding farm manure; leaving plant residue on the surface; and growing sod crops, cover crops, and green-manure crops.

Tillage should be kept to the minimum that is necessary to prepare a seedbed and control weeds, because it tends to break down soil structure. The maintenance of the organic-matter content of the plow layer also helps to protect the structure of the soil.

The production of cultivated crops on wet soils, such as Newark silt loam, can be increased by open-ditch drainage or tile drainage. Tile drains are expensive to install, but they generally provide better drainage than open ditches. Soils that have a fragipan are difficult to drain; open-ditch drainage is generally more effective for these soils than tile drainage. Open-ditch drainage is most effective if the ditches intercept the water as it moves horizontally on top of the fragipan. Drainage by either tile or open ditches requires suitable outlets.

All of the cultivated soils that are gently sloping or steeper are subject to erosion. Runoff and erosion mostly occur during the period that a crop is growing or soon after one has been harvested. A cropping system that controls runoff and erosion is needed, in combination with other erosion-control practices, on erodible soils such as Nicholson silt loam, 2 to 8 percent slopes. The term "cropping system" refers to the sequence of crops grown, as well as management practices such as minimum tillage, mulch planting, use of crop residue, growing of cover crops and green-manure crops, and the use of lime and fertilizer. Other erosion control practices are contour cultivation, terracing, contour stripcropping, diversion of runoff, and the use of grassed waterways. The effectiveness of a particular combination of these measures differs from

[2] ROSCOE ISAACS, assistant state resource conservationist, Soil Conservation Service, assisted in preparing this section.

one soil to another, but different combinations can be equally effective on the same soil. The local representative of the Soil Conservation Service can assist in the planning of an effective combination of practices.

Good pasture management is needed on some soils used for pasture to provide enough ground cover to keep the soil from eroding. Good pasture management provides for fertilization, control of grazing, selection of seeding mixtures, and other practices that are adequate for maintaining good ground cover and providing forage for grazing. Grazing is controlled by rotating the livestock from one pasture to another and by providing rest periods for the pasture after each grazing period to permit the regrowth of plants. It is important on some soils that mixtures of plants be used that require the least renovation to maintain good ground cover and provide forage for grazing.

Capability grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage different kinds of soil in the same way. These readers can make good use of the capability classification system, 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 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 woodland, for wildlife, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so droughty, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. The subclass indicates major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclasses are indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, IIe. The letter "*e*" shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; "*w*" means 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*" indicates 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 or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, woodland, or wildlife habitat.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, they require about the same management, and they have generally similar productivity and other response to management. The capability units in this survey were numbered in accordance with a statewide system. Inasmuch as all the capability units represented in Kentucky do not occur in this survey, the capability units are not consecutive.

The eight classes in the capability system and the subclasses and units in the survey area are described in the list that follows. The unit designation is given in the Guide to Mapping Units.

Class I.—Soils that have few limitations that restrict their use. (No subclasses).
- Unit I–1.—Deep, nearly level to gently sloping, well-drained soils that have a loamy subsoil; on flood plains.
- Unit I–5.—Deep, nearly level to gently sloping, well-drained soils that have a loamy subsoil; on stream terraces.

Class II.—Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe.—Soils that are subject to moderate erosion if they are not protected.
- Unit IIe–1.—Deep, gently sloping, well-drained soils that have a loamy subsoil.
- Unit IIe–2.—Deep, gently sloping, well-drained soils that have a subsoil that is clayey in the lower part.
- Unit IIe–4.—Gently sloping, moderately well-drained soils that have a fragipan.
- Unit IIe–5.—Gently sloping and sloping, well drained to moderately well drained soils that have a fragipan.

Subclass IIw.—Soils that have moderate limitations because of excessive water.
- Unit IIw–1.—Deep, nearly level, somewhat poorly drained soils that have a loamy subsoil.
- Unit IIw–3.—Nearly level, moderately well-drained soils that have a fragipan.

Subclass IIs.—Soils that have moderate limitations because they are difficult to cultivate.
- Unit IIs–2.—Deep, nearly level, well-drained soils that have a surface layer of silty clay loam.

Class III. Soils that have severe limitations that reduce the choice of plants or that require moderate conservation practices, or both.

Subclass IIIe—Soils that are subject to severe erosion if they are not protected.

Unit IIIe–1.—Deep, well-drained, sloping soils that have a loamy subsoil.
Unit IIIe–2.—Deep, sloping, well drained to moderately well drained soils that have a subsoil that is clayey in the lower part.
Unit IIIe–4.—Sloping, moderately well-drained soils that have a fragipan.
Unit IIIe–13.—Gently sloping, moderately well drained to well drained soils that have a subsoil that is clayey in the lower part.

Subclass IIIw.—Soils that have severe limitations because of excessive water.
Unit IIIe–2.—Nearly level, somewhat poorly drained soils that have a subsoil that is clayey in the lower part.
Unit IIIw–3.—Nearly level, somewhat poorly drained soils that have a fragipan.

Subclass IIIs.—Soils that have severe limitations because they are droughty.
Unit IIIs–1.—Gently sloping and sloping, excessively drained, sandy soils.

Class IV.—Soils that have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Subclass IVe.—Soils that are subject to severe erosion if they are not protected.
Unit IVe–1.—Strongly sloping, well-drained soils that have a loamy subsoil.
Unit IVe–2.—Strongly sloping, well drained to moderately well drained soils that have a subsoil that is clayey in the lower part.

Subclass IVw.—Soils that are subject to very severe limitations because of excessive water.
Unit IVw–1.—Nearly level, poorly drained or very poorly drained soils that have a fragipan, or clayey subsoil.

Class V.—Soils that are not likely to erode, but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife habitat.

Subclass Vw.—Soils that have limitations because of excessive water.
Unit Vw–1.—Nearly level, well-drained soils on flood plains that are subject to rapid flooding.

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

Subclass VIe.—Soils that are subject to severe erosion unless close-growing plant cover is maintained.
Unit VIe–3.—Strongly sloping, well-drained soils that have a clayey subsoil.
Unit VIe–4.—Shallow, strongly sloping, well-drained soils that are clayey throughout the profile.
Unit VIe–10.—Strongly sloping, well-drained, severely eroded soils that have a subsoil that is clayey in the lower part.

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

Subclass VIIe.—Soils that are subject to very severe erosion unless close-growing plant cover is maintained.
Unit VIIe–1.—Moderately steep and steep soils that have various textures.
Unit VIIe–2.—Moderately steep, flaggy, well-drained clayey soils.
Unit VIIe–3.—Strongly sloping to steep, well-drained soils that have a clayey subsoil.

Subclass VIIs.—Soils that have very severe limitations because they are shallow.
Unit VIIs–2.—Shallow, steep, clayey soils and rock outcrops.

Class VIII (none in this survey area).—Soils and landforms that have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

Estimated yields

The estimated average yields per acre for crops that are most commonly grown in the survey area are given in table 2 for two levels of management. The yields given in columns A are for a medium level of management, and those given in columns B are for a high level of management.

The yields given in table 2 are the average that may be expected over a period of several years. The yields for one year may be affected adversely by extremes of weather, insects, disease, or some other disaster, or they may be extremely high because of a combination of favorable factors.

The difference between yields in columns A and those in columns B represent the increases in yields that can be expected by improving management. No yields under a medium level of management are given for tobacco, because a high level of management is nearly always used.

Practices included in a high level of management are (1) the use of adapted, recommended varieties of plants; (2) proper rates of seeding, proper inoculation of legumes, proper dates of planting, and efficient harvesting methods; (3) control of weeds, insects, and plant disease; (4) application of fertilizer equal to or greater than the current recommendations of the University of Kentucky Agricultural Experiment Station, or application equal to or greater than the need shown by correctly interpreted soil tests; (5) adequate applications of lime; (6) drainage of naturally wet soils that are feasible to drain; (7) cropping systems that control erosion and maintain soil structure, tilth, and organic-matter content; (8) application of appropriate measures to control erosion, such as minimum tillage, contour farming, terracing, contour stripcropping, and sod waterways; (9) use of cover crops or crop residue, or both, to increase organic-matter content and to control erosion; (10) use of all applicable practices of pasture management; and (11) use of proper management practices, such as minimum tillage, management of crop residue, and winter cover crops.

TABLE 2.—*Estimated average acre yields of principal crops under two levels of management*

[Yields in columns A are those expected under a medium level of management; those in columns B are expected under a high level of management. Absence of a figure indicates that the soil is not suited to that particular crop]

Soil	Tobacco	Corn		Wheat		Alfalfa		Red clover and grass		Annual lespedeza		Pasture (tall fescue-legume)	
	B	A	B	A	B	A	B	A	B	A	B	A	B
	Lb	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Animal-unit-days*[1]	*Animal-unit-days*[1]
Alluvial land, steep												75	180
Ashton silt loam, 0 to 4 percent slopes	3,200	105	135	30	45	3.5	5.0	1.0	3.0	1.5	2.5	170	260
Boonesboro-Alluvial land complex						1.5	3.5	1.1	3.0	1.0	2.0	75	190
Brashear silty clay loam, 6 to 12 percent slopes	2,600	70	90	20	30	2.5	4.0	1.0	3.0	1.5	2.5	125	240
Brashear silty clay loam, 12 to 20 percent slopes	2,400	60	75	20	30	2.0	4.0	1.0	3.0			100	220
Brassfield silt loam, 12 to 25 percent slopes						2.0	3.5	1.0	3.0	1.0	2.0	140	180
Eden silty clay loam, 12 to 20 percent slopes	1,800	55	70			2.0	3.5	1.0	2.5			100	205
Eden flaggy silty clay, 20 to 30 percent slopes, severely eroded						1.5	3.0	.5	1.5			80	175
Elk silt loam, 0 to 2 percent slopes	3,200	100	130	30	45	3.0	5.0	1.0	3.0	1.5	2.5	150	285
Elk silt loam, 2 to 6 percent slopes	3,200	95	130	30	45	3.0	5.0	1.0	3.0	1.5	2.5	150	280
Elk silt loam, 6 to 12 percent slopes	2,800	70	115	25	35	2.5	4.5	1.0	3.0	1.5	2.5	120	250
Fairmount flaggy silty clay, 12 to 20 percent slopes								.5	1.0			60	125
Fairmount-Rock outcrop complex, 30 to 60 percent slopes												30	110
Heitt silt loam, 6 to 12 percent slopes	2,300	70	90	20	30	2.5	4.0	1.0	3.0	1.5	2.5	115	230
Huntington silt loam [2]	3,000	110	130	35	45	3.0	5.0	1.0	3.0	1.5	2.5	175	285
Lakin loamy fine sand, 2 to 12 percent slopes	1,900	50	65	10	20	1.5	3.0	1.0	2.0	1.0	1.5	75	160
Lawrence silt loam		55	75	10	20					1.5	2.5	130	225
Lowell silt loam, 2 to 6 percent slopes	2,600	80	100	25	35	2.5	4.0	1.0	3.0	1.5	2.5	125	240
Lowell silt loam, 6 to 12 percent slopes	2,300	70	90	20	30	2.5	4.0	1.0	3.0	1.5	2.5	115	230
Lowell silty clay loam, 12 to 20 percent slopes, severely eroded						1.5	3.0	.5	2.0			75	165
Markland silt loam, 2 to 6 percent slopes	2,600	70	90	23	35	2.0	3.5	1.0	3.0	1.5	2.5	110	210
Markland soils, 12 to 35 percent slopes												75	150
McGary silt loam		60	75	10	20			1.0	2.0	1.5	2.5	130	225
Newark silt loam [2]	2,400	75	110	25	35			1.0	2.5	1.5	2.5	140	235
Nicholson silt loam, 2 to 8 percent slopes	3,025	90	110	30	40	2.5	4.0	1.0	3.0	1.5	2.5	125	230
Nolin silt loam [2]	3,000	110	135	35	45	3.0	5.0	1.0	3.0	1.5	2.5	170	285
Otwell silt loam, 0 to 2 percent slopes	2,600	80	100	25	35	2.0	3.5	1.0	3.0	1.5	2.5	130	200
Otwell silt loam, 2 to 6 percent slopes	2,650	80	100	25	35	2.0	3.5	1.0	3.0	1.5	2.5	130	200
Otwell silt loam, 6 to 12 percent slopes	2,400	70	90	20	30	2.0	3.5	1.0	2.5	1.5	2.5	120	200
Robertsville silt loam		40	60							1.5	2.0	115	200
Wheeling silt loam, 0 to 2 percent slopes	3,200	100	130	30	45	3.0	5.0	1.0	3.0	1.5	2.5	150	285
Wheeling silt loam, 12 to 20 percent slopes	2,800	70	115	25	35	2.5	4.5	1.0	3.0	1.5	2.5	120	250
Woolper silty clay loam, 0 to 2 percent slopes	2,800	100	130	30	40	3.0	4.5	1.0	2.5	1.5	2.5	150	255
Woolper silty clay loam, 6 to 12 percent slopes	2,500	80	100	20	30	3.0	4.5	2.0	3.0	1.5	2.5	150	250
Woolper silty clay loam, 12 to 20 percent slopes	2,400	60	80	20	30	2.5	4.0	2.0	2.5			115	200
Zipp silty clay loam		40	60							1.3	2.1	115	200

[1] Animal-unit-days is a term used to express the carrying capacity of pasture. It is the number of days that 1 acre will support one animal unit without injury to the forage plants. One animal unit is one horse, two growing dairy calves, one beef cow and calf, five sows with litters to weaning age, a 1,000-pound dairy cow, two 500-pound yearling beef calves, five ewes with lambs, or 14 lambs after weaning.

[2] Damage caused by flooding is not considered in the yield data.

A high level of management is not considered the maximum level, but it is the level many farmers find practical to reach if they apply the proper management practices. It is the level at which the highest sustained production of crops is economically feasible.

A medium level of management is treatment through fertilization and management at a level generally considered to be the minimum required to keep the soil from deteriorating and to keep it at a level of quality sufficient to produce crops for profit.

Failure to apply one or more of the items listed for a high level of management with sufficient vigor may cause the production level to drop to a point that does not return a profit or that may result in some permanent damage to the soil, or both. Inadequate drainage and only partial application of practices to control runoff and erosion are examples of deficiencies that relate to a medium level of management.

Woodland [3]

The soils in Carroll, Gallatin, and Owen Counties were originally covered with several species of oak, yellow-poplar, white ash, black walnut, and other deciduous trees. Most of the land was cleared for farming, except for isolated spots and bluffs along the main streams. Many of these areas were used for the production of corn, and other areas were heavily grazed by sheep. This caused severe erosion on the steep clayey soils. With the development of larger, mechanized equipment, the acreage of corn and the number of sheep in the area decreased. Many of the areas of steeper soils that previously were in crops have reverted to brush and trees. Honey locust, black locust, osage-orange, redcedar, hawthorn, hickory, elm, sassafras, persimmon, black cherry, and buckbrush are in areas on uplands, and ash and sycamore are on the low-lying areas.

The average tree size in these counties is less than the average for Kentucky. More than 80 percent of the trees that are useable commercially are less than 15 inches in diameter at breast height, and stands of trees the size of pole timber, seedlings, and saplings make up more than 75 percent of the area of commercial forest. Most of the woodland is privately owned, and much of it is in scattered farm woodlots that are poorly stocked and heavily grazed. Fire generally is not a concern on the forested land in these counties.

Woodland interpretations

The soils of Carroll, Gallatin, and Owen Counties have been placed in woodland suitability groups to assist owners in planning the use of their soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees, that have the same potential productivity, and that need about the same management where the vegetation on them is similar.

Each woodland group is identified by a three-part symbol, such as 1o1, 2w1, or 3w3. The potential productivity of the soils in the group is indicated by the first number in the symbol; 1, very high; 2, high; 3, moderately high; 4, moderate; and 5, low. These ratings are based on field determination of average site index of an indicator species. Site index of a given soil is the height, in feet, that dominant and codominant trees reach in a natural, essentially unmanaged stand in 50 years, 30 years for cottonwood. Site index can be converted into the approximate expected growth and yield per acre. For this survey area, conversions of average site index into volumetric growth and yield are based on research as follows: upland oaks (*10*); yellow-poplar (*3, 7*); sweetgum (*5*); short leaf pine (*11*); cottonwood (*4*); Virginia pine (*8*); and southern hardwoods (*9*).

The second part of the symbol identifying a woodland group is a small arabic letter *x*, *w*, *d*, *c*, *s*, *f*, *r*, or *o*. Priority in placing each kind of soil into a subclass must be in the order that the letters are listed above. Except for the letter *o*, the arabic letter indicates an important soil property that imposes a hazard of limitation in managing the soils of the group for trees. The letter *x* means limitations are due to stones or rocks. The letter *w* means excessive wetness, either seasonal or all year. The letter *d* means a restricted rooting depth. The letter *c* stands for limitations due to the kind or amount of clay in the upper part of the soil profile. The letter *s* indicates dry, unstable, abrasive, sandy soils in which there is little or no difference in texture between the surface layer and subsoil. The letter *f* means limitations due to large amounts of gravel, cobbles, or other coarse rock fragments less than 10 inches in size. The letter *r* shows that the main limitation is steep slopes and that there is a hazard of erosion and possibly limitations to use of equipment. The letter *o* shows that the soils have slight or no limitations that restrict their use for trees.

The last part of the symbol, another number, differentiates groups of soils that have identical first and second parts in their identifying symbol. Soils in woodland group 3w1, for example, require different management or they are suited to other species of trees than soils in group 3w2 because of differences in soil properties or other factors.

In table 3 each woodland suitability group has a verbal rating for various management hazards or limitations. These ratings are slight, moderate, or severe, and they are described in the following paragraphs.

Erosion hazard refers to the potential hazard of soil losses in common woodland management operations. The hazard is *slight* if expected soil losses are small; *moderate* if some soil losses are expected and care is needed during logging and construction to reduce soil losses; and *severe* if special methods of operation are necessary for preventing excessive soil losses.

Equipment limitations depend on soil characteristics that restrict or prohibit the use of harvesting equipment, either seasonally or continually. *Slight* means no restrictions in the kind of equipment or time of year it is used; *moderate* means that use of equipment is restricted for 3 months of the year or less; *severe* means that special equipment is needed and that its use is severely restricted for more than 3 months of the year.

Seedling mortality refers to mortality of naturally occurring or planted tree seedlings, as influenced by

[3] CHARLES A. FOSTER, forester, Soil Conservation Service, assisted in the preparation of this section.

kinds of soil or topographic conditions when plant competition is assumed not to be a factor. *Slight* means a loss of 0 to 25 percent; *moderate* means a loss of 25 to 50 percent; and *severe* means a loss of more than 50 percent of the seedlings. It is assumed that seed supplies are adequate.

Plant competition is the degree to which undesirable plants invade openings in the tree canopy. Considered in the ratings are available water capacity, fertility, drainage, and degree of erosion. Conifers and hardwoods are rated separately in table 3. *Slight* means that plant competition does not prevent adequate natural regeneration and early growth or interfere with seedling development; *moderate* means that competition delays natural or artificial establishment and growth rate but does not prevent the development of fully stocked normal stands; *severe* means that competition prevents adequate natural or artificial regeneration, unless the site is prepared properly and maintenance practices are used.

Table 3 also lists suitable species to favor in existing stands and suitable species for planting.

Wildlife

The amount and distribution of food, shelter, and water obviously have a great effect on the welfare of a wildlife species. If any of these elements is missing, inadequate, or inaccessible, the species is absent or scarce. The kinds of wildlife that live in a given area and the number of each kind are closely related to land use, to the resulting kinds and patterns of vegetation, and to the supply and distribution of water. These factors are, in turn, generally related to the kinds of soil in an area.

Wildlife habitat normally can be created or improved by planting suitable vegetation, by properly managing the existing plant cover, by fostering the natural establishment of desirable plants, or by using a combination of these measures (*1*).

This subsection rates the soils of Carroll, Gallatin, and Owen Counties according to their suitability for seven elements of wildlife habitat and for three kinds of wildlife. Then it explains the ratings, the elements of wildlife habitat, and the classes of wildlife.

The suitability ratings in this subsection can be used as an aid in (1) planning the broad use of parks, refuges, nature study areas, and other recreational developments for wildlife; (2) selecting soils that are well suited to creating, improving, or maintaining specific elements of wildlife habitat; (3) determining the relative intensity of management needed for individual habitat elements; (4) eliminating sites that would be difficult or not feasible to manage for specific kinds of wildlife; and (5) determining areas that are suitable for acquisition for use as wildlife habitat.

The ratings used in table 4 are *good, fair, poor,* and *very poor.*

On soils rated *good,* habitat is generally easily created, improved, or maintained. There are few or no soil limitations in habitat management, and satisfactory results are assured. On soils rated *fair,* habitat usually can be created, improved or maintained, but the soils have moderate limitations that affect the creation, improvement, or maintenance of the habitat. A moderate intensity of management and fairly frequent attention may be required to assure satisfactory results. On soils rated *poor,* habitat can usually be created, improved, or maintained; but there are rather severe soil limitations. Habitat management may be difficult and expensive. Satisfactory results are questionable. On soils rated *very poor,* it is impractical to create, improve, or maintain habitat, because of the very severe soil limitations. Unsatisfactory results are probable. Not considered in the ratings are present land use, the location of a soil in relation to other soils, and the mobility of wildlife.

The elements of wildlife habitat and the kinds of wildlife in the county are discussed in the following paragraphs.

Grain and seed crops are seed-producing annuals, such as corn, sorghum, wheat, oats, millet, buckwheat, soybeans, sunflowers, and other plants commonly grown for grain or seed. The major soil properties that affect this habitat element are the depth of effective rooting, available moisture capacity, natural drainage, slopes, surface stoniness, hazard of flooding, and texture of the surface layer.

Domestic grasses and legumes are domestic perennial grasses and herbaceous legumes, established by planting, that furnish wildlife cover and food. Examples are bluegrass, fescue, brome, timothy, redtop, orchardgrass, reed canarygrass, clover, trefoil, alfalfa, and panicgrasses. The major soil properties that affect this habitat element are the depth of effective rooting, available moisture capacity, natural drainage, slope, surface stoniness, hazard of flooding, and texture of the surface layer.

Wild herbaceous plants are native or introduced perennial grasses and weeds that generally are established naturally. Examples are bluestem, indiangrass, wheatgrass, goldenrod, wild ryegrass, oakgrass, pokeweed, strawberries, lespedeza, beggarweed, wild beans, nightshade, and dandelion. These plants provide food and cover mainly to upland wildlife. The major soil properties that affect this habitat element are the depth of effective rooting, available moisture capacity, natural drainage, surface stoniness, hazard of flooding or ponding, and texture of the surface layer.

Hardwood plants are nonconiferous trees, shrubs, and woody vines. Examples are oak, beech, cherry, maple, poplar, hawthorn, dogwood, persimmon, sumac, sassafras, hazlenut, black walnut, hickory, sweetgum, blueberry, viburnum, grape, and briers. These plants produce nuts or other fruits, buds, catkins, twigs, or foliage that wildlife eat. They are generally established naturally, but they may be planted. The major soil properties that affect this habitat element are the depth of effective rooting, available moisture capacity, and natural drainage.

Several varieties of fruiting shrubs that are raised commercially for planting are also included in this group. Examples are autumn-olive, Amur honeysuckle, tatarian honeysuckle, crabapple, multiflora, rose highbrush cranberry, and silky cornel dogwood. These are some of the shrubs that generally are available and can

TABLE 3.—*Woodland*

[Alluvial land, steep (AlD) is too variable to rate, onsite

Woodland suitability group, soil series, and map symbols	Potential productivity			Management hazards and limitations	
	Species	Site index	Average annual growth per acre [1]	Erosion hazard	Equipment limitations
			Fbm		
Group 1o1: Boonesboro: Bo. Huntington: Hu. Nolin: No.	Yellow-poplar Upland oaks	>95 >85	>500 >350	Slight	Slight
Group 1o2: Ashton: AsA.	Yellow-poplar Upland oaks	>95 >85	>500 >350	Slight	Slight
Group 1w1: Newark: Ne.	Lowland oaks Cottonwood	>95 >95	>450 >570	Slight	Moderate
Group 1w2: Robertsville: Ro. Zipp: Zp.	Lowland oaks Sweetgum Cottonwood	>95 >95 >95	>450 >500 >570	Slight	Severe
Group 2c1: Brashear: BrC, BrD. Lowell: LlB, LlC, LoD3. Markland: MaB, MbD. Woolper: WoA, WoC, WoD.	Upland oaks Yellow-poplar Redcedar	75–85 85–95 55–65	240–350 380–500 ---	Generally slight; severe for MbD.	Generally moderate; severe for MbD.
Group 2o1: Elk: ElA, ElB, ElC. Nicholson: NfB. Wheeling: WhA, WhD.	Upland oaks Yellow-poplar Redcedar	75–85 85–95 55–65	240–350 380–500 ---	Slight	Slight
Group 2w1: Lawrence: Lc.	Upland oaks Sweetgum	75–85 85–95	240–350 380–500	Slight	Moderate
Group 3c1: Heitt: HeC.	Upland oaks Redcedar	65–75 45–55	160–240 ---	Slight	Moderate
Group 3c2: Eden: EdD, EfE3.	Upland oaks Redcedar	65–75 45–55	160–240 ---	Moderate to severe	Moderate to severe
Group 3s1: Lakin: LaC.	Upland oaks	65–75	160–240	Slight	Moderate
Group 3w1: Otwell: OtA, OtB, OtC.	Upland oaks Yellow-poplar	65–75 75–85	160–240 280–380	Slight to moderate	Moderate
Group 3w2: McGary: Mc.	Upland oaks	65–75	160–240	Slight	Moderate
Group 4d1: Brassfield: BsD. Fairmount: FaD.	Upland oaks Redcedar	55–65 35–45	90–160 ---	Moderate to severe	Slight to moderate
Group 4x1: Fairmount: FrF.	Upland oaks Redcedar	55–65 35–45	90–160 ---	Severe	Severe

[1] By International Rule.

interpretations

investigation required. The symbol > means more than]

Management hazards and limitations—Continued			Preferred species	
Seedling mortality	Plant competition		To favor in existing stands	For planting
	Conifers	Hardwoods		
Slight	Severe	Severe	Yellow-poplar, black walnut, white ash, hickory, white oak, northern red oak, sweetgum.	Yellow-poplar, black walnut, white ash, cottonwood, eastern white pine, sweetgum.
Slight	Severe	Severe	Yellow-poplar, black walnut, white ash, white oak, red oak, sweetgum.	Yellow-poplar, black walnut, white ash, cottonwood, eastern white pine, sweetgum.
Slight	Severe	Severe	Pin oak, red maple, cottonwood, sweetgum, white ash, sycamore.	Cottonwood, sweetgum, loblolly pine, sycamore.
Severe	Severe	Severe	Pin oak, sweetgum, cottonwood, red maple, sycamore.	Pin oak, sweetgum, sycamore.
Slight	Severe	Moderate	Yellow-poplar, white oak, black oak, hickory, eastern redcedar, white ash, black walnut.	Virginia pine, eastern redcedar, Scotch pine, black walnut, white ash.
Slight	Severe	Moderate	Black walnut, yellow-poplar, white ash, black oak, white oak, hickory.	Black walnut, yellow-poplar, eastern white pine, shortleaf pine, white ash.
Slight	Severe	Severe	Sweetgum, yellow-poplar, sycamore, white ash, white oak.	Sweetgum, sycamore, white ash, pin oak, loblolly pine.
Slight	Moderate	Slight	White oak, black oak, hickory, eastern redcedar, white ash, sugar maple.	Shortleaf pine, white ash, loblolly pine, eastern white pine, black locust, redcedar.
Moderate to severe	Moderate	Slight	Black walnut, white oak, white ash, black oak, hickory, eastern redcedar.	Black locust, redcedar, Virginia pine, Scotch pine, Austrian pine.
Moderate	Moderate	Slight	Red oak, white oak, black locust, red maple.	Black locust, shortleaf pine, loblolly pine, Virginia pine.
Slight	Moderate	Slight	Yellow-poplar, white oak, northern red oak, black oak, red maple.	Sweetgum, white ash, loblolly pine.
Slight	Severe	Moderate	Red maple, sweetgum, Shumard oak, white oak, sycamore, post oak.	Sweetgum, sycamore, pin oak.
Moderate	Slight	Slight	White oak, eastern redcedar, black locust, white ash, black oak, scarlet oak.	Virginia pine, eastern redcedar, Scotch pine.
Moderate	Slight	Slight	Eastern redcedar, white oak, hickory, scarlet oak, black oak.	Virginia pine, eastern redcedar, Scotch pine.

TABLE 4.—*Suitability of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood plants
Alluvial land, steep: AlD	Poor	Fair	Good	Good
Ashton: AsA	Good	Good	Good	Good
Boonesboro: Bo	Good	Fair	Fair	Fair
Brashear: BrC, BrD	Fair	Good	Fair	Good
Brassfield: BsD	Fair	Good	Good	Fair
Eden:				
EdD	Fair	Good	Fair	Good
EfE3	Poor	Fair	Poor	Good
Elk:				
ElA, ElB	Good	Good	Good	Good
ElC	Fair	Good	Good	Good
Fairmount:				
FaD	Poor	Poor	Poor	Poor
FrF	Very poor	Very poor	Poor	Poor
Rating not assigned to Rock outcrop part of FrF.				
Heitt: HeC	Fair	Good	Good	Good
Huntington: Hu	Good	Good	Good	Good
Lakin: LaC	Poor	Poor	Fair	Poor
Lawrence: Lc	Fair	Good	Good	Good
Lowell:				
LlB	Good	Good	Good	Good
LlC	Fair	Good	Good	Good
LoD3	Fair	Good	Fair	Good
Markland:				
MaB	Good	Good	Good	Good
MbD	Poor	Fair	Fair	Good
McGary: Mc	Fair	Good	Good	Good
Newark: Ne	Fair	Fair	Fair	Good
Nicholson: NfB	Fair	Good	Good	Good
Nolin: No	Good	Good	Good	Good
Otwell:				
OtA	Fair	Good	Good	Good
OtB, OtC	Fair	Good	Good	Good
Robertsville: Ro	Poor	Fair	Fair	Fair
Wheeling:				
WhA	Good	Good	Good	Good
WhD	Fair	Good	Good	Good
Woolper:				
WoA	Good	Good	Fair	Good
WoC, WoD	Fair	Good	Fair	Good
Zipp: Zp	Poor	Fair	Fair	Fair

be planted on soils that are rated good. Hardwoods that are not available commercially can generally be transplanted successfully.

Coniferous plants consist of cone-bearing evergreen trees and shrubs. Examples are hemlock, Virginia pine, loblolly pine, shortleaf pine, pond pine, Scotch pine, and redcedar. These plants are used by wildlife primarily as cover, but they also provide browse and seeds or fruit-like cones. They are generally established naturally in areas where cover of weeds and sod is thin, but they can also be planted. The major soil properties that affect this habitat element are the depth of effective rooting, available moisture capacity, and natural drainage.

Wetland plants are wild herbaceous annual and perennial plants. Examples are smartweed, wild millet, bulrush, sedges, burreeds, rushes, rice cutgrass, mannagrass, wild rice, and cattails. These are plants that grow on moist to wet sites, exclusive of submerged or floating aquatics. They produce a large amount of food and cover that is mainly used by wetland wildlife. The major soil properties that affect this habitat element are natural drainage, surface stoniness, slope, and texture of the surface layer.

Shallow water areas are impoundments or excavations that provide areas of shallow water, generally not exceeding 5 feet in depth, near food and cover for wetland wildlife. Examples are shallow dugouts, level ditches, blasted potholes, and devices that keep the water at a depth of 6 to 24 inches in marshes. The major soil properties that affect this habitat element are depth to bedrock, natural drainage, slope, surface stoniness, and permeability.

Open-land wildlife consists of birds and mammals that normally live in areas of cropland, pasture, meadow, and lawns and in areas overgrown by grass, herbs, and shrubs. Examples of open-land wildlife are quail, meadowlarks, field sparrows, doves, cottontail rabbits, red fox, and woodchucks.

Woodland wildlife consists of birds and mammals

of wildlife habitat and kinds of wildlife

Elements of wildlife habitat—Continued			Kinds of wildlife		
Coniferous plants	Wetland plants	Shallow water areas	Open-land wildlife	Woodland wildlife	Wetland wildlife
Good	Poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Fair	Poor	Very poor	Fair	Fair	Very poor.
Good	Poor	Very poor	Fair	Good	Very poor.
Fair	Poor	Very poor	Good	Fair	Very poor.
Good	Poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Poor	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Poor	Very poor	Poor	Poor	Very poor.
Poor	Poor	Very poor	Very poor	Poor	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Fair	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Fair	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Fair	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Fair	Good	Good	Fair	Fair	Good.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Fair	Good	Very poor.
Fair	Good	Good	Fair	Fair	Good.

that obtain food and cover in stands of hardwoods, coniferous trees, shrubs, or a mixture of these plants. Examples of woodland wildlife are ruffed grouse, woodcock, thrushes, vireos, scarlet tanagers, gray and red squirrels, gray fox, white-tailed deer, raccoon, and wild turkey.

Wetland wildlife consists of birds and mammals that normally live in wet areas, such as ponds, marshes, and swamps. Examples of wetland wildlife are ducks, geese, herons, shore birds, mink, beaver, and muskrat.

Engineering Uses of the Soils [4]

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 the soil properties that are most important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Depth to the seasonal high water table, depth to bedrock, and slope are also important. 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—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Plan farm drainage systems, irrigation sys-

[4] ARTHUR T. SMITH, area engineer, Soil Conservation Service, assisted in the preparation of this section.

tems, ponds, terraces, and other structures for controlling water and conserving soil.

4. Correlate performance of structures that are already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
5. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
6. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in table 5, 6, and 7, which show, respectively, several estimated soil properties significant to engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 5 and 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, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given 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 these terms.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*16*), used by SCS engineers, the Department of Defense, and others, and the AASHO system (*2*), 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 into 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 classes are designated by symbols for both classes; for example ML-CL.

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

Estimated properties

Estimates of several 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. 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.

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

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 less than 2 millimeters in diameter. "Loam," for example, is soil material that is 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 (*14*) are defined in the Glossary of this soil survey.

The Unified and AASHO classifications are explained in the section, "Engineering soil classification systems."

Permeability is that quality of soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

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

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.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet.

Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils greatly damage building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or of material having this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such 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* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations

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 others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of the area. In table 6, ratings are used to summarize the suitability of the soils for topsoil and road fill. For highway location, drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, terraces and diversions, and grassed waterways, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance. Terms used to rate the soils for suitability as a source of topsoil and road fill are good, fair, and poor.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used as a topdressing for lawns, gardens, and roadbanks and for similar uses. The ratings indicate suitability for such use.

Road fill is material to be used to build embankments. The ratings indicate the performance of soil material moved from borrow areas for this purpose.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features noted in the table are the principal ones that affect the geographic location of highways.

Farm pond reservoir areas are mainly affected by features of the soil that contribute to loss of water by seepage.

Farm pond embankments serve as dams. The features noted are properties of disturbed soil material from both the subsoil and substratum that are important to the use of the soil for constructing embankments.

Drainage of cropland and pasture is influenced by features of the undisturbed soil that affect the installation and performance of surface drainage installations.

Irrigation is affected by features of the undisturbed soil that influence the relationship of soil to moisture and the potential of a soil to produce specific crops. Before planning an irrigation project, a feasibility study made by a qualified consultant is desirable.

Terraces and diversions are affected by soil features that influence their stability or hinder layout and construction. Also, diversions are affected by hazards of sedimentation in channels and the difficulty of establishing and maintaining cover.

Grassed waterways are affected by soil features that influence the establishment and maintenance of plants or affect layout and construction.

There is no column for suitability as sources of sand and gravel, because there is only one known source of sand and gravel and it underlies the terraces along the Ohio River. There are several large sand and gravel quarries in Carroll and Gallatin Counties.

Engineering test data

In table 7 engineering test data for some of the major soils in the survey area are given. These tests were made to help to 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.

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

Mechanical analyses gives the proportions of soil particles of various sizes in a particular soil sample. Soil particles that do not pass through the No. 200 sieve are sand and other coarse materials. Particles that are larger than 0.002 millimeter in diameter and pass through the No. 200 sieve are silt. Particles that are smaller than 0.002 millimeter in diameter are clay. The clay fraction was determined by the hydrometer method, rather than by the pipette method, which most soil scientists use to determine the content of clay of soil samples. Coarse fragments larger than 3 inches in diameter were discarded.

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 material changes from semisolid to plastic. The plastic limit is the moisture content at which the soil material changes from a semisolid state to a plastic state. If the moisture content is further increased, the material changes from plastic to liquid. The liquid limit is the moisture content at which the material changes from a plastic state to a liquid state. The plasticity index is the nu-

TABLE 5.—*Estimated soil properties*

[The symbol > means more than,

Soil series and map symbols	Depth to—		Depth from surface	Classification			Coarse fraction greater than 3 inches
	Seasonal high water table	Bedrock		USDA texture	Unified	AASHO [1]	
	Feet	*Feet*	*Inches*				*Percent*
Alluvial land, steep: AlD. Too variable to be rated.							
Ashton:[2] AsA	>5	>10	0–18	Silt loam	ML–CL or CL	A–4 or A–6	
			18–60	Silty clay loam or silt loam.	CL or ML	A–6 or A–4	
Boonesboro:[3] Bo	>3	2–3½	0–18	Silty clay loam	CL or ML	A–4 or A–6	0–10
			18–24	Silty clay loam	CL	A–6	15–50
Alluvial land part too variable to be rated.			24	Limestone.			
Brashear: BrC, BrD	2–3	>4	0–12	Silty clay loam	CL	A–6	2–12
			12–60	Silty clay or clay	MH or CH	A–7	2–12
Brassfield: BsD	>5	2–3	0–5	Silt loam	ML	A–4	0–10
			5–12	Loam	ML	A–4	4–20
			12–26	Loam	ML or SM	A–4	10–42
			26	Shale and sandstone.			
Eden: EdD, EfE3	>5	3½–5	0–4	Silty clay loam	CL	A–6 or A–7	2–15
			4–20	Silty clay	MH, CH or CL	A–7	10–30
			20–50	Silty clay	MH, CH or CL	A–7	22–60
			50	Shale.			
Elk:[2] ElA, ElB, ElC	>5	>4	0–8	Silt loam	ML or CL	A–4 or A–6	
			8–60	Silty clay loam	ML or CL	A–6 or A–4	
Fairmount: FaD, FrF	>5	1–2	0–10	Flaggy silty clay	MH or CH	A–7	12–25
			10–16	Flaggy silty clay	MH or CH	A–7	30–46
Rock outcrop part of FrF too variable to be rated.			16	Limestone and shale.			
Heitt: HeC	>5	3½–6	0–6	Silt loam	ML or CL	A–6 or A–4	
			6–17	Silty clay	MH or CH	A–7	
			17–56	Clay	CH	A–7	0–5
Huntington:[3] Hu	>3	>5	0–80	Silt loam	ML or CL	A–4 or A–6	
Lakin: LaC	>5	>10	0–50	Loamy fine sand	SM	A–2	
			50–60	Fine sand	SM	A–2	
Lawrence:[2] Lc	[4] ½–1	>10	0–10	Silt loam	ML or CL	A–4	
			10–25	Silty clay loam	ML or CL	A–6	
			25–62	Silty clay loam (fragipan).	CL or ML	A–6 or A–7	
			62–75	Silty clay	MH or CH	A–7	
Lowell: LlB, LlC, LoD3	>5	3½–5	0–8	Silt loam	ML or CL	A–4 or A–6	
			8–14	Silty clay loam	CL	A–6 or A–7	
			14–38	Silty clay	MH or CH	A–7	
			38–47	Clay	CH	A–7	
			>47	Limestone and shale.			
Markland:[2] MaB, MbD	2–3	>10	0–6	Silt loam	ML or CL	A–4 or A–6	
			6–11	Silty clay loam	CL	A–6	
			11–24	Silty clay	MH or CH	A–7	
			24–60	Clay	CH	A–7	
McGary:[2] Mc	½–1	>5	0–6	Silt loam	ML or CL	A–4 or A–6	
			6–18	Silty clay loam	CL	A–6	
			18–60	Silty clay or clay	MH or CH	A–7	
Newark:[3] Ne	½–1	>4	0–60	Silt loam	ML or CL	A–6 or A–4	
Nicholson: NfB	[4] 2–3	5–8	0–16	Silt loam	ML or CL	A–4 or A–6	
			16–24	Silty clay loam	CL	A–6	
			24–36	Silty clay loam (fragipan).	CL	A–6 or A–7	

See footnote at end of table.

significant to engineering

and the symbol < means less than]

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
				In per hr	*In per in of soil*	*pH*			
100	100	90–100	70–90	0.6–2.0	0.19–0.23	6.1–7.3	Low	Low	Low.
100	100	95–100	80–100	0.6–2.0	0.17–0.21	6.1–7.3	Low	Low	Low.
95–100	95–100	90–100	80–95	0.6–2.0	0.14–0.19	6.6–7.8	Moderate	Low	Low.
80–95	80–95	75–95	60–90	2.0–6.0	0.07–0.14	6.6–7.8	Moderate	Low	Low.
95–100	95–100	90–100	80–95	0.6–2.0	0.15–0.19	5.1–6.5	Moderate	High	Moderate.
95–100	95–100	90–100	85–95	0.2–0.6	0.14–0.18	5.1–7.3	High	High	Moderate.
95–100	95–100	95–100	65–90	0.6–2.0	0.18–0.23	7.4–9.0	Low	Low	Low.
90–95	90–95	75–90	50–70	0.6–2.0	0.13–0.18	7.4–9.0	Low	Low	Low.
80–95	80–95	65–90	40–70	0.6–2.0	0.11–0.16	7.4–9.0	Low	Low	Low.
95–100	95–100	90–100	90–95	0.2–0.6	0.14–0.16	6.1–8.4	Moderate	Moderate	Low.
90–95	90–95	85–95	80–90	0.2–0.6	0.13–0.16	6.1–8.4	High	Moderate	Low.
80–90	80–90	75–90	70–85	<0.2	0.07–0.09	6.1–8.4	High	Moderate	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	5.1–6.0	Low	Low	Moderate.
100	100	95–100	85–95	0.6–2.0	0.17–0.21	5.1–6.0	Moderate	Low	Moderate.
90–100	90–100	85–100	80–90	0.2–0.6	0.13–0.15	6.6–8.4	High	Low	Low.
85–100	85–100	80–100	75–95	0.2–0.06	0.08–0.13	6.6–8.4	High	Low	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	5.1–6.5	Low	Low	Low.
100	100	95–100	90–95	0.2–0.6	0.15–0.18	5.1–6.0	High	Moderate	Moderate.
95–100	95–100	95–100	90–95	0.2–0.6	0.14–0.17	5.1–8.4	High	Moderate	Low.
95–100	95–100	90–100	70–90	0.6–2.0	0.19–0.23	6.1–7.8	Low	Low	Low.
100	100	70–100	20–35	>6.0	0.06–0.08	5.1–6.5	Low	Low	Moderate.
100	100	65–90	20–35	>6.0	0.05–0.07	5.1–6.5	Low	Low	Moderate.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	4.5–5.5	Low	High	High.
100	100	95–100	85–95	0.6–2.0	0.17–0.21	4.5–5.5	Low	High	High.
100	100	95–100	85–95	<0.2	0.06–0.14	4.5–5.5	Moderate	High	High.
100	100	95–100	90–95	<0.2	0.06–0.14	4.5–5.5	High	High	Moderate.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	5.6–6.5	Low	Low	Low.
100	100	95–100	85–100	0.2–0.6	0.16–0.19	5.1–6.5	Moderate	Moderate	Low.
100	100	95–100	90–100	0.2–0.6	0.15–0.18	5.1–6.5	High	Moderate	Low.
100	100	90–100	90–100	<0.2	0.14–0.17	5.6–7.3	High	Moderate	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	5.6–6.5	Low	Low	Low.
100	100	95–100	85–95	0.2–0.6	0.16–0.19	5.1–6.0	Moderate	Moderate	Moderate.
100	100	95–100	90–95	0.2–0.6	0.15–0.18	5.1–6.0	High	High	Moderate.
100	100	90–100	90–100	<0.2	0.14–0.17	6.1–8.4	High	High	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	6.1–7.3	Low	High	Low.
100	100	95–100	85–95	<0.2	0.16–0.19	5.6–6.5	Moderate	High	Moderate.
100	100	95–100	90–100	<0.2	0.14–0.18	6.1–8.4	High	High	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	6.1–7.8	Low	High	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	5.6–6.5	Low	Moderate	Low.
100	100	95–100	85–95	0.6–2.0	0.16–0.19	5.1–6.5	Moderate	High	Moderate.
100	100	95–100	85–95	<0.2	0.08–0.15	5.1–6.5	Moderate	High	Moderate.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification			Coarse fraction greater than 3 inches
	Seasonal high water table	Bedrock		USDA texture	Unified	AASHO [1]	
Nicholson NfB—Continued			36–60	Silty clay	MH or CH	A–7	
Nolin:[3] No	>3	>4	0–60	Silt loam	CL or ML	A–6 or A–4	
Otwell:[2] OtA, OtB, OtC	[4] 1½–2	>5	0–8	Silt loam	ML or CL	A–6 or A–4	
			8–21	Silty clay loam	CL or ML	A–6	
			21–63	Silty clay loam (fragipan).	CL or ML	A–6	
Robertsville:[2] Ro	[4] 0–½	>5	0–18	Silt loam	ML or CL	A–4	
			18–60	Silty clay loam (fragipan).	CL or ML	A–6	
Wheeling:[2] WhA, WhD	>5	>10	0–14	Silt loam	ML–CL	A–4	
			14–30	Silty clay loam	ML–CL	A–6	
			30–38	Clay loam	ML	A–4	
			38–54	Very fine sandy loam	ML or SM	A–4	
			54–60	Gravelly sandy loam	SM	A–2	
Woolper: WoA, WoC, WoD	>3	>4	0–6	Silty clay loam	CL	A–6	0–15
			6–60	Silty clay or clay	CL, MH or CH	A–7	0–15
Zipp:[2] Zp	0–½	>10	0–5	Silty clay loam	CL	A–7 or A–6	
			5–60	Silty clay or clay	MH, CH or CL	A–7	

[1] Estimates based on 100 percent passing the 3-inch sieve.
[2] Floods during periods of unusually high streamflow.

merical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which the soil material is plastic.

Town and Country Planning

The limitations of the soils should be considered in planning town and country uses of land. In table 8 the degree and kind of limitations for each soil in this survey are listed for 11 different uses. The information is not intended to eliminate the need for onsite investigations for specific uses, but to serve as a guide for screening sites and for planning more detailed investigations. A rating of *slight* indicates that the limitations, if any, are of minor consequence and are easy to overcome. A rating of *moderate* indicates that corrective measures are needed to overcome the limitation when the soil is used. Cost of corrective measures is an important consideration. A rating of *severe* indicates that corrective measures are needed to overcome the limitations. These measures may be too expensive to justify. Any limitation, however, can be overcome by adequate corrective measures.

The kinds of limitations, expressed in terms of soil characteristics or properties, are shown only for the moderate and severe ratings. Some of the terms may have special meaning. These are defined in the Glossary at the back of this survey.

The criteria used to rate the soils vary somewhat among the different uses. The ratings in table 8 are described in the following paragraphs:

The ratings for septic tank filter fields are based on soil permeability, depth to seasonal high water table, depth to bedrock, surface rockiness and stoniness, slope, and hazard of flooding. Possible pollution hazards to a water supply source are not a consideration here, but this would be a severe limitation on some soils such as those of the Lakin series.

Sewage lagoons are shallow ponds that are used for disposal of sewage by oxidation. The ratings for this use are based on permeability (basin floor), slope, depth to bedrock, percent of coarse fragments, surface stoniness, class of soil material at the site, hazard of flooding, and organic-matter content in the soil.

Sanitary landfills are areas used for disposal of trash and garbage. It is assumed that the operation will be by trench method. No importation of fill or cover material is considered in the ratings. The ratings are based on depth to seasonal high water table, slope, depth to bedrock, surface stoniness and rockiness, texture of the surface layer, and hazard of flooding.

The soils are rated for shallow excavations for basements, pipelines, cemeteries, etc. The ratings are based on the soil properties that affect the ease and amount of excavation. Included are depth to seasonal water table, slope, depth to bedrock, texture, stoniness, and percentage of coarse fragments.

The soils are rated for low building foundations. The ratings are for undisturbed soils that are used to support foundation footings for houses, or other low buildings no higher than three stories. Footings are

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
100	100	95–100	90–95	<0.2	0.08–0.15	5.6–7.8	High	High	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	6.6–7.8	Low	Low	Low.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	5.1–6.5	Low	Moderate	Moderate.
100	100	95–100	75–95	0.6–2.0	0.17–0.21	4.5–5.5	Low	Moderate	Moderate.
100	100	95–100	85–95	<0.2	0.06–0.14	4.5–5.5	Moderate	Moderate	High.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	4.5–6.5	Low	High	Moderate.
100	100	95–100	85–95	<0.2	0.06–0.14	4.5–5.5	Moderate	High	Moderate.
100	100	90–100	70–90	0.6–2.0	0.19–0.23	6.6–7.3	Low	Low	Low.
100	100	95–100	75–95	0.6–2.0	0.17–0.21	6.1–6.5	Low	Moderate	Low.
100	100	90–100	70–80	0.6–2.0	0.16–0.17	5.6–6.0	Low	Low	Moderate.
100	100	70–85	40–55	2.0–6.0	0.08–0.10	5.1–5.5	Low	Low	Moderate.
80–95	75–90	50–60	20–30	>6.0	0.05–0.07	5.1–5.5	Low	Low	Moderate.
95–100	95–100	90–100	80–95	0.2–0.6	0.17–0.21	6.1–7.8	Moderate	Moderate	Low.
95–100	95–100	90–100	85–95	0.2–0.6	0.15–0.18	6.1–7.8	High	High	Low.
100	100	95–100	85–95	0.6–2.0	0.17–0.21	6.6–7.8	Moderate	High	Low.
100	100	95–100	85–95	<0.2	0.15–0.18	6.6–7.8	High	High	Low.

[3] Subject to flooding.
[4] Perched water table.

assumed to be 1 foot wide and a minimum of 18 inches deep. The ratings are based on the depth to the seasonal high water table, depth to bedrock, slope, surface rockiness and stoniness, hazard of flooding, and shrink-swell potential. Slope is more restrictive for subdivision locations than for other areas.

Camp areas are areas used for tents and trailers. The ratings for this use are based on depth to bedrock, permeability, depth to seasonal high water table, surface rockiness and stoniness, texture of surface layer, and hazard of flooding. Slope is more restrictive for trailer parks than for tent areas.

The ratings for streets and low-cost roads are based on depth to seasonal high water table, slope, depth to rock, surface rockiness and stoniness, hazard of flooding, and shrink-swell potential. Slope is a more restrictive factor for parking lots and streets than for main highways.

Playgrounds are areas used intensively for team sports such as baseball, football, volleyball, and other sports that normally require a nearly level, finished area and are subject to heavy foot traffic. The ratings are based on depth to seasonal high water table, soil permeability, slope, depth to bedrock, surface rockiness and stoniness, texture of the surface layer, and hazard of flooding.

Picnic areas are subject to less intensive use than playgrounds. The ratings are based on depth to seasonal high water table, slope, depth to bedrock, surface stoniness and rockiness, texture of the surface layer, and hazard of flooding. These factors are less restrictive for picnic areas than for playgrounds.

The soils are rated for lawns and landscaping with the assumption that soil material at the site, rather than trucked-in fill or topsoil, will be used. The ratings are based on depth to seasonal water table, slope, depth to bedrock, surface stoniness and rockiness, texture of the surface layer, and hazard of flooding.

The ratings for paths and trails are for nonintensive uses such as cross-country hiking and bridle paths that allow random movement of people. It is assumed that the areas will be used as they occur in nature. The ratings are based on depth to seasonal high water table, slope, surface rockiness and stoniness, texture of the surface layer, and hazard of flooding.

Formation and Classification of the Soils

This section has two parts. In the first part, the factors of soil formation and their relation to the soils in Carroll, Gallatin, and Owen Counties are described. In the second part, the system of soil classification is briefly described, and the soil series are placed in some categories of the system.

Factors of Soil Formation

The characteristics of soils depend on climate, on the physical and chemical composition of parent material, on relief, on plant and animal life, and on time. The relative importance of these factors is not con-

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir areas
Alluvial land: AlD. Too variable to be rated.				
Ashton: AsA	Good	Fair: A-4 or A-6; fair compaction qualities.	Subject to flooding in places.	Somewhat porous material allows seepage in places.
Boonesboro: Bo. Alluvial land part too variable to be rated.	Fair: coarse fragments; moderate content of clay.	Fair: bedrock at a depth of 2 to 3½ feet; moderate shrink-swell potential.	Subject to flooding	Excessive seepage in subsoil.
Brashear: BrC, BrD	Poor: coarse fragments; clayey subsoil.	Poor: A-6 to A-7; high shrink-swell potential.	Subject to hillside creep; some steep slopes.	Impervious below a depth of about 3 feet.
Brassfield: BsD	Poor: coarse fragments; slopes of 12 to 25 percent.	Fair: A-4; slopes of 12 to 25 percent; bedrock at a depth of 2 to 3 feet.	Slopes of 12 to 25 percent; bedrock at a depth of 2 to 3 feet.	Porous in places
Eden: EdD, EfE3	Poor: clayey subsoil; some coarse fragments.	Poor: A-7; high shrink-swell potential; slopes of 12 to 30 percent.	Slopes of 12 to 30 percent; some danger of slipping.	Steep side slopes; thin limestone layers allow seepage in places.
Elk: ElA, ElB, ElC	Fair: moderate content of clay.	Poor: A-6; moderate shrink-swell potential.	Subject to flooding in places.	Likely to be porous at lower depths.
Fairmount: FaD, FrF. Rock outcrop part of FrF too variable to be rated.	Poor: coarse fragments; clayey.	Poor: A-7; high shrink-swell potential; slopes of 12 to 60 percent; bedrock at a depth of 1 to 2 feet.	Slopes of 12 to 60 percent; bedrock at a depth of 1 to 2 feet.	Creviced limestone allows seepage in places.
Heitt: HeC	Poor: clayey subsoil	Poor: A-6 or A-7; high shrink-swell potential.	Highly erodible	Thin limestone layers allow seepage in places.
Huntington: Hu	Good	Fair to poor: A-4 to A-6, high organic-matter content.	Subject to flooding	Excessive seepage in subsoil.
Lakin: LaC	Poor: low available water capacity; loamy sand.	Good	Porous sandy material	Porous material
Lawrence: Lc	Fair: moderate content of clay.	Poor: A-6 to A-7; poor compaction qualities.	Subject to flooding in places; seasonal high water table at a depth of 6 inches to 1 foot.	Porous under fragipan in places.
Lowell: LlB, LlC, LoD3	Poor: clayey subsoil	Poor: A-6 to A-7; high shrink-swell potential.	Highly erodible	Impervious material below a depth of 3 feet, but creviced limestone allows seepage in places.
Markland: MaB, MbD	Poor: clayey subsoil	Poor: A-4 to A-7; high shrink-swell potential.	Highly erodible; some steep slopes.	Thin, sandy, porous layers below subsoil in places.
McGary: Mc	Poor: clayey subsoil	Poor: A-7; high shrink-swell potential.	Seasonal high water table at a depth of 6 inches to 1 foot.	Thin, porous, sandy and silty layers below subsoil.

properties of the soils

Soil features affecting—Continued				
Farm ponds—Continued	Drainage of cropland and pasture	Irrigation (sprinkler)	Terraces and diversions	Grassed waterways
Embankments				
Good slope stability	Not applicable	All features favorable	All features favorable	All features favorable.
Bedrock at a depth of 2 to 3½ feet.	Not applicable	Bedrock at a depth of 2 to 3½ feet.	Slopes of 0 to 4 percent; bedrock at a depth of 2 to 3½ feet; coarse fragments.	Stony and gravelly in places.
Poor compaction qualities	Not applicable	Moderately slow permeability.	Some slopes of more than 12 percent; channel highly erodible.	Highly erodible; clayey subsoil.
Bedrock at a depth of 2 to 3 feet.	Not applicable	Bedrock at a depth of 2 to 3 feet.	Slopes of more than 12 percent; bedrock at a depth of 2 to 3 feet.	Slopes of 12 to 25 percent.
Poor compaction qualities	Not applicable	Moderately slow permeability; slopes of 12 to 30 percent.	Slopes of more than 12 percent; coarse fragments.	Slopes of 12 to 30 percent; highly erodible; clayey subsoil.
Good slope stability	Not applicable	All features favorable	All features favorable	All features favorable.
Poor compaction qualities; bedrock at a depth of 1 to 2 feet.	Not applicable	Bedrock at a depth of 1 to 2 feet; slopes of 12 to 60 percent.	Bedrock at a depth of 1 to 2 feet; slopes of more than 12 percent.	Bedrock at a depth of 1 to 2 feet; slopes of 12 to 60 percent.
Poor compaction qualities	Not applicable	Moderately slow permeability.	Channel highly erodible	Highly erodible; clayey subsoil.
Good slope stability	Not applicable	All features favorable	Slopes of 0 to 4 percent	All features favorable.
Poor resistance to piping	Not applicable	Rapid permeability; low fertility.	Subject to channel filling.	Droughty; low fertility.
Good slope stability to a depth of 5 feet.	Slow permeability; seasonal high water table at a depth of 6 inches to 1 foot.	Slowly permeable layer at 1½ to 2½ feet.	Slopes of 0 to 4 percent	Seepy areas.
Poor compaction qualities	Not applicable	Moderately slow permeability.	Channel highly erodible; some slopes of more than 12 percent.	Highly erodible; clayey subsoil.
Poor compaction qualities	Not applicable	Moderately slow permeability.	Channel highly erodible; some slopes of more than 12 percent.	Highly erodible; clayey subsoil.
Poor compaction qualities	Slow permeability; seasonal high water table at a depth of 6 inches to 1 foot; areas of surface ponding.	Slow permeability	Slopes of 0 to 2 percent; clayey subsoil.	Seepy areas; clayey subsoil.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir areas
Newark: Ne	Good	Poor: A–6; poor compaction qualities.	Subject to flooding: seasonal high water table at a depth of 6 inches to 1 foot.	Excessive seepage in substratum.
Nicholson: NfB	Good	Poor: A–6 to A–7; moderate to high shrink-swell potential.	Seasonal high water table at a depth of 2 to 3 feet.	Impervious material below fragipan; creviced limestone layers allow seepage in places.
Nolin: No	Good	Poor: A–6; poor compaction qualities.	Subject to flooding	Excessive seepage in substratum.
Otwell: OtA, OtB, OtC	Fair: moderate content of clay.	Poor: A–6; poor compaction qualities.	Seasonal high water table at a depth of 1½ to 2 feet; flooding in places.	Somewhat porous below fragipan in places.
Robertsville: Ro	Poor: poorly drained	Poor: A–6; poorly drained; poor compaction qualities.	Seasonal high water table at a depth of 0 to 6 inches.	Porous under fragipan in places.
Wheeling: WhA, WhD	Good	Fair: A–4 to A–6; fair compaction qualities.	Subject to flooding in places.	Somewhat porous material below subsoil.
Woolper: WoA, WoC, WoD.	Poor: clayey subsoil	Poor: A–6 to A–7; high shrink-swell potential.	Subject to hillside creep; subject to flooding in places; some slopes of more than 12 percent.	Some slopes of more than 12 percent.
Zipp: Zp	Poor: poorly drained; clayey subsoil.	Poor: A–7; high shrink-swell potential; poorly drained.	Subject to flooding; seasonal high water table at a depth of 0 to 6 inches.	Excessive seepage below subsoil.

stant from one soil to another. In some areas one factor may be the dominant force in the formation of soil characteristics, and in other areas another factor may be dominant. In an area the size of three counties, the factors of climate or plant and animal life are not likely to vary greatly, but there may be differences in relief or parent material. The interrelationships between the five factors are so complex that the effect of any one factor on the formation of a soil is hard to determine. The following is a brief discussion of some of the ways in which these factors influence soil formation in Carroll, Gallatin, and Owen Counties.

Climate

The climate of the survey area is humid and temperate. The average annual precipitation is about 38 inches, and it is fairly well distributed throughout the year. The soils are never dry and are subject to leaching throughout most of the year. The average annual temperature is about 56° F, and the average January temperature is about 43° lower than the average July temperature.

The soils that best show the influence of climate in this area have a leached, acid (unlimed), dark grayish-brown Ap horizon and an illuviated brown, strong-brown, or yellowish-brown Bt horizon that is finer textured than the surface layer. Examples are the well-drained Elk and Lowell soils. The depth of leaching is not great, because the base saturation of most of the soils (within 50 inches of the surface) is more than 35 percent. Lime nodules are at a depth of 2 to 3 feet in the Markland soils, but the upper part of the B horizon is strongly acid.

Parent material

Parent material is the unconsolidated mass in which soils form. It is produced by the weathering or decomposition of rocks and minerals. In this survey area the soils formed from eolian sand, glacial outwash (*13*), stream alluvium, colluvium, loess, and residual material.

The soils on the stream terraces along the Ohio River formed in eolian sand, glacial outwash, and loess. Here, Lakin and Wheeling soils are coarser tex-

properties of the soils—Continued

Soil features affecting—Continued				
Farm ponds—Continued Embankments	Drainage of cropland and pasture	Irrigation (sprinkler)	Terraces and diversions	Grassed waterways
Good slope stability	Subject to stream overflow; seasonal high water table at a depth of 6 inches to 1 foot.	Somewhat poorly drained; seasonal high water table at a depth of 6 inches to 1 foot.	Slopes of 0 to 2 percent	Somewhat poorly drained.
Good to poor compaction qualities.	Not applicable	Slowly permeable layer at a depth of 1½ to 2½ feet.	Slowly permeable layer at a depth of 1½ to 2½ feet.	Some seepage from side slopes.
Good slope stability	Not applicable	All features favorable	Slopes of 0 to 4 percent	All features favorable.
Good slope stability	Slow permeability; perched seasonal water table at a depth of 1½ to 2 feet.	Slowly permeable layer at a depth of 1½ to 2 feet.	Slowly permeable layer at a depth of 1½ to 2 feet.	Some seepage from side slopes.
Good slope stability	Slow permeability; seasonal high water table at a depth of 0 to 6 inches.	Slowly permeable layer at a depth of 1½ to 2½ feet.	Slopes of 0 to 2 percent; poorly drained.	Seepy areas.
Poor resistance to piping	Not applicable	All features favorable	Some slopes of more than 12 percent.	All features favorable.
Poor compaction qualities	Not applicable	Moderately slow permeability.	Channel highly erodible; some slopes of more than 12 percent.	Highly erodible; clayey subsoil.
Poor compaction qualities	Slow permeability; seasonal high water table at a depth of 0 to 6 inches; surface ponding.	Surface puddles in places; slow permeability.	Slopes of 0 to 2 percent; poorly drained; clayey subsoil.	Clayey subsoil; seepy areas.

tured and more permeable than Huntington soils, which formed in more recent material on the flood plains, or the soils that formed along the Kentucky River.

The soils along the Kentucky River and smaller streams formed in alluvium derived mostly from limestone and calcareous shale. Near the mouth of the Kentucky River, Markland and McGary soils formed in clayey alluvium that was deposited in slack water that was backed up by the Ohio River, probably during the ice age. Markland and McGary soils are finer textured and less permeable than Nolin soils, which formed in more recent alluvium on the present flood plains, or Elk soils, which formed in coarser alluvium further upstream. Nolin soils along the Kentucky River are lighter colored than Huntington soils along the Ohio River.

Brashear and Woolper soils formed in colluvium. They are very similar in texture and color to the soils on the hillsides above them, but they have a thicker solum and are deeper to bedrock.

A thin layer of silty material (loess) is on many of the soils on uplands. The loess is generally thinner on the steep hillsides than on the more nearly level ridgetops, probably because much of the loess has been removed by erosion. The upper horizons of Nicholson soils are silty and are thought to have formed in 3 to 4 feet of loess underlain by clayey residuum.

The residual material in the survey area is from limestone, calcareous shale, siltstone, and sandstone of the Ordovician geologic period. On the upper hillsides in the northern part of the area, limestone makes up more than 50 percent of the Bull Fork and Fairview Formations. In the southern part of the area, and on the lower slopes in the northern part, soft calcareous shale makes up more than 50 percent of the Kope Formation. Fairmount soils that formed mostly in limestone residuum are darker colored, thinner, and more rocky than Eden soils, which formed mostly in shale residuum.

Brassfield soils, which occur in a small area in western Carroll County, formed mainly in calcareous sandstone and siltstone residuum. These soils are coarser

TABLE 7.—*Engineering*

[Tests performed by the Kentucky Department of Highways Research Laboratory in accordance

Soil name and location	Parent material	Depth	Moisture-density [1]		Mechanical analyses [2]			
			Maximum dry density	Optimum moisture	Percentage passing sieve—			
					1 inch	⅜ in	No. 4 (4.7 mm)	No. 10 (2.0 mm)
		Inches	*Lb per cu ft*	*Percent*				
Fairmount silty clay: latitude-38°38′35″N, longitude-85°12′24″W (modal).	Thin-bedded limestone.	6–18	99	24	100	100	99	99
Lakin loamy fine sand: latitude-38°43′20″N, longitude-85°05′04″W (modal).	Eolian and alluvial material from Ohio River.	8–43	112	12	100	100	100	100
Lowell silt loam: latitude-38°39′40″N, longitude-85°12′26″N (modal).	Thin-bedded limestone and some shale.	7–22	101	20	100	100	100	100
		22–46	89	28	100	100	100	100
Nicholson silt loam: latitude-38°44′30″N, longitude-85°00′05″W (modal).	Loess over interbedded limestone and shale.	6–20	106	16	100	100	100	100
		38–60	103	21	100	100	100	100
Woolper silty clay loam: latitude-38°40′42″N, longitude-85°12′08″W (modal).	Colluvium from Fairmount soils.	13–34	99	22	100	100	100	100
		34–48	108	17	99	97	97	97

[1] AASHO Designation T99-57, Method A (*2*).

[2] Mechanical analyses according to AASHO Designation T88-57 (*2*). Results by the procedure may differ somewhat from results 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 of the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

textured and more alkaline than Fairmount or Eden soils.

Relief

The relief of the landscape influences the formation of soils primarily through its effect on drainage and erosion. It also influences the formation of soils through variations in exposure to sun and wind, in air drainage, and in plant cover.

In areas of steep soils, a considerable amount of water is lost through runoff and only a small amount of water enters the soil. As a result, erosion is rapid, and the soil material is removed almost as rapidly as it forms. The strongly sloping to steep Eden and Fairmount soils are nearly neutral in reaction and have a thin B horizon. Much of the acreage of these soils is severely eroded.

In areas of nearly level to level soils, a large amount of water enters the soil and there is little or no erosion. The somewhat poorly drained Lawrence soils and the poorly drained Robertsville soils are nearly level. In areas of these soils, there is little or no erosion and the soils have a water table that is perched by a fragipan.

Newark soils are somewhat poorly drained and have a seasonal high water table because they are in low areas on flood plains where water collects. In these positions the soils are accumulating material.

Plant and animal life

Plants affect soil formation mostly by adding organic matter. Animals, bacteria, and fungi mainly contribute to soil formation by converting the remains of plants to organic matter. The organic matter imparts a dark color to the soil material and affects the soil structure.

The soils of this area formed under a hardwood forest. Hardwood trees allow calcium and other bases to leach from the soil more readily than do grasses. In the few remaining undisturbed areas, soils such as Nicholson or Elk have a thin, very dark grayish-brown A1 horizon that has moderate, fine, granular structure; a thin, leached, light-colored A2 horizon that has weak, granular structure; and a brighter colored B horizon that commonly has moderate, medium, subangular blocky structure.

The environment in which the soils in this area formed was changed by man when he cleared the

test data

with standard procedures of the American Association of State Highway Officials (AASHO)

Mechanical analyses [2]—Continued						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued		Percentage smaller than—						AASHO [3]	Unified [4]
No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
						Percent			
98	91	86	72	46	36	55	27	A-7-6(18)	MH-CH
99	22	16	12	4	3	18	1	A-2-4(0)	SM
99	99	93	78	46	36	44	19	A-7-6(12)	ML-CL
99	96	91	82	62	50	73	38	A-7-5(20)	MH-CH
99	95	90	66	36	28	34	9	A-4(8)	ML-CL
99	95	89	77	54	43	55	31	A-7-6(19)	CH
99	95	93	82	52	40	53	24	A-7-6(16)	MH-CH
96	94	87	75	51	39	44	21	A-7-6(13)	CL

[3] Based on AASHO Designation M 145-49 (*2*).

[4] The Soil Conservation Service and the Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within 2 points of the A-line are to be given a borderline classification. Examples of borderline classifications so obtained are MH-CH and ML-CL.

trees. Most areas of the soils have been limed, seeded to grasses and legumes, and plowed many times since the trees were removed. Much erosion has resulted in places. The main change made in the soils by man is the creation of a plow layer instead of a thin, dark, organic mineral layer over a leached layer. Much of the plow layer consists of material from the surface layer and subsoil mixed.

Time

The length of time that the processes of soil formation have been in progress is reflected in the degree of development of the soil profile. An immature soil has very little horizon development, and a mature soil has well-expressed soil horizons.

Soils in this survey area range from immature to mature. Nolin, Huntington, and Newark soils are on flood plains that are subject to overflow. These soils are immature because they receive new sediment during each flood. They have developed only weak structure below the plow layer. Fairmount and Eden soils are somewhat immature, as indicated by a thin B horizon. This is because of excessive erosion during development. Lakin soils are also somewhat immature because of the ability of the sandy material to withstand chemical and physical weathering. They have very little structure in the B horizon. Nicholson and Elk soils are mature and have well-developed horizons.

Classification of the Soils

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

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

TABLE 8.—*Limitations of the soils*

Soil series and map symbols	Estimated degree of limitation and kind of limitation if rating is moderate or severe				
	Septic tank filter fields	Sewage lagoons	Sanitary landfills (trench type)	Shallow excavations	Low building foundations
Alluvial land: AlD	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope
Ashton: AsA	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: silty clay loam subsoil.	Severe: flooding
Boonesboro: Bo	Severe: flooding; bedrock at a depth of 2 to 3½ feet.	Severe: flooding bedrock at a depth of 2 to 3½ feet.	Severe: flooding	Severe: bedrock at a depth of 2 to 3½ feet.	Severe: flooding
Brashear:					
BrC	Severe: Moderately slow permeability.	Severe: slope	Severe: silty clay subsoil.	Severe: silty clay subsoil.	Severe: high shrink-swell potential.
BrD	Severe: slope; moderately slow permeability.	Severe: slope	Severe: slope; silty clay subsoil.	Severe: slope; silty clay subsoil.	Severe: slope; high shrink-swell potential.
Brassfield: BsD	Severe: slope; bedrock at a depth of 2 to 3 feet.	Severe: slope; bedrock at a depth of 2 to 3 feet.	Severe: slope; bedrock at a depth of 2 to 3 feet.	Severe: slope; bedrock at a depth of 2 to 3 feet.	Severe: slope
Eden:					
EdD	Severe: slope; moderately slow permeability.	Severe: slope	Severe: slope; silty clay subsoil.	Severe: slope; silty clay subsoil.	Severe: slope; high shrink-swell potential.
EfE3	Severe: slope; moderately slow permeability.	Severe: slope	Severe: slope; silty clay subsoil.	Severe: slope; silty clay subsoil.	Severe: slope; high shrink-swell potential.
Elk:					
ElA	Severe: flooding	Severe: flooding	Severe: flooding	Slight	Severe: flooding
ElB	Slight	Moderate: slope; moderate permeability.	Slight	Moderate: silty clay loam subsoil.	Moderate: moderate shrink-swell potential.
ElC	Moderate: slope	Severe: slope	Moderate: slope	Moderate: slope; silty clay loam subsoil.	Moderate: slope; moderate shrink-swell potential.
Fairmount:					
FaD	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; silty clay subsoil; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.
FrF. No rating assigned to Rock outcrop part.	Severe: slope; bedrock at a depth of 1 to 2 feet; rock outcrops.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; rock outcrops; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.
Heitt: HeC	Severe: moderately slow permeability.	Severe: slope	Severe: silty clay subsoil.	Severe: silty clay subsoil.	Severe: high shrink-swell potential.
Huntington: Hu	Severe: flooding	Severe: flooding	Severe: flooding	Slight	Severe: flooding
Lakin: LaC	Moderate: slope	Severe: rapid permeability; slope.	Severe: rapid permeability.	Severe: loamy sand subsoil.	Moderate: slope
Lawrence: Lc	Severe: water table at a depth of 6 inches to 1 foot; slow permeability.	Slight	Severe: water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.	Severe: water table at a depth of 6 inches to 1 foot.

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Estimated degree of limitation and kind of limitation if rating is moderate or severe—Continued					
Camp areas	Streets and low-cost roads	Playgrounds	Picnic areas	Lawns and landscaping	Paths and trails
Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Moderate: flooding	Moderate: flooding	Slight	Slight	Slight	Slight.
Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: flooding.
Moderate: slope; moderately slow permeability; silty clay loam surface layer.	Severe: high shrink-swell potential.	Severe: slope	Moderate: slope; silty clay loam surface layer.	Moderate: slope; silty clay loam surface layer.	Moderate: slope; silty clay loam surface layer.
Severe: slope	Severe: slope; high shrink-swell potential.	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Severe: slope	Severe: slope; high shrink-swell potential.	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Severe: slope	Severe: slope; high shrink-swell potential.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Moderate: flooding	Moderate: flooding	Slight	Slight	Slight	Slight.
Slight	Moderate: moderate shrink-swell potential.	Moderate: slope	Slight	Slight	Slight.
Moderate: slope	Moderate: slope; moderate shrink-swell potential.	Severe: slope	Moderate: slope	Moderate: slope	Slight.
Severe: slope	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope	Severe: slope; bedrock at a depth of 1 to 2 feet; flags.	Moderate: slope.
Severe: slope; rock outcrops.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope; bedrock at a depth of 1 to 2 feet.	Severe: slope	Severe: slope; bedrock at a depth of 1 to 2 feet; flags.	Severe: slope; rock outcrops.
Moderate: slope; moderately slow permeability.	Severe: high shrink-swell potential.	Severe: slope	Moderate: slope	Moderate: slope	Slight.
Moderate: flooding	Severe: flooding	Severe: flooding	Moderate: flooding	Moderate: flooding	Moderate: flooding.
Moderate: loamy fine sand surface layer.	Moderate: slope	Severe: slope	Moderate: loamy fine sand; slope.	Moderate: loamy fine sand; slope.	Moderate: loamy fine sand.
Severe: water table at a depth of 6 inches to 1 foot; slow permeability.	Severe: water table at a depth of 6 inches to 1 foot.	Severe: water table at a depth of 6 inches to 1 foot; slow permeability.	Moderate: water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.

TABLE 8.—*Limitations of the soils*

Soil series and map symbols	Estimated degree of limitation and kind of limitation if rating is moderate or severe				
	Septic tank filter fields	Sewage lagoons	Sanitary landfills (trench type)	Shallow excavations	Low building foundations
Lowell:					
LIB	Severe: moderately slow permeability.	Moderate: slope; bedrock at a depth of 40 to 60 inches.	Severe: silty clay subsoil.	Severe: silty clay subsoil.	Severe: high shrink-swell potential.
LIC	Severe: moderately slow permeability.	Severe: slope	Severe: silty clay subsoil.	Severe: silty clay subsoil.	Severe: high shrink-swell potential.
LoD3	Severe: slope; moderately slow permeability.	Severe: slope	Severe: slope; silty clay subsoil.	Severe: slope; silty clay subsoil.	Severe: slope; high shrink-swell potential.
Markland:					
MaB	Severe: slow permeability.	Moderate: slope	Severe: silty clay subsoil.	Severe: silty clay subsoil.	Severe: high shrink-swell potential.
MbD	Severe: slope; slow permeability.	Severe: slope	Severe: slope; silty clay subsoil.	Severe: slope; silty clay subsoil.	Severe: slope; high shrink-swell potential.
McGary: Mc	Severe: slow permeability; water table at a depth of 6 inches to 1 foot.	Slight	Severe: water table at a depth of 6 inches to 1 foot; silty clay subsoil.	Moderate: water table at a depth of 6 inches to 1 foot; silty clay subsoil.	Severe: water table at a depth of 6 inches to 1 foot; high shrink-swell potential.
Newark: Ne	Severe: flooding; water table at a depth of 6 inches to 1 foot.	Severe: flooding	Severe: flooding; water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.	Severe: flooding; water table at a depth of 6 inches to 1 foot.
Nicholson: NfB	Severe: slow permeability.	Moderate: slope	Moderate: silty clay loam subsoil; water table at a depth of 2 to 3 feet.	Moderate: silty clay loam subsoil.	Moderate: water table at a depth of 2 to 3 feet; high shrink-swell potential.
Nolin: No	Severe: flooding	Severe: flooding	Severe: flooding	Slight	Severe: flooding
Otwell:					
OtA	Severe: flooding; water table at a depth of 1½ to 2 feet; slow permeability.	Severe: flooding	Severe: flooding; water table at a depth of 1½ to 2 feet.	Moderate: water table at a depth of 1½ to 2 feet.	Severe: flooding; water table at a depth of 1½ to 2 feet.
OtB	Severe: water table at a depth of 1½ to 2 feet; slow permeability.	Moderate: slope	Severe: water table at a depth of 1½ to 2 feet.	Moderate: water table at a depth of 1½ to 2 feet.	Moderate: water table at a depth of 1½ to 2 feet.
OtC	Severe: water table at a depth of 1½ to 2 feet; slow permeability.	Severe: slope	Severe: water table at a depth of 1½ to 2 feet.	Moderate: slope; water table at a depth of 1½ to 2 feet.	Moderate: slope; water table at a depth of 1½ to 2 feet.
Robertsville: Ro	Severe: water table at a depth of 0 to 6 inches; slow permeability.	Slight	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.
Wheeling:					
WhA	Slight	Severe: moderately rapid permeability.	Slight	Slight	Slight

for town and country planning—Continued

Estimated degree of limitation and kind of limitation if rating is moderate or severe—Continued					
Camp areas	Streets and low-cost roads	Playgrounds	Picnic areas	Lawns and landscaping	Paths and trails
Moderate: moderately slow permeability.	Severe: high shrink-swell potential.	Moderate: slope; moderately slow permeability.	Slight	Slight	Slight.
Moderate: moderately slow permeability.	Severe: high shrink-swell potential.	Severe: slope	Moderate: slope	Moderate: slope	Slight.
Severe: slope	Severe: slope; high shrink-swell potential.	Severe: slope	Severe: slope	Severe: slope	Moderate.
Moderate: slow permeability.	Severe: high shrink-swell potential.	Moderate: slope; slow permeability.	Slight	Slight	Slight.
Severe: slope	Severe: slope; high shrink-swell potential.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Severe: water table at a depth of 6 inches to 1 foot.	Severe: water table at a depth of 6 inches to 1 foot; high shrink-swell potential.	Severe: water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.
Severe: flooding; water table at a depth of 6 inches to 1 foot.	Severe: flooding; water table at a depth of 6 inches to 1 foot.	Severe: flooding; water table at a depth of 6 inches to 1 foot.	Moderate: flooding; water table at a depth of 6 inches to 1 foot.	Moderate: flooding; water table at a depth of 6 inches to 1 foot.	Moderate: water table at a depth of 6 inches to 1 foot.
Severe: slow permeability.	Moderate: water table at a depth of 2 to 3 feet.	Moderate: slope; slow permeability.	Slight	Slight	Slight.
Moderate: flooding	Severe: flooding	Severe: flooding	Moderate: flooding	Moderate: flooding	Moderate: flooding.
Severe: flooding; slow permeability.	Moderate: water table at a depth of 1½ to 2 feet.	Severe: slow permeability.	Slight	Slight	Moderate: water table at a depth of 1½ to 2 feet
Severe: slow permeability.	Moderate: water table at a depth of 1½ to 2 feet.	Severe: slow permeability.	Slight	Slight	Moderate: water table at a depth of 1½ to 2 feet.
Severe: slow permeability.	Moderate: slope; water table at a depth of 1½ to 2 feet.	Severe: slope; slow permeability.	Moderate: slope	Moderate: slope	Moderate: water table at a depth of 1½ to 2 feet.
Severe: water table at a depth of 0 to 6 inches; slow permeability.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches; slow permeability.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.
Slight	Slight	Slight	Slight	Slight	Slight.

TABLE 8.—*Limitations of the soils*

Soil series and map symbols	Estimated degree of limitation and kind of limitation if rating is moderate or severe				
	Septic tank filter fields	Sewage lagoons	Sanitary landfills (trench type)	Shallow excavations	Low building foundations
Wheeling—Continued WhD	Severe: slope	Severe: slope; moderately rapid permeability.	Severe: slope	Severe: slope	Severe: slope
Woolper: WoA	Severe: flooding; moderately slow permeability.	Severe: flooding	Severe: flooding; silty clay subsoil.	Severe: silty clay subsoil.	Severe: flooding; high shrink-swell potential.
WoC	Severe: moderately slow permeability.	Severe: slope	Severe: silty clay subsoil.	Severe: silty clay subsoil.	Severe: high shrink-swell potential.
WoD	Severe: slope; moderately slow permeability.	Severe: slope	Severe: slope; silty clay subsoil.	Severe: slope; silty clay subsoil.	Severe: slope; high shrink-swell potential.
Zipp: Zp	Severe: water table at a depth of 0 to 6 inches; slow permeability.	Slight	Severe: water table at a depth of 0 to 6 inches; silty clay subsoil.	Severe: water table at a depth of 0 to 6 inches; silty clay subsoil.	Severe: water table at a depth of 0 to 6 inches; high shrink-swell potential.

The system of soil classification used was adopted by the National Cooperative Soil Survey in 1965. Because this sytem is under continual study, readers interested in developments of the current system should search the latest literature available (*12, 15*).

The system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this sytem 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 9, the soil series of Carroll, Gallatin, and Owen Counties are placed in four categories of the classification system. Some 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 occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Alf-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 differences resulting from the climate or vegetation.

GREAT GROUP: Each suborder is divided 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 or movement of water, or both; and a thick, dark-colored surface layer. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like.

SUBGROUP: Each great group is 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 may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Hapludalfs (a typical Hapludalf).

FAMILY: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on that are used as family differentiae in table 9.

for town and country planning—Continued

Estimated degree of limitation and kind of limitation if rating is moderate or severe—Continued					
Camp areas	Streets and low-cost roads	Playgrounds	Picnic areas	Lawns and landscaping	Paths and trails
Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Moderate: flooding; silty clay loam surface layer.	Severe: flooding; high shrink-swell potential.	Moderate: silty clay loam surface layer.	Moderate: flooding silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: flooding; silty clay loam surface layer.
Moderate: slope; moderately slow permeability; silty clay loam surface layer.	Severe: high shrink-swell potential.	Severe: slope	Moderate: slope; silty clay loam surface layer.	Moderate: slope; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Severe: slope	Severe: slope; high shrink-swell potential.	Severe: slope	Severe: slope	Severe: slope	Moderate: slope; silty clay loam surface layer.
Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.	Severe: water table at a depth of 0 to 6 inches.

An example is the fine, mixed, mesic family of Typic Hapludalfs.

General Nature of the Counties

This section provides general information about the survey area. It also briefly describes physiography, geology, and relief; climate; farming; and recreation.

Carroll County was the 87th county to be formed in Kentucky. It was created from part of Gallatin County in 1838. This county was named in honor of Charles Carroll, of Maryland, one of the signers of the Declaration of Independence. Gallatin County was the 33rd county to be formed. It was created from parts of Franklin and Shelby Counties in 1798. Gallatin County was named in honor of Albert Gallatin, Secretary of the Treasury under Thomas Jefferson. Owen County was the 62nd county to be formed. This county was created from parts of Gallatin, Pendleton, Franklin, and Scott Counties in 1819. Owen county was named after Colonel Abraham Owen, whose family later settled in Shelby County (*6*).

Soil, water, sand, and gravel are the most important natural resources in the survey area. The abundance of cool, pure water that lies under the beds of sand and gravel along the Ohio River, Kentucky River, and Eagle Creek can be tapped with deep wells. These resources are attracting industry, and speculators are buying large tracts of good farmland along the rivers. Several new plants, such as an electric plant, aluminum plants, and chemical plants, have recently been built along the Ohio River. A large volume of sand and gravel is quarried in Carroll and Gallatin Counties and shipped by river barges or trucks (fig. 13).

Carrollton is the largest town in the area. It has eight looseleaf tobacco warehouses, a tobacco redrying plant, and a furniture factory. There is a boat factory at Sparta, a furniture factory in Warsaw, and a cheese plant in Owenton. Industry is needed in Owen County.

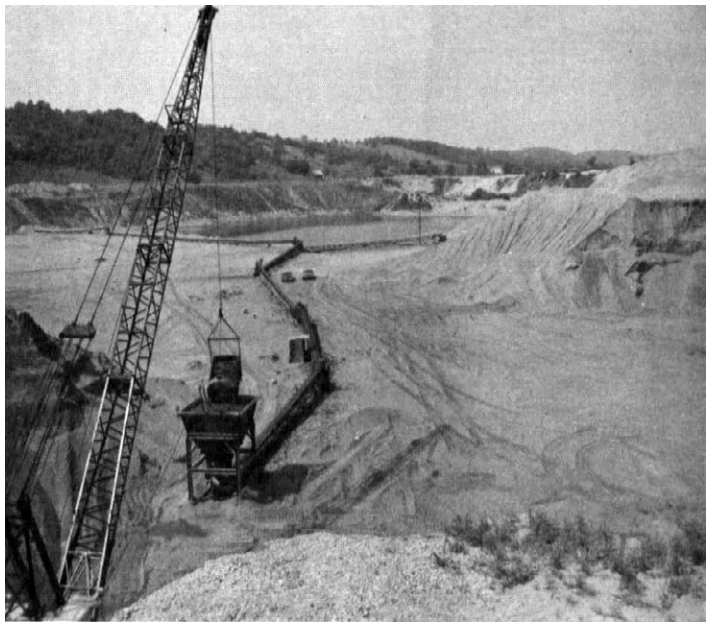

Figure 13.—**Quarrying sand and gravel from material underlying Wheeling soils.**

TABLE 9.—*Classification of the soil series*

Soil series	Family	Subgroup	Order
Ashton	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Boonesboro	Fine-loamy, mixed, mesic	Fluventic Hapludolls	Mollisols.
Brashear	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Brassfield	Fine-loamy, carbonatic, mesic	Rendollic Eutrochrepts	Inceptisols.
Eden	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Elk	Fine-silty, mixed, mesic	Ultic Hapludalfs	Alfisols.
Fairmount	Clayey, mixed, mesic, shallow	Typic Hapludolls	Mollisols.
Heitt	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Huntington	Fine-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Lakin	Mixed, mesic	Alfic Udipsamments	Entisols.
Lawrence	Fine-silty, mixed, mesic	Aquic Fragiudalfs	Alfisols.
Lowell	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Markland	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
McGary	Fine, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Newark	Fine-silty, mixed, nonacid, mesic	Aeric Fluvaquents	Entisols.
Nicholson	Fine-silty, mixed, mesic	Typic Fragiudalfs	Alfisols.
Nolin	Fine-silty, mixed, mesic	Dystric Fluventic Eutrochrepts	Inceptisols.
Otwell	Fine-silty, mixed, mesic	Typic Fragiudalfs	Alfisols.
Robertsville	Fine-silty, mixed, mesic	Typic Fragiaqualfs	Alfisols.
Wheeling	Fine-loamy, mixed, mesic	Ultic Hapludalfs	Alfisols.
Woolper	Fine, mixed, mesic	Typic Argiudolls	Mollisols.
Zipp	Fine, mixed, nonacid, mesic	Typic Haplaquepts	Inceptisols.

The Louisville and Nashville Railroad runs through Carroll and Gallatin Counties. There is no railroad in Owen County. A new interstate highway has been built through Carroll and Gallatin Counties, and there is a new four-lane highway from the interstate highway to Owenton. The Ohio River has considerable capacity for transportation, and there is some transport activity along the Kentucky River.

Physiography, Geology, and Relief

All three counties in the survey area are in the Bluegrass Region of Kentucky. They are underlain by sedimentary rocks of Ordovician age. The southern part of Owen County is in the Hills of the Bluegrass. Most of Carroll and Gallatin Counties are in the Outer Bluegrass, and a small part is in the Hills of the Bluegrass. The Hills of the Bluegrass area is rather steep and is dominantly Eden soils. This area is underlain by calcareous shale and thin beds of limestone and siltstone of the Eden, or Kope, Formation (*13*).

Most of the Outer Bluegrass is rolling to undulating, but it is steep in the western part of Carroll County and is highly dissected. The dominant soils are Nicholson, Lowell, and Fairmount. The Outer Bluegrass is underlain by thin layers of even-bedded limestone and thin layers of shale of the Maysville, or Fairview, Formation (*13*).

The areas along the Ohio River are silty and sandy soils that are generally better drained than the soils along the Kentucky River and Eagle Creek. In those areas the soils are silty to clayey in texture. There are deposits of loess, eolian sand, and glacial outwash along the Ohio River, but the deposits along the Kentucky River and Eagle Creek are of slack-water clay and silty alluvium.

Climate [5]

Carroll, Gallatin, and Owen Counties have a temperate and humid climate. The survey area has an average January temperature of about 34° F., an average July temperature of about 76°, and an average annual temperature of about 56°. Rainfall averages about 38 inches per year. There are no regular wet or dry seasons, and precipitation is relatively well distributed throughout the year. Although droughty conditions occur, rainfall prevents complete crop failure. The climate is favorable for many kinds of plants and animals. The average length of the growing season is about 185 days.

Temperature and precipitation data are given in table 10, and probabilities of freezing temperatures in spring and fall are given in table 11.

Thunderstorms occur on an average of about 50 days a year. They are more frequent from March to August but may occur in any month. Most of the short, high-intensity rains occur in summer as thundershowers. Less intensive rainfall that lasts for several days sometimes occurs in spring and causes tillage to be delayed. Prolonged rainfall generally causes flooding because it occurs when the soils are frozen, snow covered, or saturated. Long periods of mild, sunny weather are typical of the fall harvest season.

The climate of this area is favorable for corn, tobacco, fall-seeded small grain, soybeans, many kinds of grasses and legumes, and many kinds of fruits and vegetables. Moisture conditions in spring are generally favorable for the preparation of the seedbed and for the germination of seed. Germination is retarded in some fall seasons because the soil is dry.

[5] This section was written in collaboration with ALLEN B. ELAM, JR., climatologist for Kentucky, National Weather Service, U.S. Department of Commerce.

TABLE 10.—*Temperature and precipitation* [1]

[Data from National Weather Service Station at Carrollton Lock 1, Carroll County, Ky.]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average high	Average low	Average total	One year in 10 will have—		Days with 1.0 inch or more of snow cover	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	43	24	64	−1	2.9	1.1	7.4	7	3
February	47	26	65	6	3.1	.8	6.2	4	3
March	55	33	74	16	4.3	1.3	7.9	2	4
April	69	44	84	27	3.4	1.6	6.0	0	0
May	77	52	89	36	3.8	1.7	6.9	0	0
June	84	61	94	47	3.6	1.2	7.9	0	0
July	87	65	96	54	3.9	2.0	5.2	0	0
August	86	63	95	51	2.5	1.3	6.0	0	0
September	81	56	93	40	2.7	.8	4.8	0	0
October	71	44	84	28	2.4	.8	4.1	0	0
November	56	35	74	16	2.9	.9	5.7	1	3
December	46	28	65	7	2.8	1.1	4.4	2	2
Year	67	44	[2] 97	[3] −5	38.3	[4] 30.1	[4] 48.5	16	3

[1] Period of record, 1951–70.
[2] Annual average highest temperature.
[3] Annual average lowest temperature.
[4] Based on data from 1892 to 1970.

TABLE 11.—*Probabilities of last freezing temperatures in spring and first in fall* [1]

[Data from National Weather Service at Carrollton Lock 1, Carroll County, Ky.]

Probability	Dates for given probability and temperature				
	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	March 27	April 1	April 12	April 24	May 6
2 years in 10 later than	March 19	March 26	April 6	April 18	May 1
5 years in 10 later than	March 5	March 24	March 25	April 7	April 21
Fall:					
1 year in 10 earlier than	November 23	November 7	October 25	October 15	October 3
2 years in 10 earlier than	November 28	November 13	October 31	October 21	October 8
5 years in 10 earlier than	December 8	November 23	November 10	October 30	October 18

[1] All data based on temperatures in a standard National Weather Service thermometer shelter at a height of about 5 feet above the ground. Lower temperatures occur at times nearer the ground or in local areas subject to air drainage, or both. Based on records from 1951 to 1970.

Farming

According to the 1964 Census of Agriculture, 91.1 percent of Carroll County, 89.6 percent of Gallatin County, and 80.8 percent of Owen County was farmland. There were 496 farms in Carroll County, and the average size was 113.0 acres; 445 farms in Gallatin County, average size 118.7 acres; and 1,125 farms in Owen County, average size 144.7 acres.

Tobacco is the main crop, but the total acreage in tobacco is small. In 1964 there were 162 dairy farms in the three counties and 525 farms that were miscellaneous and unclassified.

Part-time farmers perform a large part of the farming in the survey area. These farmers work full-time off the farm. The trend is toward larger farms and part-time farming.

The University of Kentucky Eden Shale Experiment Station farm is located about 5 miles east of Owenton. This farm is about 1,000 acres in size.

Recreation

Water sports are an important activity on the Kentucky and Ohio Rivers and on Eagle Creek. There is about 50 miles of shoreline along the Kentucky River and about 40 miles of shoreline along the Ohio River that provide ideal camping and boating. Water sports increased after the Markland Lock and Dam on the Ohio River was completed, which raised the level of

the Ohio River and created many new bays and coves. These areas are now lined with boat docks, ramps, and private cabins that are used on weekends and vacations. Owen county has two large fishing lakes and many small private lakes and ponds. Eagle Creek furnishes good fishing, and a new dam has been proposed by the Corps of Engineers.

General Butler State Park is located about 3 miles southeast of Carrollton. It has a beautiful, year-round lodge and a lake and a golf course that attract many tourists. Perry Park, a privately owned recreation area, is located on the Kentucky River in Owen County.

There are two wildlife preserves in Owen County.

Literature Cited

(1) Allan, Philip F., Garland, Lloyd E., and Dugan, R. Franklin. 1963. Rating soils for their suitability for wildlife habitat. Wildlife and Natural Res. Trans.: pp. 247–261.

(2) American Association of State Highway Officials. 1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v. illus.

(3) Beck, Donald E. 1962. Yellow-poplar site index curves. U.S. Dept. of Agr., Forest Serv., Southern Forest Expt. Sta. Research Note No. 180. 2 pp., illus.

(4) Broadfoot, W. M. 1960. Field guide for evaluating cottonwood sites. U.S. Dept. of Agr., Forest Serv., Southeast Forest Expt. Sta. Research Note No. 178. 6 pp., Illus.

(5) Broadfoot, W. M. and Krinard, R. M. 1959. Guide for evaluating sweet gum sites. U.S. Dept. of Agr. Forest Serv., Southeast Forest Expt. Sta. Occas. Paper 176. 8 pp., illus.

(6) Collins, Lewis and Richard H. 1874. Historical sketches of Kentucky, history of Kentucky, 2 v., 804 pp, illus. [Reprinted in 1966].

(7) McCarthy, E. F. 1933. Yellow-poplar characteristics, growth and management. U.S. Dept. of Agr. Tech. Bull. No. 356. 58 pp., illus.

(8) Nelson, T. C., Clutter, J. L. and Chaiken, L. E. 1961. Yield of Virginia pine. U.S. Dept. of Agr. Southeast Forest Expt. Sta., Station Paper 124.

(9) Putnam, John A., Furnival, George M., and McKnight, J. S. 1960. Management and inventory of southern hardwoods. U.S. Dept. of Agr. Handbook 181. 102 pp., illus.

(10) Schnur, G. Luther. 1937. Yield, stand and volume table for even-aged upland oak forests. U.S. Dept. of Agr., Tech. Bull. No. 560, 88 pp., illus. [Reprinted in 1961].

(11) Schumacher, F. X. and Coile, T. S. 1960. Growth and yields of natural stands of the southern pines. T. S. Coile, Inc., Durham, N. C.

(12) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137, No. 3535. pp. 1027–1034.

(13) Swadley, W. C. 1969 [1970]. Geologic map of parts of the Patriot and Florence quadrangles, north-central Kentucky. U.S. Geol. Surv., Geologic quadrangle map No. 846.

(14) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dept. of Agr. Handbook No. 18, 503 pp., illus. [Supplement issued in 1962].

(15) United States Department of Agriculture. 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and September 1968]

(16) United States Department of Defense. 1968. Unified soil classification system for roads, airfields, embankments and foundations. MIL–STD–619B, 30 pp.

Glossary

Acidity. See Reaction, soil.

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.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface. In this area it is either soft unweathered calcareous shale, thin layers of rippable limestone, or both.

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.

Depth, soil. In this survey it refers to the thickness of the soil from the surface to bedrock. The relative terms are: (1) deep, more than 40 inches; (2) moderately deep, 20 to 40 inches; and (3) shallow, less than 20 inches.

Drainage class (natural). 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 have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

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.

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

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flaggy. Soil texture that refers to thin fragments of limestone 6 to 15 inches long. A single piece is a flagstone.

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.

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 horizon to the underlying C horizoin. 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.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

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.

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 reaction; 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

Residuum. Unconsolidated, partly weathered mineral material that accumulates over disintegrating solid rock. Residual material is not soil but is frequently the material in which a soil has formed.

Root zone. The part of the soil that is penetrated, or can be penetrated, by plant roots. Terms used in this survey are (1) shallow, less than 20 inches (2) moderately deep, 20 to 40 inches; and (3) deep, more than 40 inches.

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.

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

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.

Slope, gradient. Terms used in this survey to describe the range of slopes are (1) nearly level, 0 to 2 percent; (2) gently sloping, 2 to 6 percent; (3) sloping, 6 to 12 percent; (4) strongly sloping, 12 to 20 percent; (5) moderately steep, 20 to 30 percent; and (6) steep, more than 30 percent.

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

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

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

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

Subsurface layer. The soil between the surface layer and the subsoil. The part of an A horizon that is designated A2.

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

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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."

Underlying material. Technically the C or R horizon or both the C and R horizons. The layer that is generally unaffected by living organisms. It commonly is under the subsoil but may be under the surface layer.

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

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. In referring to a capability unit, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and extent, table 1, page 8.
Estimated yields, table 2, page 33.
Woodland interpretations, table 3, page 36.
Engineering uses of the soils, tables 5, 6, and 7, pages 42 through 51.
Limitations of soils for town and country planning, table 8, page 52.

Map symbol	Mapping unit	Page	Capability unit	Woodland suitability group
			Symbol	Number
AlD	Alluvial land, steep	6	VIIe-1	----
AsA	Ashton silt loam, 0 to 4 percent slopes	8	I-5	1o2
Bo	Boonesboro-Alluvial land complex	9	Vw-1	1o1
BrC	Brashear silty clay loam, 6 to 12 percent slopes	10	IIIe-2	2c1
BrD	Brashear silty clay loam, 12 to 20 percent slopes	10	IVe-2	2c1
BsD	Brassfield silt loam, 12 to 25 percent slopes	11	VIe-4	4d1
EdD	Eden silty clay loam, 12 to 20 percent slopes	12	VIe-3	3c2
EfE3	Eden flaggy silty clay, 20 to 30 percent slopes, severely eroded	12	VIIe-2	3c2
ElA	Elk silt loam, 0 to 2 percent slopes	13	I-5	2o1
ElB	Elk silt loam, 2 to 6 percent slopes	13	IIe-1	2o1
ElC	Elk silt loam, 6 to 12 percent slopes	13	IIIe-1	2o1
FaD	Fairmount flaggy silty clay, 12 to 20 percent slopes	14	VIe-4	4d1
FrF	Fairmount-Rock outcrop complex, 30 to 60 percent slopes	15	VIIs-2	4x1
HeC	Heitt silt loam, 6 to 12 percent slopes	16	IIIe-2	3c1
Hu	Huntington silt loam	17	I-1	1o1
LaC	Lakin loamy fine sand, 2 to 12 percent slopes	17	IIIs-1	3s1
Lc	Lawrence silt loam	18	IIIw-3	2w1
L1B	Lowell silt loam, 2 to 6 percent slopes	19	IIe-2	2c1
L1C	Lowell silt loam, 6 to 12 percent slopes	19	IIIe-2	2c1
LoD3	Lowell silty clay loam, 12 to 20 percent slopes, severely eroded	19	VIe-10	2c1
MaB	Markland silt loam, 2 to 6 percent slopes	20	IIIe-13	2c1
MbD	Markland soils, 12 to 35 percent slopes	20	VIIe-3	2c1
Mc	McGary silt loam	21	IIIw-2	3w2
Ne	Newark silt loam	22	IIw-1	1w1
NfB	Nicholson silt loam, 2 to 8 percent slopes	23	IIe-5	2o1
No	Nolin silt loam	23	I-1	1o1
OtA	Otwell silt loam, 0 to 2 percent slopes	24	IIw-3	3w1
OtB	Otwell silt loam, 2 to 6 percent slopes	24	IIe-4	3w1
OtC	Otwell silt loam, 6 to 12 percent slopes	24	IIIe-4	3w1
Ro	Robertsville silt loam	25	IVw-1	1w2
WhA	Wheeling silt loam, 0 to 2 percent slopes	27	I-5	2o1
WhD	Wheeling silt loam, 12 to 20 percent slopes	27	IVe-1	2o1
WoA	Woolper silty clay loam, 0 to 2 percent slopes	28	IIs-2	2c1
WoC	Woolper silty clay loam, 6 to 12 percent slopes	28	IIIe-2	2c1
WoD	Woolper silty clay loam, 12 to 20 percent slopes	29	IVe-2	2c1
Zp	Zipp silty clay loam	30	IVw-1	1w2

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