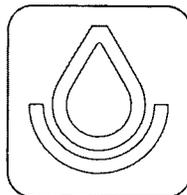


SOIL SURVEY OF

# Hopkins and Rains Counties, Texas

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**United States Department of Agriculture**  
**Soil Conservation Service**  
In cooperation with  
**Texas 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. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1963 to 1971. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Hopkins-Rains Soil and Water Conservation District.

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

## HOW TO USE THIS SOIL SURVEY

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

### Locating Soils

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

### Finding and Using Information

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

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability.

For example, soils that have a slight limitation for a given use can be colored green, those 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 from the discussions of the capability units, the range sites, and the pasture and hayland groups.

*Ranchers and others* can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

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

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

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

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

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

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

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# SOIL SURVEY OF HOPKINS AND RAINS COUNTIES, TEXAS

BY GAYLON L. LANE, SOIL CONSERVATION SERVICE

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

**H**OPKINS AND RAINS COUNTIES are in the northeastern part of Texas (fig. 1). The total land area is 658,560 acres, or 1,029 square miles. The area of Hopkins County is 508,160 acres, and the area of Rains County is 150,400 acres.

Sulphur Springs, the county seat of Hopkins County, serves a productive dairying and livestock farming area. The population of Hopkins County was 20,710 in 1970, and it continues to increase.

Emory, the county seat of Rains County, serves a productive livestock and farming area. The population of Rains County was 3,752 in 1970, and it also continues to increase.

Approximately 83 percent of the land in Hopkins and Rains Counties is used for grazing or for growing hay for livestock. The major farm enterprise is the production of dairy and beef cattle. Hopkins is the leading milk-producing county in Texas, with approximately 600 grade A dairies (fig. 2). Introduced bermudagrass, pensacola bahia, and lovegrass provide most

of the forage for grazing and hay. About 11 percent of the land area in Hopkins and Rains Counties is used for crops. Small grains, truck crops, cotton, corn, and sorghums are the most common crops. Fishing, wildlife habitat, and recreation are economic land uses that contribute to the income of the counties.

Hopkins and Rains Counties are divided into two major physiographic areas—Blackland Prairie and Claypan. Blackland Prairie occupies the northern half and southwest quarter of Hopkins County and the western third of Rains County. Claypan, or “post oak belt,” occupies the southeast quarter of Hopkins County and the eastern two-thirds of Rains County. The major soils of Hopkins and Rains Counties are discussed in the section “General Soil Map.”

## How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Hopkins and Rains Counties, where they are located, and how they can be used. The 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

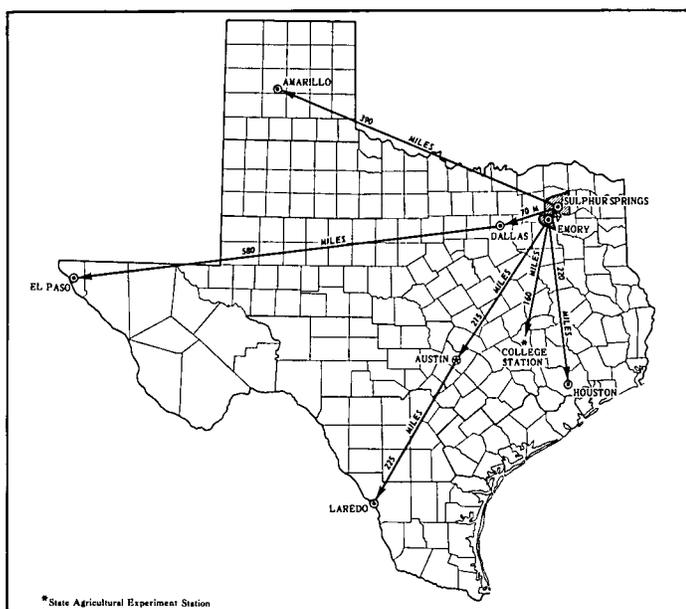


Figure 1.—Location of Hopkins and Rains Counties in Texas.



**Figure 2.**—Dairy barn and grain storage tanks on Wolfpen loamy fine sandy soils.

of that series was first observed and mapped. Crockett and Wilson, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Crockett loam, 1 to 3 percent slopes, is one of several phases within the Crockett series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to

show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Hopkins and Rains Counties: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small 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. Lufkin-Raino complex is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Nahatche soils is an undifferentiated group in Hopkins and Rains Counties.

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 a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations of suitability of soils for present and potential uses.

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

## General Soil Map

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

Each of the seven soil associations in Hopkins and Rains Counties are described in the following paragraphs. The terms for texture used in the title for the associations apply to the texture of the surface layer.

For example, in the title of association 1, the word loamy refers to the texture of the surface layer.

### 1. Crockett Association

*Deep, loamy, moderately well drained, very slowly permeable soils*

This association consists of nearly level to gently sloping soils on uplands. These soils are in large, broad areas that make up about 35 percent of the survey area. Crockett soils make up about 75 percent of the association, and minor soils of the Nahatche, Wilson, Lufkin, and Woodtall series make up the remaining 25 percent.

The Crockett soils have a surface layer of dark grayish-brown loam about 9 inches thick. The subsoil is clay about 36 inches thick. The upper part of it is dark reddish brown, the middle part is dark grayish brown, and the lower part is light olive brown. The underlying material, to a depth of 84 inches, is layers of variegated gray, yellow, and very pale brown clay loam and shale.

Although Crockett soils are used mostly to produce pasture and hay, a small percent of the acreage is cultivated. Improved pastures are increasing, and the present trend is toward livestock operations.

### 2. Woodtall-Freestone Association

*Deep, loamy, moderately well drained, very slowly permeable to slowly permeable soils*

This association consists of sloping and strongly sloping upland soils along sides of drainageways in a landscape of gently sloping ridgetops and interstream divides. These soils make up about 35 percent of the survey area. Woodtall soils make up about 43 percent of the association; Freestone soils, about 30 percent; and minor soils, 27 percent. Minor soils included Nahatche, Lufkin, Raino, and Annona.

Woodtall soils are gently sloping to strongly sloping. They are along sides of drainageways and on oblong, convex ridges. The surface layer is loam and is about 9 inches thick. The upper 3 inches is very dark grayish brown, and the lower 6 inches is yellowish brown. The subsoil is a clay about 37 inches thick. The upper part is yellowish red with grayish-brown mottles, the middle part is red with gray and yellowish-brown mottles, and the lower part is gray with red and yellowish-brown mottles. The next lower layer, to a depth of 58 inches, is light gray with brownish-yellow and red mottles. The underlying material, to a depth of 72 inches, is light olive-brown clay loam and shale with layers of variegated gray and yellow.

Freestone soils are on gently sloping interstream divides. The surface layer is fine sandy loam about 16 inches thick. The upper 3 inches is brown, and the lower 13 inches is yellowish brown. The upper 22 inches of the subsoil is yellowish-brown sandy clay loam that has brown, yellowish-red, and light brownish-gray mottles. The lower 34 inches of it is mottled, light-gray, red, and yellowish-brown clay. The next lower layer, to a depth of 90 inches, is light-gray sandy clay

loam that has brownish-yellow and reddish-yellow mottles.

Woodtell and Freestone soils are used mainly for pasture and hay. While many areas of these soils are in improved pasture, some are in oak forest, and a small percent are cultivated.

### 3. Wolfpen Association

*Deep, sandy, well drained, moderately permeable soils*

This association consists of gently sloping upland soils that make up about 8 percent of the survey area. Wolfpen soils make up about 65 percent of the association, and minor soils, about 35 percent. Minor soils include Pickton, Woodtell, Nahatche, and Freestone.

Wolfpen soils are on oval ridges and interstream divides. The surface layer, to a depth of 27 inches, is loamy fine sand. The upper part is brown, and the lower part is pale brown. The subsoil, to a depth of 100 inches, is sandy clay loam. The upper part is yellowish brown and is mottled in shades of dark yellowish brown, yellowish brown, strong brown yellowish red, grayish brown, and red. The lower part is gray, red, and yellowish brown. It is also mottled.

These soils are used mostly for pasture and hay (fig. 3). A few areas are used mainly to grow truck crops. A few small areas are in pine plantations. These soils also provide a source of sand for construction purposes.

### 4. Wilson-Bazette Association

*Deep and moderately deep, loamy, somewhat poorly drained and well drained, very slowly permeable to slowly permeable soils*

This association consists of nearly level to strongly sloping upland soils that make up about 8 percent of the survey area. Wilson soils make up about 37 percent of the association; Bazette soils, about 25 percent; and minor soils, about 38 percent. Minor soils include Crockett, Ellis, Ferris, Leson, Woodtell, Nahatche, Hopco, and Kaufman.

Wilson soils are nearly level to gently sloping. The surface layer is very dark gray clay loam about 5 inches thick. The subsoil is clay and is about 49 inches thick. The upper part is very dark gray with dark grayish-brown mottles, while the lower part is dark grayish brown with olive-brown mottles. The next lower layer is mottled, gray, strong-brown, and dark-



Figure 3.—Jersey heifers grazing in a pasture of Coastal bermudagrass on Wolfpen loamy fine sand.

gray clay. It extends to a depth of 66 inches. The underlying material, to a depth of 82 inches, is gray and strong brown stratified shale and clay.

Bazette soils are gently sloping to strongly sloping. They are on narrow ridges and along sides of drainage-ways. The surface layer is very dark grayish-brown clay loam about 4 inches thick. The subsoil is clay about 24 inches thick. The upper part is light olive brown with yellowish-brown mottles, while the lower part is olive brown. The underlying material, to a depth of 60 inches, is layers of variegated gray, grayish-brown, and light olive-brown clay and shale.

Most areas of the Wilson soils were formerly cultivated. The trend of land use is now toward pasture and hay. The Bazette soils are mainly in oak timber areas.

## 5. Nahatche Association

*Deep, loamy, somewhat poorly drained, moderately permeable soils on bottom lands*

This association consists of nearly level soils on flood plains. It makes up about 7 percent of the survey area. Nahatche soils make up 95 percent of the association, and minor soils, 5 percent. Gladewater soils are among the minor ones in this association.

Nahatche soils have a dark grayish-brown clay loam surface layer about 7 inches thick. Below this to a depth of 34 inches, the soil material is grayish brown. The upper part of this material is loam that has yellowish-brown and very dark grayish-brown mottles, while the lower part is clay loam that has yellowish-brown and yellowish-red mottles. Between depths of 34 and 65 inches is dark-gray clay loam that has dark yellowish-brown mottles.

Most areas of Nahatche soils are used for pasture and hay. Other areas are predominantly in hardwood trees.

## 6. Kaufman-Gladewater Association

*Deep, clayey, somewhat poorly drained and poorly drained, very slowly permeable soils on bottom lands*

This association consists of nearly level soils on flood plains. They make up about 4 percent of the survey area. Kaufman soils make up 41 percent of the association; Gladewater soils, 35 percent; and minor soils, 24 percent. Minor soils include Nahatche and Hopco.

Kaufman soils have a surface layer of black clay about 64 inches thick. The underlying material, to a depth of 84 inches, is very dark gray.

Gladewater soils have a surface layer of black clay about 5 inches thick. The next lower layer, about 4 inches thick, is very dark gray clay that has dark yellowish-brown and dark-brown mottles. Below this, to a depth of 65 inches, is dark-gray clay that has yellowish-brown, dark yellowish-brown, and olive-brown mottles.

Open areas of Kaufman and Gladewater soils are used mainly for pasture and hay, but about half the area of this association is used to produce hardwood trees. These are used for firewood, fenceposts, and

lumber. They also provide cover for white-tailed deer and squirrels.

## 7. Bernaldo-Kirvin Association

*Deep, loamy, well-drained, moderately permeable to moderately slowly permeable soils*

This association consists of gently sloping and sloping soils on uplands. They make up about 3 percent of the survey area. Bernaldo soils make up about 52 percent of the association; Kirvin soils, 19 percent; and minor soils, 29 percent. Minor soils include Nahatche, Freestone, Annona, Raino, and Woodtell.

Bernaldo soils are gently sloping. They are on ridges and interstream divides. These soils have a surface layer of fine sandy loam about 10 inches thick. The upper 3 inches is dark grayish brown, and the lower 7 inches is yellowish brown. The subsoil, to a depth of about 80 inches, is sandy clay loam. The upper part is yellowish brown and has red and yellowish-red mottles. The lower part is red, yellowish brown, gray, and reddish yellow. It, too, has mottles.

Kirvin soils are gently sloping to sloping. They are on oval, convex ridges. These soils have a surface layer of gravelly fine sandy loam about 12 inches thick. The upper 4 inches of it is dark brown, and the lower 8 inches is brown. The subsoil is clay about 19 inches thick. The upper part is yellowish red, and the lower part is red. The lower part has strong-brown mottles. The next lower layer, about 12 inches thick, is sandy clay loam. It has yellowish-red, red, and yellowish-brown mottles. The underlying material, to a depth of 64 inches, is stratified layers of yellowish-brown, reddish-yellow, pinkish-gray, and red sandy clay loam, clay loam, and weakly cemented sandstone.

Although these soils are used mostly for pasture and hay, a few small areas are cultivated. Wooded areas consist of pine and hardwood trees. The Kirvin soils in this association provide a source of gravel.

## Descriptions of the Soils

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

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the 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 either stated in describing the mapping unit or are apparent in the name of the mapping unit.

Preceding the name of each mapping unit is a symbol. 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 pasture and hayland group in which the mapping unit has been placed. The page for each soil mapping unit and each capability unit, range site, pasture and hayland group, or other interpretative group can be found 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 (8).<sup>1</sup>

### Annona Series

The Annona series consists of deep and nearly level loamy soils on uplands and old terraces. These soils formed in clayey and loamy sediment under a plant community of oak trees and native grass.

In a representative profile the surface layer is loam about 9 inches thick. This layer is very dark grayish brown in the upper 3 inches and yellowish brown in the lower 6 inches. The subsoil, to a depth of 68 inches, is mottled clay. The upper 7 inches of it is yellowish red, the next 8 inches is red, the next 30 inches is yellowish brown, and the lower 14 inches is light yellowish brown. The next lower layer, to a depth of 95 inches, is a mottled clay loam.

Annona soils are somewhat poorly drained. Permeability is very slow in these soils, and available water capacity is high.

These soils are used mainly for pasture.

Representative profile of Annona loam in an intermountain area of Annona-Raino complex, 5.7 miles east of Sulphur Springs on Texas Highway 11, 3.8 miles south on Farm Road 1569, 3.6 miles southeast on Farm Road 2948, and 50 feet north of road:

- A1—0 to 3 inches, very dark grayish-brown (10YR 4/2) loam; weak, fine, subangular blocky structure; hard, very friable; many roots; strongly acid; clear, smooth boundary.
- A2—3 to 9 inches, yellowish-brown (10YR 5/4) loam; few medium, faint, light-gray (10YR 7/1) mottles; weak, medium, subangular blocky structure; hard, very friable; few roots; many fine and medium pores; few black concretions; very strongly acid; clear, wavy boundary.
- B21t—9 to 16 inches, yellowish-red (5YR 5/8) clay; few medium, light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; very hard, firm; few roots; few clay films; few black concretions; very strongly acid; gradual, wavy boundary.
- B22t—16 to 24 inches, prominently mottled red (2.5YR 4/8), light yellowish-brown (10YR 5/8), and light brownish-gray (10YR 6/2) clay; moderate, medium, blocky structure; extremely hard, very firm; few

roots; common clay films; few pressure faces; few black concretions; very strongly acid; gradual, wavy boundary.

- B23t—24 to 43 inches, yellowish-brown (10YR 5/8) clay; many, medium, distinct light-gray (10YR 7/1) and common, medium, distinct yellowish-red (5YR 5/6) mottles; moderate, medium, blocky structure; extremely hard, very firm; few roots; many clay films; common pressure faces; few black concretions; very strongly acid; gradual, wavy boundary.
- B24t—43 to 54 inches, yellowish-brown (10YR 5/4) clay; common, medium, distinct light-gray (10YR 7/1) and few, fine, distinct reddish-yellow (7.5YR 6/6) mottles; moderate, medium, blocky structure; extremely hard, very firm; few roots; many clay films; common slickensides; few black concretions; strongly acid; gradual, wavy boundary.
- B25t—54 to 68 inches, light yellowish-brown (10YR 6/4) clay; many, medium, faint, light brownish-gray (10YR 6/2) and common, medium, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, blocky structure; extremely hard, very firm; few roots; few clay films, few slickensides; common black concretions; medium acid; gradual, wavy boundary.
- B3—68 to 95 inches, light brownish-gray (2.5Y 6/2) clay loam; common, fine and medium light gray (10YR 7/1) and brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; hard, firm; few roots; few patchy clay films; few black concretions; few white, neutral salt masses; slightly acid.

The solum is 60 to about 100 inches thick. Texture of the A horizon is loam or fine sandy loam. In the A horizon reaction ranges from very strongly acid to slightly acid. The A1 horizon is very dark grayish brown, dark grayish brown, or brown. The A2 horizon is yellowish brown, pale brown, and light yellowish brown. The combined A horizons are 6 to 12 inches thick.

The Bt horizon is clay or clay loam that is 35 to 55 percent clay. Reaction ranges from very strongly acid in the upper part to moderately alkaline in the lower part. The B21t horizon is yellowish red or red and has few to many mottles of gray, grayish brown, light brownish gray, and yellowish brown. The B22t and B23t horizons are red, yellowish brown, or yellowish red. They have mottles of light yellowish brown, light brownish gray, light gray, yellowish red, red, or gray. The B24t, B25t, and B3 horizons have mottles of yellowish brown, light gray, reddish yellow, light yellowish brown, light brownish gray, brownish yellow, gray, or red.

**Ar—Annona-Raino complex.** This nearly level soil complex is on ridgetops or stream divides. Mapped areas are irregular in shape, and they range from 20 to about 300 acres in size. Surfaces are uneven, and circular and elongated low mounds 1 to 3 feet higher than the intermountain areas are present. Circular mounds are 20 to 80 feet in diameter; elongated mounds are 30 to 200 feet long and 10 to 60 feet wide. The overall slope is less than 1 percent. The mounds consist mainly of the Raino soil, and the intermountain areas consist mainly of Annona soils. The Raino soil has the profile described as representative of the Raino

Annona soils make up about 45 percent of this complex; the Raino soil, 35 percent; and soils that are in too intricate a pattern to be delineated at the scale of mapping used, 20 percent.

Included with these soils in mapping are areas of Lufkin and Freestone soils less than 3 acres in size. Lufkin soils are in low, wet spots in intermountain areas.

Runoff is slow on these Annona-Raino soils, and water ponds on the surface of the Annona soils during wet periods.

<sup>1</sup> Italic numbers in parentheses refer to Literature Cited, p. 57.

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

| Soil   | Hopkins County |              | Rains County   |                  | Survey Area    |              |
|--|----------------|--------------|----------------|------------------|----------------|--------------|
|  | Acres          | Percent      | Acres          | Percent          | Acres          | Percent      |
| Annona-Raino complex .....                                   | 15,500         | 3.0          | 5,450          | 3.6              | 20,950         | 3.2          |
| Bazette clay loam, 3 to 5 percent slopes .....               | 4,000          | .8           | 380            | .3               | 4,380          | .7           |
| Bazette clay loam, 5 to 12 percent slopes .....              | 9,100          | 1.8          | 1,300          | .9               | 10,400         | 1.6          |
| Bernaldo fine sandy loam, 1 to 3 percent slopes .....        | 11,200         | 2.2          | 1,550          | 1.0              | 12,750         | 2.0          |
| Crockett loam, 0 to 1 percent slopes .....                   | 9,400          | 1.9          | 600            | .4               | 10,000         | 1.5          |
| Crockett loam, 1 to 3 percent slopes .....                   | 95,784         | 18.9         | 18,000         | 12.1             | 113,784        | 17.3         |
| Crockett loam, 3 to 5 percent slopes .....                   | 3,900          | .8           | 200            | .1               | 4,100          | .6           |
| Crockett loam, 2 to 5 percent slopes, eroded .....           | 44,900         | 8.9          | 5,000          | 3.3              | 49,900         | 7.6          |
| Ellis clay, 5 to 12 percent slopes .....                     | 2,800          | .5           | 80             | ( <sup>1</sup> ) | 2,880          | .5           |
| Ferris clay, 5 to 12 percent slopes, eroded .....            | 4,400          | .9           | 120            | ( <sup>1</sup> ) | 4,520          | .7           |
| Freestone fine sandy loam, 1 to 3 percent slopes .....       | 51,494         | 10.1         | 22,652         | 15.1             | 74,146         | 11.3         |
| Gladewater clay .....  | 2,000          | .4           | 11,250         | 7.5              | 13,250         | 2.0          |
| Heiden clay, 3 to 5 percent slopes, eroded .....             | 700            | .1           | -----          | -----            | 700            | .1           |
| Hopco silty clay loam .....                                  | 2,600          | .5           | -----          | -----            | 2,600          | .4           |
| Kaufman clay .....   | 14,600         | 2.9          | -----          | -----            | 14,600         | 2.2          |
| Kirvin gravelly fine sandy loam, 3 to 8 percent slopes ..... | 3,400          | .7           | -----          | -----            | 3,400          | .5           |
| Kirvin soils, 3 to 8 percent slopes .....                    | 500            | .1           | 150            | .1               | 650            | .1           |
| Leson clay, 1 to 3 percent slopes .....                      | 3,000          | .6           | 350            | .2               | 3,350          | .5           |
| Leson clay, 3 to 5 percent slopes .....                      | 4,100          | .8           | 60             | ( <sup>1</sup> ) | 4,160          | .6           |
| Lufkin-Raino complex .....                                   | 15,500         | 3.0          | 6,480          | 4.3              | 21,980         | 3.3          |
| Nahatche soils .....   | 75,024         | 14.8         | 16,400         | 10.9             | 91,424         | 13.9         |
| Pickton loamy fine sand, 1 to 5 percent slopes .....         | 2,900          | .6           | 1,230          | .8               | 4,130          | .6           |
| Wilson clay loam, 0 to 2 percent slopes .....                | 16,500         | 3.2          | 3,530          | 2.3              | 20,030         | 3.0          |
| Wolfpen loamy fine sand, 1 to 5 percent slopes .....         | 28,200         | 5.5          | 8,250          | 5.5              | 36,450         | 5.5          |
| Woodtell loam, 2 to 5 percent slopes .....                   | 51,882         | 10.2         | 14,600         | 9.7              | 66,482         | 10.0         |
| Woodtell loam, 5 to 12 percent slopes .....                  | 32,500         | 6.4          | 21,900         | 14.7             | 54,400         | 8.3          |
| Woodtell stony loam, 1 to 5 percent slopes .....             | 1,700          | .3           | 500            | .3               | 2,200          | .3           |
| Water .....  | 576            | .1           | 10,368         | 6.9              | 10,944         | 1.7          |
| <b>Total</b> .....   | <b>508,160</b> | <b>100.0</b> | <b>150,400</b> | <b>100.0</b>     | <b>658,560</b> | <b>100.0</b> |

<sup>1</sup> Less than 0.05 percent.

About 60 percent of the acreage of the soils in this complex is in oak trees that have an understory of native grasses. Open areas are used mainly for pasture of introduced and native grasses. Examples of adapted grasses and legumes grown in places on these soils are bermudagrass, bahiagrass, lovegrass, vetch, crimson clover, and arrowleaf clover. The soils of this complex are not well suited to crops, but grain sorghum and hay are grown in places.

Surface drainage systems help to remove excess water. Returning crop residue to the soil and turning it under near the surface help to maintain soil tilth and improve infiltration. Lime is needed for some kinds of legumes. Capability unit IIIw-2; pasture and hayland group 8A.

### Bazette Series

The Bazette series consists of moderately deep, gently sloping to strongly sloping, loamy soils on uplands. These soils formed in clay and shale alkaline sediment under tall and mid grasses.

In a representative profile the surface layer is very dark grayish-brown clay loam about 4 inches thick. The subsoil is light olive-brown clay about 18 inches thick. The next lower layer, to a depth of 28 inches, is olive-brown clay. The underlying material, to a depth of 60 inches, is variegated layers of gray, grayish-brown, and light olive-brown shale and clay that contains a few concretions and soft masses of calcium carbonate.

Bazette soils are well drained. Permeability is slow in these soils, and available water capacity is medium. These soils are used mainly for native pasture.

Representative profile of Bazette clay loam, 5 to 12 percent slopes, 9 miles north of Sulphur Springs on Texas Highway 154, 6 miles east on Farm Road 71, 1.4 miles north on Farm Road 1563, 0.7 mile west on county road, and 90 feet south of county road:

- A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) clay loam; moderate, medium, granular structure; slightly hard, friable; many roots; neutral; clear, smooth boundary.
- B21t—4 to 22 inches, light olive-brown (2.5Y 5/4) clay; few, fine and medium, faint, yellowish-brown (10YR 5/4) mottles; moderate, medium, subangular blocky structure; very hard, very firm; few roots; many clay films; slightly acid; gradual, wavy boundary.
- B3—22 to 28 inches, olive-brown (2.5Y 4/4) clay; moderate, medium, blocky structure; very hard, firm; few roots; about 20 percent yellowish-brown shale fragments; few calcium carbonate concretions in lower part; neutral; gradual, wavy boundary.
- C—28 to 60 inches, variegated layers of gray (2.5Y 5/0), grayish-brown (2.5Y 5/2), and light olive-brown (2.5Y 5/4) clay and shale; massive; very hard, very firm; few roots; about 3 percent soft, powdery calcium carbonate masses; moderately alkaline.

The solum is 24 to 40 inches thick. In the A horizon reaction ranges from medium acid to neutral. It is very dark grayish brown, dark grayish brown, very dark brown, and brown. The A horizon is 3 to 6 inches thick.

The Bt horizon is clay, silty clay, or clay loam. Reaction ranges from medium acid to neutral. The Bt and B3 horizons are light olive brown, olive brown, and yellowish brown. They have few to common mottles in shades of

brown and yellow. The B3 horizon is 5 to 20 percent gray and yellow shale fragments. Soft masses, films, and concretions of calcium carbonate are in the lower part of the B3 horizon and in the C horizon of most of these soils.

The C horizon is massive and consists of gray, brown, and yellow clay, silty clay, and silty clay loam thinly bedded with shale. It is slightly acid to moderately alkaline.

**BaC—Bazette clay loam, 3 to 5 percent slopes.** This gently sloping soil occupies narrow ridges and is along sides of small drainageways. Mapped areas are about 20 to 75 acres in size.

The surface layer is dark grayish-brown clay loam about 5 inches thick. The subsoil is olive-brown clay about 24 inches thick. The next lower layer is light olive-brown clay. The underlying material is olive-brown, yellowish-brown, and gray layers of shale and clay. It contains a few calcium carbonate concretions and soft masses.

Runoff is rapid on this soil. The erosion hazard is very severe if the surface is bare and unprotected.

The vegetation on this soil consists of native and introduced grasses used mostly for pasture. About 50 percent of the total area is in oak trees that have an understory of native grasses.

In places adapted grasses and legumes are grown on this soil. Examples of these are bermudagrass, bahia-grass, lovegrass, vetch, crimson clover, and arrowleaf clover. Small grain, grain sorghum, and hay are grown on this soil, even though it is not well suited to crops.

Contour farming, terracing, and keeping grass on waterways help control the hazard of erosion and excess runoff. Returning crop residue on the surface helps to reduce the hazard of erosion and maintain soil tilth. Lime is needed for some legumes. Capability unit IVe-1; pasture and hayland group 8B.

**BaD—Bazette clay loam, 5 to 12 percent slopes.** This sloping to strongly sloping soil is on side slopes paralleling rivers and large drainageways. Areas are narrow and long, ranging from about 30 to 150 acres in size. This soil has the profile described as representative for the Bazette series.

Included with this soil in mapping are small areas of Woodtall loam, 5 to 12 percent slopes, and Ellis clay, 5 to 12 percent slopes. These two soils make up less than 15 percent of any one area.

Runoff is very rapid. The erosion hazard is very severe.

Most areas of this soil are used for native pasture and, to a lesser extent, for wildlife habitat. About 75 percent of the total area is in oak trees that have an understory of native grasses.

Some adapted grasses and legumes are grown on this soil. Examples of these are bermudagrass, lovegrass, crimson clover, arrowhead clover, and singletary peas.

This soil is not suitable for cropland because of hazard of erosion. Permanent cover is needed to prevent erosion. Capability unit VIe-1; pasture and hayland group 8B.

### Bernaldo Series

The Bernaldo series consists of deep, gently sloping, loamy soils on uplands. These soils formed in loamy,

unconsolidated sediment under mixed oak and pine trees.

In a representative profile the surface layer is fine sandy loam about 10 inches thick. This layer is dark grayish brown in the upper 3 inches and yellowish brown in the lower 7 inches. The subsoil is sandy clay loam to a depth of 80 inches. The upper part of it is yellowish brown. The lower part is mottled and is red, yellowish brown, reddish yellow, gray, and red.

Bernaldo soils are well drained. Permeability is moderate and available water capacity is high. These soils are used mainly for pasture.

Representative profile of Bernaldo fine sandy loam, 1 to 3 percent slopes, 11.5 miles east of Sulphur Springs on Texas Highway 11, 2.6 miles south on county road, and 80 feet south of county road:

- A1—0 to 3 inches, dark grayish-brown (10YR 4/2) fine sandy loam; weak, very fine, subangular blocky structure; hard, very friable; many roots; slightly acid; clear, smooth boundary.
- A2—3 to 10 inches, yellowish-brown (10YR 5/4) fine sandy loam; single grained; hard, very friable; many roots; few fine and medium pores; slightly acid; clear, smooth boundary.
- B21t—10 to 16 inches, yellowish-brown (10YR 5/6) sandy clay loam; weak, fine, subangular blocky structure; very hard, friable; few roots; few patchy clay films; common fine pores; medium acid; gradual, wavy boundary.
- B22t—16 to 28 inches, yellowish-brown (10YR 5/8) sandy clay loam; common, medium, distinct yellowish-red (5YR 4/6) mottles; moderate, medium and fine, subangular blocky structure; very hard, friable; few roots; continuous clay films; common medium pores; slightly acid; gradual, wavy boundary.
- B23t—28 to 48 inches, yellowish-brown (10YR 5/8) sandy clay loam; many, medium, distinct red (2.5YR 4/6) mottles; moderate, medium, subangular blocky structure; very hard, friable; few roots; common clay films; few black concretions; medium acid; gradual, irregular boundary.
- B24t & A'2—48 to 66 inches, mottled, red (10YR 4/6), yellowish-brown (10YR 5/6), and reddish-yellow (7.5YR 6/8) sandy clay loam; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, friable; few roots; few patchy clay films on faces of peds and along root channels; about 10 percent of horizon made up of light-gray uncoated sand and silt grains on vertical faces of prisms that have streaks and pockets 2 to 10 millimeters wide and 10 to 20 centimeters long; few black concretions; very strongly acid; diffuse, gradual boundary.
- B25t—66 to 80 inches, reddish-yellow (7.5YR 6/8) sandy clay loam; common, medium, distinct gray (10YR 5/1) and red (2.5YR 4/6) mottles; weak, medium, subangular blocky structure; very hard, friable; few roots; few patchy clay films; few streaks of uncoated sand; medium acid.

The solum is 60 to more than 100 inches thick. In the A horizon reaction ranges from strongly acid to slightly acid. The A1 or Ap horizon is dark grayish brown, dark brown, brown, and dark yellowish brown. The A2 horizon is brown, yellowish brown, pale brown, or light brownish gray. The A1 or Ap horizon is 2 to 6 inches thick, while the thickness of the entire A horizon is 8 to 20 inches.

The B2t horizon is sandy clay loam, loam, or clay loam. Reaction is very strongly acid to slightly acid. The upper part of the B2t horizon is yellowish brown, strong brown, or light yellowish brown. The lower part is mottled in shades of brown, yellow, red, and gray, but gray mottles are not present above a depth of 30 inches. The B24t and A'2 hori-

zon is 5 to 15 percent, uncoated sand and silt grains in the form of streaks, coatings, and pockets.

**BeB—Bernaldo fine sandy loam, 1 to 3 percent slopes.** This gently sloping soil is on narrow ridges and interstream divides. Areas are irregular in shape. They are generally about 50 acres in size but range to 300 acres. Included in mapping are areas of Freestone soils that are in low, wet spots and are less than 3 acres in size.

Runoff is slow on this Bernaldo soil. The erosion hazard is moderate.

Although most areas of this soil were cultivated in the past, they are now used mainly for meadows of pasture and hay. A few areas, however, are being cultivated. Corn, truck crops, hay, and small grains are grown on this soil. In places adapted grasses and legumes are grown. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, arrowleaf clover, vetch, singletary peas, and lespedeza.

Contour farming and terracing help control erosion. Diversion terraces and grassed waterways help control outside or excess runoff water. Lime is needed for most crops and pastures. Returning crop residue to the surface helps maintain soil tilth and control hazard of erosion. Capability unit IIe-1; pasture and hayland group 8C.

### Crockett Series

The Crockett series consists of deep, nearly level to gently sloping, loamy soils on uplands. These soils formed in alkaline shale and clay under mid and tall grasses.

In a representative profile the surface layer is dark grayish-brown loam about 9 inches thick. The subsoil is clay about 36 inches thick. The upper part is mottled dark reddish brown; the middle part is mottled dark grayish brown; and the lower part is mottled light olive brown. The underlying material, to a depth of 84 inches, is variegated layers of gray, yellow, and very pale brown clay loam and shale.

Crockett soils are moderately well drained. Permeability is very slow in these soils, and available water capacity is high.

These soils are used mainly for pasture.

Representative profile of Crockett loam, 1 to 3 percent slopes, 6.6 miles west of Sulphur Springs on Texas Highway 11; 1 mile north on county road and 250 feet east of county road:

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) loam; few, fine, distinct yellowish-brown (10YR 5/4) mottles; weak, fine and medium, subangular blocky structure; very hard, very friable; many roots; slightly acid; abrupt, wavy boundary.

B21t—9 to 18 inches, dark reddish-brown (5YR 3/3) clay; common, medium, distinct, dark-gray (10YR 4/1) mottles; moderate, fine and medium, blocky structure; extremely hard, very firm; common roots; many clay films; few pressure faces; slightly acid; gradual, wavy boundary.

B22t—18 to 36 inches, dark grayish-brown (2.5Y 4/2) clay; few, fine, distinct, dark reddish-brown (5YR 3/2) mottles; weak, coarse, blocky structure parting to moderate, fine, blocky; extremely hard, very firm; few roots; common clay films; common slickensides;

few fine calcium concretions in lower part of horizon; neutral; gradual, wavy boundary.

B3tca—36 to 45 inches, light olive-brown (2.5Y 5/4) clay; common, fine and medium, distinct, dark-gray (10YR 4/1) and yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; extremely hard, firm; few roots; few patchy clay films; common calcium carbonate concretions and few, soft, masses, calcareous, moderately alkaline; gradual, wavy boundary.

C—45 to 84 inches, thin layers of gray (10YR 5/1), yellow (10YR 7/6), and very pale-brown (10YR 7/4) clay loam and shale; massive with evident bedding planes; extremely hard, very firm; few calcium carbonate concretions and soft masses in upper part of horizon; noncalcareous; moderately alkaline.

The solum is about 40 to 60 inches thick. The A horizon is dark grayish brown, dark brown, brown, and very dark grayish brown. It is 4 to 15 inches thick. Reaction ranges from medium acid to neutral.

The Bt horizon is clay or sandy clay. The dominant color of the matrix and the degree of mottling in the B21t horizon are extremely variable within distances of a few feet. They range from a matrix prominently mottled in shades of brown, red, and olive to a reddish-brown matrix having few to common mottles of brown, yellow, and gray. The lower Bt horizons are mainly shades of brown and olive. It ranges from medium acid to mildly alkaline.

The C horizon is clay loam, loam, sandy clay loam, and shaly clay interbedded with shale. Colors are in shades of brown, gray, and yellow. This horizon is mildly or moderately alkaline with or without calcium carbonate concretions and masses.

**CrA—Crockett loam, 0 to 1 percent slopes.** This nearly level soil is on broad interstream divides. Mapped areas are oval shaped and range from 20 to 200 acres in size.

The surface layer is brown loam about 6 inches thick. The subsoil is clay about 47 inches thick. The upper part is brown and has common reddish-brown mottles, and the lower part is olive brown. The underlying material, to a depth of 84 inches, is layers of variegated light olive-brown, olive-yellow, and light brownish-gray loam. It is interbedded with shale.

Included with this soil in mapping in low, wet spots, are areas of Wilson less than 5 acres. They make up less than 15 percent of the total acreage.

Runoff is slow on this Crockett soil. The erosion hazard is slight.

The vegetation on this soil consists of introduced or native grasses used mainly for pasture. Some areas are cultivated.

Cotton, corn, hay, and small grain are the principal crops grown on this soil. In places adapted grasses and legumes are grown. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, vetch, and arrowleaf clover. Returning crop residue to the surface helps improve soil tilth. Lime is needed for some legumes. Capability unit IIIs-1; pasture and hayland group 8A.

**CrB—Crockett loam, 1 to 3 percent slopes.** This gently sloping soil is on broad interstream divides. Areas vary in size and shape and range from about 20 acres to several thousand acres in size. This soil has the profile described as representative for the Crockett series.

Included with this soil in mapping are small areas

of Crockett loam, 2 to 5 percent slopes, eroded, and small areas of Wilson soils. The eroded Crockett soil occupies the more sloping parts of the landscape. The Wilson soils are in low, wet spots. These inclusions make up less than 10 percent of the acreage.

Runoff is slow and the erosion hazard is moderate.

This soil is used mainly for pastures of introduced grasses. In places, however, areas are used for native pasture or are cultivated. Cotton, grain sorghum, small grain, corn, and hay are principal crops grown on this soil. In places adapted grasses and legumes are grown. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, vetch, and arrowleaf clover.

Contour farming, terracing, and keeping a cover of grass on waterways help to control erosion. Returning crop residue to the surface helps to maintain soil tilth and control erosion. Lime is needed for some legumes. Capability unit IIIe-1; pasture and hayland group 8A.

**CrC—Crockett loam, 3 to 5 percent slopes.** This gently sloping soil is along sides of drainageways. Mapped areas are narrow and long, ranging from 20 to about 60 acres in size.

The surface layer is dark-brown loam about 9 inches thick. The subsoil is clay about 38 inches thick. The upper part is mottled in shades of brown and reddish brown, and the lower part is olive brown. The underlying material, to a depth of 84 inches, is layers of variegated gray and olive-yellow shale and clay loam.

Included with this soil in mapping are small spots of Bazette soils that make up less than 5 percent of the acreage.

Runoff is rapid on this Crockett soil. The erosion hazard is very severe.

This soil is used mostly for native pasture. Adapted grasses and legumes are grown on this soil in places. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, vetch, and arrowleaf clover. Hay, small grain, and grain sorghum are grown in a few areas.

Contour farming, terracing, and keeping grass on waterways help to control erosion and excess loss of water. Returning crop residue to the surface helps to maintain soil tilth and control erosion. Lime is needed for some legumes. Capability unit IVe-1; pasture and hayland group 8A.

**CrC2—Crockett loam, 2 to 5 percent slopes, eroded.** This gently sloping soil is on broad ridges and sides of drainageways. Mapped areas range from 15 to about 300 acres in size and the shape of these areas varies. Slopes are plain or convex, and the average slope is 3 percent. In about half the areas of this soil there are gullies about 100 to 250 feet apart. These gullies are 8 to 75 feet in width, 30 to 500 feet in length, and 1 to 3 feet in depth. Most of these can be crossed by farm machinery. In the remaining half of the areas few or no gullies are present, but in places sheet erosion has occurred.

The surface layer is brown loam about 4 inches thick, and the subsoil is clay about 35 inches thick. The upper part of the subsoil is dark reddish brown, and the lower part is light olive brown. The underlying material, to

a depth of 60 inches, is layers of variegated gray and olive-yellow shale and clay loam.

Included with this soil in mapping are spots of Crockett loam, 1 to 3 percent slopes, on foot slopes or in small concave areas. These are 1 to 5 acres in size, and they make up 5 to 20 percent of the acreage.

Runoff is rapid and the hazard of erosion is very severe.

Most areas of this soil are used for pasture. Adapted grasses and legumes are grown in places on this soil. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, vetch, and arrowleaf clover. Hay and small grain for grazing are grown in a few areas.

Terraces and grassed waterways help to control erosion. Returning crop residue to the surface helps to maintain soil tilth and control erosion. Lime is needed for some legumes. Capability unit IVe-1; pasture and hayland group 8A.

## Ellis Series

The Ellis series consists of moderately deep, sloping to strongly sloping, clayey soils on uplands. These soils formed in alkaline shale under tall and mid grasses.

In a representative profile the surface layer is dark grayish-brown clay about 6 inches thick. The next layer is about 25 inches thick. The upper part of it is light olive-brown clay, and the lower part is olive silty clay. The underlying material, to a depth of 66 inches, is layers of variegated gray and olive-yellow shale and clay.

Ellis soils are well drained. Permeability is very slow in these soils, and available water capacity is medium. They are used mainly for native pasture.

Representative profile of Ellis clay, 5 to 12 percent slopes, 9.2 miles northwest of Sulphur Springs on Farm Road 2285, 3.8 miles west of Farm Road 71, 1.1 miles north on county road, and 400 feet west of county road:

- A1—0 to 6 inches, dark grayish-brown (2.5Y 4/2) clay; moderate, fine and medium, blocky structure; very hard, firm; many roots; neutral; clear, wavy boundary.
- B2—6 to 20 inches, light olive-brown (2.5Y 5/4) clay; common, fine and medium, faint olive-yellow (10YR 6/6) mottles; moderate, medium, blocky structure; very hard, firm; many roots; common slickensides in lower part; neutral; gradual, wavy boundary.
- B3—20 to 31 inches, olive (5Y 5/4) silty clay; common, fine, faint, olive-yellow (10YR 6/6) mottles; few grayish-brown shale fragments; weak, medium, blocky structure; very hard, firm; common pressure faces and few small slickensides; calcareous; moderately alkaline; gradual, wavy boundary.
- C—31 to 66 inches, layers of variegated gray (10YR 5/1) and olive-yellow (2.5Y 6/6) shale and clay; massive with evident bedding planes; extremely hard, very firm; few calcium carbonate concretions; calcareous; moderately alkaline.

The solum is 15 to 36 inches thick. In the A horizon reaction ranges from slightly acid to moderately alkaline. Colors are dark grayish brown, olive, grayish brown, olive gray, and light yellowish brown.

The B horizon is clay or silty clay. Reaction ranges from neutral to moderately alkaline. The B horizon is light olive brown, olive, and olive brown and in places is mottled in shades of olive, brown, and yellow. Typically there are

grayish shale fragments in the lower part. The B and C horizons are 0 to 3 percent calcium carbonate concretions and masses.

The C horizon is clay and shale in shades of gray, olive, and yellow. Reaction in this material is neutral to moderately alkaline.

**EsD—Ellis clay, 5 to 12 percent slopes.** This sloping to strongly sloping soil is along sides of drainageways. Mapped areas are long and narrow, ranging from about 30 to 150 acres in size. A few gullies are present in most areas.

Included with this soil in mapping are small spots of Bazette, 12 percent slopes, and Ferris soils. These inclusions make up less than 15 percent of the acreage.

Runoff is rapid on this Ellis soil. The hazard of erosion is very severe.

This soil is used mainly for native pasture, but other pasture grasses have been introduced and established in some areas. Such adapted grasses and legumes as bermudagrass, johnsongrass, King Ranch bluestem, burclover, black medic, and singletary peas are grown in places on this soil.

Seedbed preparation is difficult in this clay soil. Grazing when this soil is wet results in surface packing, which increases the rate of water runoff. Slopes and the hazard of erosion make this soil unsuitable for crops. Capability unit VIe-2; pasture and hayland group 7B.

### Ferris Series

The Ferris series consists of deep, sloping to strongly sloping, clayey soils on uplands. These soils formed in clay and shale under tall and mid grasses.

In a representative profile the surface layer is dark grayish-brown calcareous clay about 4 inches thick. Below the surface layer, to a depth of 36 inches, is light olive-brown calcareous silty clay that has a few olive-yellow mottles. The underlying material, to a depth of about 66 inches, is olive, calcareous, shaly clay.

Ferris soils are well drained and available water capacity is medium. Infiltration of water is rapid when the soil is dry and cracked, but permeability is very slow when the soil is wet.

This soil is used mainly for native pasture.

Representative profile of Ferris clay, 5 to 12 percent slopes, eroded, in a pasture 9.2 miles north of Sulphur Springs on Farm Road 2285, 1.1 miles west on Farm Road 71, and 160 feet south of road:

A11—0 to 4 inches, dark grayish-brown (2.5Y 4/2) clay; common, medium, faint, light olive-brown (2.5Y 5/4) mottles; moderate, medium and fine, subangular blocky structure; very hard, firm; many roots; few pressure faces; few calcium carbonate concretions; calcareous; moderately alkaline; clear, wavy boundary.

A12—4 to 13 inches, light olive-brown (2.5Y 5/4) silty clay; moderate, fine and medium, blocky structure; very hard, firm; few roots; common slickensides, a few of which intersect; few fine calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.

AC1ca—13 to 23 inches, light olive-brown (2.5Y 5/4) silty clay; few, fine, faint, olive-yellow (2.5Y 6/6) mottles; moderate, fine and medium, blocky structure; very hard, firm; few roots; few intersecting slick-

ensides; about 20 percent visible calcium carbonate soft masses and concretions; calcareous; moderately alkaline; gradual, wavy boundary.

AC2ca—23 to 36 inches, light olive-brown (2.5Y 5/4) silty clay; few, medium, faint, olive-yellow (2.5Y 6/6) vertical streaks and common, medium, distinct, grayish-brown shale fragments; moderate, medium, blocky structure; very hard, firm; few roots; few small slickensides; about 15 percent visible calcium carbonate concretions and soft masses; calcareous; moderately alkaline; gradual, wavy boundary.

C—36 to 66 inches, olive (5Y 5/3) shaly clay with layers and splotches of olive yellow (2.5Y 6/6) and gray (10YR 5/1); massive; bedding planes evident; extremely hard, very firm; about 10 percent visible calcium carbonate concretions and masses in upper part; calcareous; moderately alkaline.

The solum is 30 to 50 inches thick. Typically, the soil is moderately alkaline and calcareous throughout. The A horizon is dark grayish brown, olive gray, light olive brown, and olive brown.

The AC horizon is clay or silty clay. In places this horizon has few to common shale fragments in the lower part. Colors are light olive brown, yellowish brown, or pale olive. Mottles in the AC horizon are in shades of brown, olive, yellow, and gray. The AC and C horizons have few to many calcium carbonate concretions and masses.

The C horizon is weathered shaly clay and calcareous clay in shades of brown, olive, gray, and yellow.

**FeD2—Ferris clay, 5 to 12 percent slopes, eroded.** This sloping to strongly sloping soil is along sides of drainageways and elongated ridges. Areas are narrow and long in shape, ranging from about 20 to 80 acres in size. Gullies are at intervals of about 100 to 500 feet. They are 3 to 20 feet in width, 1 to 5 feet in depth, and 30 to 200 feet in length. Gullies make up about 10 to 35 percent of the mapped areas. In some areas the gullies have been filled in and the surface has been smoothed over.

Included with this soil in mapping are small areas of Leson soils along the break of the slopes or at the head of drainageways. They are less than 5 acres in size and make up less than 15 percent of any area.

Runoff is rapid on this Ferris soil. The hazard of erosion is very severe.

This soil is used mostly for native pasture. A few areas, however, are used for improved grasses. Such adapted grasses and legumes as bermudagrass, johnsongrass, King Ranch bluestem, burclover, black medic, and singletary peas are grown in places on this soil.

Seedbed preparation is difficult on this clay soil. Grazing when the soil is wet results in surface packing which increases the rate of water runoff. This soil is not suited to crops because of the slopes and the hazard of erosion. Capability unit VIe-2; pasture and hayland group 7B.

### Freestone Series

The Freestone series consists of deep, gently sloping, loamy soils on uplands. They formed in acid and alkaline clay sediment under a plant community of oak trees and native grass.

In a representative profile the surface layer is fine sandy loam about 16 inches thick. It is brown in the upper 3 inches and yellowish brown in the lower 13 inches. The upper 22 inches of the subsoil is yellowish-

brown sandy clay loam that has light brownish-gray, brown, and yellowish-red mottles. The next 34 inches of it is mottled, light-gray, red, and yellowish-brown clay. Below this, to a depth of 90 inches, the subsoil is light-gray sandy clay loam that has brownish-yellow and yellowish-red mottles.

The Freestone soils are moderately well drained. Permeability is slow in these soils, and available water capacity is medium. They are used mainly for pasture.

Representative profile of Freestone fine sandy loam, 1 to 3 percent slopes, 8.7 miles south of Sulphur Springs on Texas Highway 154, 2.7 miles west on Farm Road 1567, 1.3 miles south on county road, and 300 feet east of road:

- A1—0 to 3 inches, brown (10YR 4/3) fine sandy loam; moderate, fine, granular structure; hard, very friable; many roots; strongly acid; clear, smooth boundary.
- A2—3 to 16 inches, yellowish-brown (10YR 5/4) fine sandy loam; weak, fine, granular structure; hard, very friable; many roots; few black concretions; medium acid; clear, wavy boundary.
- B21t—16 to 30 inches, yellowish-brown (10YR 5/6) sandy clay loam; few, fine, faint, light brownish-gray (10YR 6/2) and few, medium, distinct brown (10YR 5/3) mottles; moderate, fine and medium, subangular blocky structure; very hard, friable; common roots; common patchy clay films; few fine pores; few black concretions; strongly acid; gradual, wavy boundary.
- B22t & A'2—30 to 38 inches, yellowish-brown (10YR 5/4) sandy clay loam; many, medium, distinct yellowish-red (5YR 5/6) and few, medium, faint, light brownish-gray (10YR 6/2) mottles; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, friable; common roots; many patchy clay films; light-gray (10YR 7/1) uncoated sand and silt grains on vertical faces of prisms, streaks and pockets 2 to 10 millimeters wide and 10 to 20 centimeters long making up about 10 percent of the mass; few black concretions; strongly acid; clear, wavy boundary.
- B23t—38 to 72 inches, light gray (10YR 6/1) clay; many, fine, distinct red (2.5YR 4/6) and few, fine, distinct yellowish-brown (10YR 5/4) mottles; moderate, fine, blocky structure; extremely hard, firm; few roots; many clay films; few streaks of uncoated sand; few small slickensides; few black concretions; strongly acid; gradual, wavy boundary.
- B3—72 to 90 inches, light gray (10YR 7/1) sandy clay loam; many fine and medium, distinct, brownish-yellow (10YR 6/6) and reddish-yellow (7.5YR 6/6) mottles; weak, medium, subangular blocky structure; very hard, firm; few roots; few patchy clay films; few white neutral salt masses; few black concretions; medium acid.

The solum is 60 to more than 100 inches thick. In the A horizon reaction is strongly acid to neutral. The A1 or Ap horizon is dark grayish brown, brown, and pale brown. The A2 horizon is yellowish brown, brown, pale brown, or very pale brown. The combined thickness of the A1 and A2 horizons ranges from 8 to 20 inches.

The B2t horizon is very strongly acid to slightly acid. The B21t horizon is sandy clay loam or loam. It is yellowish brown, strong brown, or brownish yellow. In places this horizon has mottles in shades of red, brown, or gray. The B2t and A'2 and lower Bt horizons are mottled in shades of brown, gray, yellow, and red. Streaks and pockets of uncoated sand and silt grains make up 5 to 15 percent of the B2t and A'2 horizon. The B22t and A'2 horizons are sandy clay loam or clay loam. The lower B2t horizons are clay or clay loam. The B3 horizon is medium acid to mildly

alkaline sandy clay loam, loam, and clay loam. It is mottled in shades of brown, gray, and yellow.

**FrB—Freestone fine sandy loam, 1 to 3 percent slopes.** This gently sloping soil occupies broad inter-stream divides. Mapped areas range from 10 to about 1,000 acres in size and vary considerably in shape. The average size is about 40 acres.

Included with this soil in mapping are small areas of Lufkin, Bernaldo, and Raino soils. Lufkin soils are in low, wet spots. Bernaldo soils are in elongated areas at slightly higher elevations. Raino soils are on small, low mounds. These included soils are less than one acre in size and make up less than 20 percent of the acreage.

Runoff is slow on this Freestone soil. The hazard of erosion is moderate. A perched water table is at a depth of 12 to 36 inches for short periods after heavy rains.

Although this soil is used mainly for improved pasture, it is cultivated in some areas (fig. 4).

Corn, truck crops, hay, and small grain are grown on this soil. In places adapted grasses and legumes are grown. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, vetch, arrowleaf clover, singletary peas, and lespedeza.

Contour farming, terracing, and keeping grass on waterways help to control erosion. Returning crop residue to the surface helps to maintain soil tilth and control erosion. Lime is needed for most cultivated crops and pasture. Capability unit IIe-2; pasture and hay-land group 8C.

### Gladewater Series

The Gladewater series consists of deep, nearly level, clayey soils on bottom land. These soils formed in clayey alluvium.

In a representative profile the surface layer is black clay in the upper 5 inches and very dark gray clay with dark yellowish-brown and dark-brown mottles in the lower 4 inches. Below this layer, to a depth of 65 inches, is dark-gray clay with yellowish-brown and olive-brown mottles.

Gladewater soils are poorly drained. Permeability is very slow in these soils, and available water capacity is high. They are used mainly for native pasture.

Representative profile of Gladewater clay in the Sabine River flood plain; 2.5 miles east of Emory on Texas Highway 69, 3.5 miles south on Farm Road 779, 0.8 mile south on county road, 0.8 mile east, 1.7 miles south, 1 mile west, 0.8 mile south on private road, and 50 feet west of road:

- A11—0 to 5 inches, black (10YR 2/1) clay; moderate, medium, subangular blocky structure; extremely hard, very firm; many roots; neutral; clear, wavy boundary.
- A12—5 to 9 inches, very dark gray (10YR 3/1) clay; common, fine, distinct dark yellowish-brown (10YR 4/4) and dark brown (10YR 3/3) mottles; moderate, medium, subangular blocky structure; extremely hard, very firm; few roots; few pressure faces; common black concretions; slightly acid; gradual, wavy boundary.
- B21g—9 to 28 inches, dark-gray (10YR 4/1) clay; many fine and medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky



Figure 4.—A good stand of purple hull peas on Freestone fine sandy loam, 1 to 3 percent slopes.

structure; extremely hard, very firm; few roots; many pressure faces; few black concretions; strongly acid; gradual, wavy boundary.

B22g—28 to 50 inches, dark-gray (10YR 4/1) clay; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, blocky structure; extremely hard, very firm; few roots; many slickensides; few black concretions; slightly acid; gradual, wavy boundary.

Cg—50 to 65 inches, dark-gray (10YR 4/1) clay; common, medium, distinct, olive-brown (2.5Y 4/4) mottles; massive; extremely hard, very firm, few slickensides; common black concretions; neutral.

The solum is 20 to about 50 inches thick. In the A horizon reaction is medium acid to neutral. This horizon is black or dark gray and in places has brownish mottles. It is 4 to 9 inches thick.

In the B2g horizon reaction ranges from strongly acid to slightly acid. Colors are dark gray, gray or light brownish gray. Few to many yellowish-brown, dark yellowish-brown, olive-gray, or reddish-brown mottles are present.

The C horizon is generally clay, but in places it is clay loam or silty clay loam. Reaction is strongly acid to neutral. This horizon is dark gray or gray and has yellowish-brown, olive-brown, or strong-brown mottles.

**Gw—Gladewater clay.** This nearly level soil is in long flood plains of streams that are about 1/4 of a mile to 2 miles wide. This soil ranges from small 20 acre spots to large flood plains consisting of several thousand acres.

Included with this soil in mapping, and making up less than 10 percent of the acreage, are small areas of Kaufman and Nahatche soils.

Runoff is very slow on this Gladewater soil, and areas become flooded several times during most years. In places they remain flooded for periods of 1 to 6 weeks (fig. 5).

Gladewater clay is used mostly for native pasture. About 75 percent is in oak and elm trees that have an understory of native grasses. Adapted grasses and legumes are grown in places on this soil. Examples of these are bahiagrass, bermudagrass, fescue, white clover, and singletary peas.

Seedbed preparation is difficult in this wet clay soil. Grazing when the soil is wet causes puddling of the surface. This soil is not suited to crops because of the hazard of floods. Capability unit Vw-2; pasture and hayland group 1B.

### Heiden Series

The Heiden series consists of deep, gently sloping, clayey soils on uplands. These soils formed in calcareous clay marine sediment under tall native grasses.

In a representative profile the surface layer is very dark grayish-brown calcareous clay about 20 inches thick. The next layer is 20 inches thick. The upper part



**Figure 5.**—Water standing on nearly level flood plain. The soil is Gladewater clay.

is mottled, olive-gray calcareous clay, and the lower part is mottled, olive clay. The underlying material, to a depth of 60 inches, is mottled, olive-gray and light olive-brown calcareous shaly clay.

Heiden soils are well drained, and they have high available water capacity. Permeability is rapid when the soil is dry and cracked and very slow when the soil is wet. These soils are used mainly for native and improved pasture.

A representative profile of Heiden clay, 3 to 5 percent slopes, eroded, 9.2 miles southwest of Sulphur Springs on Farm Road 2285, 3.5 miles west on Farm Road 71, 0.6 mile north on county road, and 50 feet east of road:

- A11—0 to 6 inches, very dark grayish-brown (2.5Y 3/2) clay; moderate, medium and fine, blocky structure; very hard, firm; common roots; few pressure faces; common calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.
- A12—6 to 20 inches, very dark grayish-brown (2.5Y 3/2) clay; many, coarse, faint, olive-gray (5Y 5/2) mottles; moderate, medium and fine blocky structure; very hard, firm; few roots; common slickensides in lower part of layer; common calcium carbonate concretions and soft masses; calcareous; moderately alkaline; gradual, wavy boundary.
- AC1—20 to 30 inches, olive-gray (5Y 4/2) clay; common, medium, faint, olive (5Y 5/3) and dark olive-gray

(5Y 3/2) mottles; moderate, medium, blocky structure; very hard, very firm; few roots; many intersecting slickensides; few fine calcium carbonate concretions and soft masses; calcareous; moderately alkaline; gradual, wavy boundary.

- AC2—30 to 40 inches, olive (5Y 5/3) clay; common, medium, faint, dark olive-gray (5Y 3/2) mottles; weak, fine and medium, blocky structure; very hard, very firm; few roots; few intersecting slickensides; few calcium carbonate concretions and soft masses; few shale fragments; calcareous; moderately alkaline; diffuse, wavy boundary.

- C—40 to 60 inches, mottled, olive-gray (5Y 5/2) and light olive-brown (2.5Y 5/6) shaly clay; massive; extremely hard, very firm; few calcium carbonate concretions and soft masses; calcareous; moderately alkaline.

The solum is about 40 to 60 inches thick. It contains few to common calcium carbonate concretions and soft masses. When the soil is dry, cracks, 1 to 3 inches wide, extend through the solum.

The A horizon is very dark grayish brown or dark olive gray. In places mottles in shades of brown or gray are present in this horizon. It ranges from 12 inches thick on microknolls to 24 inches thick in microdepressions. Distances between microknolls and microdepressions range from 3 to about 12 feet.

The AC horizon is olive gray, olive, olive brown, and light olive brown. In places mottles in shades of yellow, gray, or olive are present in this horizon.

The C horizon is calcareous shale, shaly clay, and clay, mottled in shades of gray, yellow, brown, and olive. The

upper part is weathered and is intermingled with soil and massive shale. It contains few to common calcium carbonate concretions and soft masses.

fine, faint olive-yellow (2.5Y 6/6) mottles; weak, subangular blocky structure; very hard, firm; few black concretions; neutral.

**HeC2—Heiden clay, 3 to 5 percent slopes, eroded.** This gently sloping soil is on interstream divides and narrow ridgetops. Mapped areas are irregular in shape and range from 15 to about 80 acres in size. Shallow gullies are at intervals of 30 to 200 feet. They are 30 to 150 feet in width, 1 to 2 feet in depth, and 100 to 500 feet in length. When the soil was cultivated in the past, sheet erosion was active. Under present soil use, however, the gullies and sheet erosion are not readily noticeable in most areas.

Reaction in the solum ranges from neutral to moderately alkaline. Texture is silty clay loam, silt loam, loam, and clay loam. Between depths of 10 and 40 inches the soil material is 25 to 35 percent clay. Less than 15 percent of this material is fine or coarser sand.

The A horizon is 24 to 65 inches thick. It is very dark grayish brown, very dark gray, or dark brown and has few to common brown and gray mottles.

The B2g horizon is mottled in shades of olive, brown, gray, and yellow.

Runoff is rapid on this soil. The hazard of erosion is severe.

Most areas of this soil are used for native and improved pasture.

Adapted grasses and legumes are grown in places on this soil. Examples of these are bermudagrass, lovegrass, johnsongrass, burclover, and singletary peas.

Seedbed preparation on this soil is difficult. Allowing cattle to graze on this soil when it is wet causes puddling. Terracing, contour farming, and keeping grass on waterways help to control erosion if crops such as cotton, corn, and grain sorghum are grown. Capability unit IIIe-3; pasture and hayland group 7A.

**Ho—Hopco silty clay loam.** This nearly level soil is in long flood plains of streams that are 100 feet to about 1 mile wide. It commonly makes up the entire flood plain. Mapped areas range from about 300 to 500 acres in size. Slopes are 0 to 1 percent.

Included with this soil in mapping are spots of a soil similar to but better drained than this soil. These spots make up about 10 percent of the acreage.

Runoff is slow on Hopco silty clay loam, and areas of it become flooded for periods generally of less than 3 days two to four times during most years.

Although this soil is used mainly for pasture of improved grasses, it is cultivated and used for pecan orchards in some areas. Adapted grasses and legumes are grown on this soil. Examples of these are bermudagrass, fescue, bahiagrass, johnsongrass, white clover, and singletary peas. Although this is a fertile soil, it is not well suited to crops because of the hazard of floods. Capability unit Vw-1; pasture and hayland group 2A.

## Hopco Series

The Hopco series consists of deep, nearly level, loamy soils on bottom land. These soils formed in recent loamy alluvium.

In a representative profile the upper 16 inches of the surface layer is very dark grayish-brown silty clay loam. Below this is 32 inches of very dark silty clay loam underlain by 12 inches of very dark gray clay loam. The subsoil, at a depth of 60 inches and extending to a depth of 80 inches, is olive-brown clay loam.

Hopco soils are somewhat poorly drained. Permeability is moderately slow in these soils, and available water capacity is high. They are used mainly for pasture.

Representative profile of Hopco silty clay loam in a pasture 9.3 miles northwest of Sulphur Springs on Farm Road 2285, 2.1 miles west on Farm Road 71, and 60 feet south of road:

A11—0 to 16 inches, very dark grayish-brown (10YR 3/2) silty clay loam; few, medium, faint very dark gray (10YR 3/1) mottles; moderate, fine, subangular blocky structure; hard, friable; sticky; many roots, few medium pores; moderately alkaline; clear, wavy boundary.

A12—16 to 48 inches, very dark gray (10YR 3/1) silty clay loam; moderate, fine, subangular blocky structure; hard, friable; sticky; few roots; common fine pores; moderately alkaline; gradual, smooth boundary.

A13—48 to 60 inches, very dark gray (10YR 3/1) clay loam; common, medium, faint dark grayish-brown (10YR 4/2) and few, fine, distinct yellowish-brown (10YR 5/4) mottles; moderate, medium and coarse, subangular blocky structure; very hard, firm; sticky; few roots; neutral; gradual, smooth boundary.

B2g—60 to 80 inches, olive-brown (2.5Y 4/4) clay loam; common, medium, distinct gray (10YR 6/1) and dark grayish-brown (10YR 4/2) mottles and few,

## Kaufman Series

The Kaufman series consists of deep, nearly level, clayey, soils on bottom lands. These soils formed in alkaline, clayey alluvium.

In a representative profile the surface layer is black clay about 64 inches thick. The underlying material, to a depth of 84 inches, is very dark gray clay. It contains a few calcium carbonate concretions.

Kaufman soils are somewhat poorly drained. Water enters the soil rapidly when the surface is dry and cracked, but permeability is very slow when the soil is wet. Available water capacity is high in these soils. They are used mainly for pasture.

Representative profile of Kaufman clay in the flood plain of the South Sulphur River 8.5 miles west of Sulphur Springs on Texas Highway 11, 4.2 miles north on Farm Road 2653, 1.2 miles west on Farm Road 71, and 125 yards north of road:

A11—0 to 10 inches, black (10YR 2/1) clay; weak, coarse, prismatic structure parting to moderate, medium and fine, blocky; extremely hard, very firm; common roots; slightly acid; gradual, wavy boundary.

A12—10 to 64 inches, black (10YR 2/1) clay; moderate, coarse, blocky structure parting to moderate, medium and fine, blocky; extremely hard, very firm; common roots; common pressure faces and many grooved intersecting slickensides in lower part; few black concretions; neutral; diffuse, wavy boundary.

Cca—64 to 84 inches, very dark gray (10YR 3/1) clay; massive; extremely hard, very firm; few roots; common grooved slickensides; few calcium carbon-

ate concretions and soft masses; few black concretions; mildly alkaline.

The solum ranges from 40 to about 100 inches thick. These soils are clayey throughout. The soil material is 60 to 72 percent clay. Reaction ranges from medium acid to mildly alkaline. The A horizon is black or very dark gray. In places the lower part is mottled in shades of brown, yellowish brown, or dark yellowish brown. When the soil is dry, cracks 1 to 3 inches wide extend to a depth of more than 20 inches.

The Cca horizon is dark gray, very dark gray, or gray. In places mottles in shades of brown or gray are present.

**Ka—Kaufman clay.** This nearly level soil is in long flood plains that are 200 feet to about 2 miles wide. Mapped areas vary considerably in size, ranging from 30-acre spots to flood plains that have an area of several thousand acres. Slopes are 0 to 1 percent.

Included with this soil in mapping, and making up less than 10 percent of the acreage, are small spots of Gladewater and Hopco soils.

Runoff is slow and this soil becomes flooded one to four times during most years. After heavy rains it remains flooded for 2 to 10 days. Approximately 20 percent of the acreage of this soil has low levees that provide some flood protection. Nevertheless, these areas flood at least once during the growing season of most years.

Although the soil is used mainly for pasture of improved and native grasses, a few areas are cultivated. Approximately 25 percent of the total area is in oak and elm trees that have an understory of native grasses. Some areas of this soil are used for wildlife habitat.

Adapted grasses and legumes are grown in places on this soil. Examples of these are bahiagrass, bermudagrass, fescue, white clover, and singletary peas.

Seedbed preparation is difficult on this wet clay soil. Grazing when the soil is wet results in puddling. The soil is not well suited to crops because of the hazard of flooding. Capability unit Vw-2; pasture and hayland group 1A.

## Kirvin Series

The Kirvin series consists of deep, gently sloping to sloping, loamy and gravelly loamy soils on uplands. These soils formed under mixed hardwood and pine trees in acid clay, silt, sand, and sandstone strata.

In a representative profile the surface layer is gravelly fine sandy loam about 12 inches thick. It is dark brown in the upper 4 inches and brown in the lower 8 inches. The subsoil is clay and is about 19 inches thick. The upper part is yellowish red, and the lower part is red. The next lower layer is yellowish-red, mottled sandy clay loam about 12 inches thick. The underlying material, to a depth of 64 inches, is stratified layers of yellowish-brown, reddish-yellow, pinkish-gray, and red sandy clay loam, clay loam, and sandstone.

Kirvin soils are well drained. Permeability is moderately slow in these soils, and available water capacity is medium. These soils are used mainly for pasture

Representative profile of Kirvin gravelly fine sandy loam, 3 to 8 percent slopes, 4.2 miles south of Pickton

on Farm Road 269, 0.3 mile southeast on Farm Road 852, and 10 feet south of road:

A1—0 to 4 inches, dark-brown (7.5YR 3/2) gravelly fine sandy loam; weak, fine, granular structure; hard, very friable; many roots; 15 percent iron-enriched pebbles and fragments that are 2 millimeters to 50 millimeters in diameter; a few fragments up to 18 inches across the long axis; neutral; clear, smooth boundary.

A2—4 to 12 inches, brown (7.5YR 4/4) gravelly fine sandy loam; weak, fine, granular structure; hard, very friable; many roots; 40 to 50 percent of iron-enriched pebbles and fragments that are 2 millimeters to 50 millimeters in diameter; slightly acid; abrupt, wavy boundary.

B21t—12 to 24 inches, yellowish-red (5YR 4/6) clay; strong, medium, blocky structure; very hard, firm; many roots; many clay films; strongly acid; gradual, wavy boundary.

B22t—24 to 31 inches, red (2.5YR 4/8) clay; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; very hard, firm; many roots; many clay films; very strongly acid; gradual boundary.

B3—31 to 43 inches, yellowish-red (5YR 4/8) sandy clay loam that has thin strata and streaks of red (2.5YR 4/6), gray (10YR 5/1), and yellowish brown (10YR 5/4); moderate, medium, subangular blocky structure grading to weakly stratified layers; very hard, friable; few roots; common clay films; very strongly acid; diffuse, irregular boundary.

C—43 to 64 inches, stratified layers of yellowish-brown (10YR 5/6), reddish-yellow (5YR 6/8), pinkish-gray (7.5YR 6/2), and red (2.5YR 4/6) sandy clay loam, clay loam, and weakly cemented sandstone; massive; very hard, firm; very strongly acid.

The solum ranges from 40 to 60 inches thick. The A horizon is gravelly fine sandy loam or sandy clay loam. It is 4 to 18 inches thick. Reaction is medium acid to neutral. The A1 horizon is dark brown, brown, dark reddish brown, or dark grayish brown. The A2 horizon is strong brown, brown, pale brown, or yellowish red. The A horizon is 10 to 50 percent iron-enriched pebbles from 2 millimeters to 50 millimeters in diameter. On or near the surface are a few large stones that range from 10 to 18 inches across this long axis.

The Bt horizon is clay or sandy clay. Content of clay in this horizon ranges from 40 to 60 percent. Reaction is extremely acid to strongly acid. The Bt horizon is yellowish red and red, and it is mottled in shades of brown and red. The B3 horizon is sandy clay loam, clay loam, or clay. It has mottles, streaks, and thin strata in shades of red, brown, yellow, and gray.

The C horizon is stratified sandy clay loam, clay loam, and sandstone in shades of red, brown, yellow, and gray. Reaction is extremely acid to very strongly acid.

These soils are outside the range of the Kirvin series since the clay fraction is borderline to kaolinitic mineralogy. This difference, however, does not alter use, management, or behavior of the soil.

**KnD—Kirvin gravelly fine sandy loam, 3 to 8 percent slopes.** This gently sloping to sloping soil is on oval, convex ridges. Most slopes are about 5 percent. Mapped areas range from 15 to about 80 acres in size. This soil has the profile described as representative for the Kirvin series.

Included with this soil in mapping are areas of Bernaldo soils, 1 to 3 acres in size, at the heads of drainageways and in small concave spots. These are 1 to 3 acres in size. They make up 5 to 10 percent of some mapped areas. Stony areas are also included in

mapping. They are at the apex of slopes and are 1 to 3 acres in size. These areas make up about 5 to 10 percent of the total acreage.

Runoff is medium to rapid on this Kirvin soil. The hazard of erosion is very severe.

This soil is used mainly for pasture of improved and native grasses. A few small areas are in pine trees. This soil provides a source of gravel for fill material. Adapted grasses and legumes are grown in places on this soil. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, arrowleaf clover, vetch, singletary peas, and lespedeza. A few areas are planted to truck crops, hay, and small grains.

Contour farming, terracing, and keeping grass on waterways help control the hazard of erosion. Returning crop residues to the surface helps maintain soil tilth and control erosion. Lime is needed for most plants. Capability unit IVE-2; pasture and hayland group 8C.

**KvD—Kirvin soils, 3 to 8 percent slopes.** This gently sloping to sloping soil is on oval, convex ridges. Mapped areas range from 10 to about 40 acres in size. The original surface layer of gravelly fine sandy loam has been removed in most areas of this soil and used as fill material for roads, parking lots, and other purposes. The texture of the surface layer varies and includes gravelly fine sandy loam, sandy clay loam, and clay.

In a representative profile the surface layer is about 4 inches thick. It is strong-brown sandy clay loam and 5 to 10 percent iron-enriched pebbles and fragments. The subsoil is about 33 inches thick. The upper part is red clay, and the lower part is mottled and stratified, yellowish-brown, red, and pinkish-gray sandy clay loam and clay. The underlying material, to a depth of 64 inches, is brown sandy clay loam.

Runoff is rapid on this soil. The erosion hazard is very severe.

This soil is either used mainly for pasture or is idle. Pine trees have been planted in a few areas.

Adapted grasses and legumes are grown in places on this soil. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, arrowleaf clover, vetch, and singletary peas. Cover is difficult to establish and maintain on this soil after the surface has been removed. Lime is needed for most plants. Capability unit VIe-3; pasture and hayland group 8C.

## Leson Series

The Leson series consists of deep, gently sloping, clayey, soils on uplands. These soils formed in alkaline shale and clay under tall native grasses.

In a representative profile the surface layer, to a depth of 30 inches, is black clay. Below the surface layer, to a depth of 60 inches, is olive calcareous clay. The underlying material, to a depth of 80 inches, is olive-gray calcareous shaly clay.

Leson soils are moderately well drained. Water intake is rapid when the surface is dry and cracked, but these soils are very slowly permeable when wet. Available water capacity is high. The soils are used mainly for pasture.

Representative profile of Leson clay, 1 to 3 percent slopes, 225 feet north of Texas Highway 11, which is 10.8 miles west of intersection of Texas Highways 11 and 19 in Sulphur Springs:

- Ap—0 to 10 inches, black (10YR 2/1) clay; moderate, fine, blocky structure; extremely hard, very firm; common shiny pressure faces; few fine black concretions; moderately alkaline; gradual, wavy boundary.
- A1—10 to 30 inches, black (10YR 2/1) clay; weak, coarse, blocky parting to moderate, medium, blocky structure; extremely hard, very firm; common intersecting slickensides and wedge-shaped aggregates having long axis tilted 30 to 45 degrees from the horizontal; few fine black concretions; moderately alkaline; gradual, wavy boundary.
- AC—30 to 60 inches, olive (5Y 5/3) clay; common, medium and coarse, distinct very dark-gray (10YR 3/1) and many, fine, faint, light olive-brown (2.5Y 5/6) mottles; moderate, fine, blocky structure; very hard, firm; few intersecting slickensides; common, fine and medium, calcium carbonate concretions and few, soft masses of calcium carbonate a few shale fragments in lower part of horizon; calcareous matrix; moderately alkaline; gradual, wavy boundary.
- C—60 to 80 inches, olive-gray (5Y 5/2) shaly clay; alternating layers of light olive brown (2.5Y 5/6); evident bedding planes; extremely hard, very firm; few slickensides; approximately 10 percent calcium carbonate in the form of concretions and soft masses; few black concretions; calcareous matrix; moderately alkaline.

The solum is 40 to 80 inches in thickness. When the soil is dry, cracks 1 to 3 inches wide extend through it. The A horizon is slightly acid to moderately alkaline. The lower part is black, very dark gray, or dark gray, and in places is mottled in shades of brown or olive. In undisturbed areas there is gilgai microrelief. Distance between the microknolls and microdepressions ranges from 4 to about 16 feet. The A horizon is 10 to 20 inches thick on microknolls and 30 to 60 inches thick in microdepressions.

The AC horizon is neutral or moderately alkaline. It is grayish brown, dark grayish brown, very dark grayish brown, olive, olive gray, or pale olive and has few to many mottles in shades of gray, brown, and yellow.

The C horizon is made up of alternating layers of clay and shale in shades of brown, olive, and gray. It is mildly or moderately alkaline with few to common calcium carbonate concretions and soft masses.

**LeB—Leson clay, 1 to 3 percent slopes.** This gently sloping soil is on interstream divides and narrow ridgetops. Mapped areas are irregular in shape, and range from 15 to 100 acres in size.

This Leson soil has the profile described as representative for the Leson series.

Runoff is medium on this Leson soil. The hazard of erosion is moderate.

This soil is used mostly for pasture of introduced or native grasses, but some areas are cultivated.

Corn, cotton, small grains, grain sorghum, and hay are grown on this soil. Examples of adapted grasses and legumes grown are bermudagrass, lovegrass, johnsongrass, burclover, and singletary peas.

Seedbed preparation is difficult in this clay soil. Allowing cattle to graze on this soil when it is wet results in puddling. Terracing, contour farming, and keeping grass on waterways help control erosion and prevent excess runoff. Leaving crop residue on or near the surface helps to maintain soil tilth and con-

trol erosion. Capability unit IIe-3; pasture and hayland group 7A.

**LeC—Leson clay, 3 to 5 percent slopes.** This gently sloping soil is along sides of small drainageways and oval-shaped ridges. Mapped areas are irregular in shape and range from 20 to 150 acres in size.

The surface layer, to a depth of about 30 inches, is black clay. Below this, to a depth of 48 inches, is olive clay that is calcareous at a depth of about 42 inches. The underlying material, to a depth of 80 inches, is olive shaly clay.

Included with this soil in mapping are small areas of Heiden soils.

Runoff is medium to rapid on this Leson soil. The hazard of erosion is severe.

This soil is used mainly for pasture of native or introduced grasses.

In places adapted grasses and legumes are grown on this soil. Examples of these are bermudagrass, lovegrass, johnsongrass, burclover, and singletary peas.

Seedbed preparation is difficult in this clay soil. Allowing cattle to graze on this soil when it is wet results in puddling. Terracing, contour farming, and keeping grass on waterways help control erosion where crops such as cotton, corn, and grain sorghums are grown. Capability unit IIIe-3; pasture and hayland group 7A.

### Lufkin Series

The Lufkin series consists of deep, nearly level, loamy soils on uplands. These soils formed in slightly acid to alkaline clayey sediment under a plant community of oak trees and native grasses.

In a representative profile the surface layer is loam about 9 inches thick. The upper 3 inches is dark grayish brown, and the lower 6 inches is light brownish gray. The subsoil, to a depth of about 44 inches, is dark grayish-brown. The next lower layer is 9 inches of a grayish-brown clay that has yellowish-brown mottles. The underlying material, to a depth of 65 inches, is light-gray clay. It has thin layers of light brownish-gray and yellowish-brown silty clay loam and sandy loam. These soils are used mainly for pasture.

Representative profile of Lufkin loam is in an intermound area of Lufkin-Raino complex, 15 miles east of Sulphur Springs on Interstate 30, 7.6 miles north on Farm Road 900, 100 yards on county road, and 50 feet west of road:

- A1—0 to 3 inches, dark grayish-brown (10YR 4/2) loam; weak, fine, granular structure; hard, friable; strongly acid; clear, smooth boundary.
- A2—3 to 9 inches, light brownish-gray (10YR 6/2) loam; weak, medium and fine, subangular blocky structure; hard, friable; very strongly acid; abrupt, wavy boundary.
- B2tg—9 to 44 inches, dark grayish-brown (10YR 4/2) clay; moderate, medium and fine, blocky structure; extremely hard, very firm; common clay films; few black concretions; very strongly acid; gradual, wavy boundary.
- B3g—44 to 53 inches, grayish-brown (10YR 5/2) clay; common medium, distinct yellowish-brown (10YR 5/4) mottles; weak, medium, blocky structure; extremely hard, very firm; mildly alkaline; gradual, wavy boundary.
- Cg—53 to 65 inches, light-gray (10YR 7/1) clay that has

strata of light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/4) silty clay loam and sandy loam; massive; extremely hard, very firm; mildly alkaline.

Solum is 35 to 60 inches thick. The A horizon is loam or silt loam. Reaction ranges from slightly acid to very strongly acid. The A1 horizon is dark grayish brown, dark gray, grayish brown, or very dark grayish brown. It is 2 to 5 inches thick. The A2 horizon is light brownish gray, light gray, or grayish brown. The A horizon is 2 to 8 inches thick.

The Bg horizon is clay or clay loam. Reaction is very strongly acid to mildly alkaline. It is dark grayish brown, grayish brown, dark gray, or gray and is mottled in shades of olive brown and yellow.

The Cg horizon is clay or sandy clay loam that has sandier strata. It is grayish brown, light brownish gray, yellowish brown, or light gray. Reaction is slightly acid to moderately alkaline.

**Lr—Lufkin-Raino complex.** This nearly level soil complex is on broad ridgetops or stream divides. Mapped areas are irregular in shape, and they range from 20 to about 400 acres in size. Surfaces are uneven, and circular and elongated low mounds 1 to 3 feet higher than intermound areas are present. Circular mounds are 20 to 100 feet in diameter, and elongated mounds are 30 to 300 feet long and 10 to 80 feet wide. Slopes are 0 to 1 percent.

The mounds are mainly Raino soils, and the intermound areas consist mainly of Lufkin soils (fig. 6). Lufkin soils make up about 50 percent of this complex; Raino soils, 35 percent; and soils that are in too intricate patterns to be delineated at the scale of mapping used, 15 percent.

The surface layer of Raino soils is dark yellowish-brown loam and is about 6 inches thick. The next layer is loam and is about 30 inches thick. This layer is strong brown and is mottled in shades of light brownish gray and yellowish red in the lower part. It is about 20 percent streaks and pockets of uncoated sand and silt grains that extend into the layer below. The material below, to a depth of 90 inches, is mottled in shades of red, brown, and gray. The upper part of it is clay, and the lower part is sandy clay loam.

Included with these soils in mapping are small areas of Annona soils in low, wet intermound areas.

Runoff is slow on these Lufkin-Raino soils, and water ponds on them during wet periods.

About half the acreage of the soils in this complex is in oak trees. These soils are used mainly for pasture of improved and native grasses, but adapted grasses and legumes are also grown in them. Examples of adapted grasses and legumes are bermudagrass, bahiagrass, fescue, white clover, and singletary peas. Seedbed preparation is difficult in these wet soils. Surface drainage systems help to remove excess water. Lime is needed for some legumes. Capability unit IIIw-2; pasture and hayland group 8E.

### Nahatche Series

The Nahatche series consists of deep, nearly level, loamy soils on uplands. These soils formed in loamy alluvium.

In a representative profile the surface layer is dark grayish-brown clay loam about 7 inches thick. Below



Figure 6.—Lufkin soils are in the foreground where vegetation is short; Raino soils are on mounds where vegetation is tall.

this, to a depth of 34 inches, the soil is grayish brown and is mottled. The upper part is loam that has dark yellowish-brown mottles, and the lower part is clay loam that also has yellowish-brown mottles. The next lower layer, to a depth of 65 inches, is dark-gray clay loam that has dark yellowish-brown mottles.

Nahatche soils are somewhat poorly drained. Permeability is moderate, and available water capacity is high. These soils are used mainly for pasture.

Representative profile of Nahatche soils in a pasture 6.3 miles east of Sulphur Springs on Texas Highway 67, 2.4 miles north on Farm Road 69, and 300 feet west of road:

- A1—0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam; common, fine and medium, faint, dark yellowish-brown (10YR 4/4) mottles; moderate, fine and medium, subangular blocky structure; hard, friable; common roots; slightly acid; clear, smooth boundary.
- C1g—7 to 13 inches, grayish-brown (10YR 5/2) loam; common, fine and medium, dark yellowish-brown (10YR 4/4) and very dark grayish-brown (10YR 3/2) mottles; weak fine, subangular blocky structure; hard, friable; few roots; strongly acid; gradual boundary.
- C2g—13 to 34 inches, grayish-brown (10YR 5/2) clay loam; common, fine, distinct yellowish-brown (10YR 5/4) and few, medium, distinct yellowish-red (5YR

5/6) mottles; moderate, medium, subangular blocky structure; very hard, firm; few roots; medium acid; clear, smooth boundary.

C3g—34 to 50 inches, dark-gray (10YR 4/1) clay loam; common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, fine and medium, subangular blocky structure; hard, firm; few roots; slightly acid; gradual boundary.

C4g—50 to 65 inches, dark-gray (10YR 4/1) clay loam; many, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; very hard, firm; neutral.

Nahatche soils are strongly acid to mildly alkaline. Textures are clay loam, loam, and silty clay loam. The A horizon is dark brown or dark grayish brown and in places is mottled in shades of yellow, brown, and gray. It is 4 to 10 inches in thickness.

The C1g and C2g horizons are grayish brown, light brownish gray, or dark grayish brown. They have few to many mottles in shades of yellow, brown, gray, or red. The C3g and C4g horizons are light gray or dark gray and have mottles in shades of yellow, gray, and brown.

**Na—Nahatche soils.** These nearly level soils are in long flood plains that are 100 feet to about 2 miles wide. Mapped areas vary in size, ranging from small 20-acre spots to large flood plains of several thousand acres. Because of flooding the texture of the surface layer varies from brown clay loam to silty clay loam to loam. Slopes are 0 to 1 percent.

Included with these soils in mapping are spots of a soil that is similar to Nahatche soil except that it is better drained. These spots are on natural levees along stream channels. They make up about 15 percent of the acreage.

Runoff is slow, and this soil becomes flooded several times during most years. Periods of flooding are brief, generally lasting 2 to 10 days.

Nahatche soils are used mainly for pastures and hay meadows of improved grasses, but a few small areas are cultivated. Approximately 40 percent of the acreage is in oak and hardwood trees that have an understory of native grasses. In places adapted grasses and legumes are grown in these soils. Examples of these are bermudagrass, fescue, bahiagrass, johnsongrass, white clover, and singletary peas.

Although this is a fertile soil, it is not suited to crops because of the hazard of floods. Capability unit Vw-1; not assigned to a pasture and hayland group.

### Pickton Series

The Pickton series consists of deep, gently sloping, sandy soils on uplands. These soils formed in lenticular sands under a mixture of hardwood and pine trees.

In a representative profile the surface layer, to a depth of 54 inches, is loamy fine sand. The upper 8 inches is brown, the next 18 inches is dark yellowish brown, and the lower 28 inches is yellowish brown. The subsoil, to a depth of 90 inches, is sandy clay loam. The upper part is yellowish brown and is mottled in shades of dark yellowish brown and reddish brown. The lower part is red and is mottled in shades of gray, strong brown, and red.

Pickton soils are well drained. Permeability is moderate, and available water capacity is low. These soils are used mainly for pasture.

Representative profile of Pickton loamy fine sand, 1 to 5 percent slopes, 15 miles east of Sulphur Springs on Interstate 30, 5.5 miles south on Farm Road 269, and 20 feet west of road:

- Ap—0 to 8 inches, brown (10YR 5/3) loamy fine sand; single grained; loose; few roots; slightly acid; gradual, smooth boundary.
- A21—8 to 26 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; single grained; loose; few roots; slightly acid; gradual, smooth boundary.
- A22—26 to 54 inches, yellowish-brown (10YR 5/4) loamy fine sand; single grained; loose; few roots; slightly acid; clear, smooth boundary.
- B21t—54 to 63 inches, yellowish-brown (10YR 5/8) sandy clay loam; common, medium, distinct dark yellowish-brown (10YR 4/4) and few, medium, distinct reddish-brown (5YR 4/4) mottles; moderate, medium, subangular blocky structure; hard, friable; few medium pale-brown (10YR 6/3) spots of uncoated sand grains; few patchy clay films; slightly acid; gradual, smooth boundary.
- B22t—63 to 90 inches, prominently and coarsely mottled, gray (10YR 6/1), strong-brown (7.5YR 5/6), and red (10YR 4/6) sandy clay loam; moderate, medium, subangular blocky structure; hard, friable; many clay films; few petrified wood fragments; strongly acid; gradual, smooth boundary.
- B3—90 to 120 inches, yellowish-red (5YR 5/8) sandy clay loam; common, medium, prominent gray (10YR 6/1) and common, medium, faint, red (2.5YR 4/8)

mottles; weak, medium and coarse, subangular blocky structure; hard, friable; few patchy clay films; few mica flakes; very strongly acid.

The solum is 80 to more than 120 inches thick. Reaction in the A horizon is medium acid to neutral. The A1 or Ap horizon is brown, dark yellowish brown, yellowish brown, or dark grayish brown. The A2 horizon is very pale brown, light yellowish brown, yellowish brown, or dark yellowish brown. The total A horizon thickness of it ranges from 40 to 72 inches.

The Bt horizon is sandy clay loam, fine sandy loam, or clay loam. It is very strongly acid to slightly acid. The B21t horizon is yellowish brown or strong brown and in places is mottled in shades of yellow, brown, and red. The B22t and B3 horizons are yellowish brown, strong brown, or yellowish red and have few to many mottles in shades of gray, yellow, brown, and red.

### PkC—Pickton loamy fine sand, 1 to 5 percent slopes.

This gently sloping soil is on convex ridges. Mapped areas are oval in shape and are 20 to about 150 acres in size.

Included with this soil in mapping are small, concave areas of Wolfpen soils. These areas make up less than 15 percent of the total acreage.

Runoff is very slow in this Pickton soil.

This soil is used mainly for pastures and meadows of improved grasses, but some areas are cultivated and used for truck crops and corn. In places adapted grasses and legumes are grown. Examples of these are bermudagrass, lovegrass, vetch, and singletary peas.

This soil is droughty, and when it is left bare soil blowing results. It does not retain its fertility well. Small and frequent applications of fertilizer are more effective than large and infrequent ones. Certain crops require lime. Returning crop residue to the surface layer helps to maintain content of organic matter and control soil blowing. Capability unit IIIs-3; pasture and hayland group 9B.

### Raino Series

The Raino series consists of deep, nearly level, loamy soils on uplands. These soils formed in clayey sediment under a plant community of oak trees and native grass.

In a representative profile the surface layer is dark yellowish-brown loam about 5 inches thick. Below this, to a depth of about 35 inches, is strong-brown loam that is mottled in shades of light brownish gray and yellowish red in the lower part. Streaks and pockets of uncoated sand and silt grains make up about 20 percent of the material in the lower part and extend into the layer below. Between depths of 35 and 90 inches, the soil material is mottled in shades of red, yellow, brown, and gray. The upper part is clay, and the lower part is sandy clay loam.

Raino soils are moderately well drained. Permeability is very slow, and available water capacity is high. These soils are used mainly for pasture. They are mapped only in complexes with the Annona and Lufkin soils.

Representative profile of Raino loam is in a mound in an area of Annona-Raino complex, 5.7 miles east of Sulphur Springs on Texas Highway 11, 3.8 miles south on Farm Road 1569, 3.6 miles southeast on Farm Road 2948, and 25 feet north of road:

- A1—0 to 5 inches, dark yellowish-brown (10YR 4/4) loam; moderate, very fine, subangular blocky structure; hard, very friable; many roots; strongly acid; clear, smooth boundary.
- B1—5 to 25 inches, strong-brown (7.5YR 5/6) loam; moderate, fine and medium, subangular blocky structure; hard, very friable; few pores; few uncoated sand grains in lower part; few black concretions; very strongly acid; gradual, irregular boundary.
- B21t & A'2—25 to 35 inches, strong-brown (7.5YR 5/6) loam; common, medium, faint, yellowish-red (5YR 5/6) and few, fine, distinct light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; hard, friable; few roots; light yellowish-brown (10YR 6/4) uncoated sand around some peds and a few streaks, 1/8 to 1/2 inch wide, that extend into next layer; uncoated sand makes up about 20 percent of layer; few black concretions; few patchy clay films; very strongly acid; gradual, irregular boundary.
- B22t & A'2—35 to 42 inches, mottled, red (2.5YR 4/6), light brownish-gray (2.5Y 6/2), and yellowish-brown (10YR 5/4) clay; moderate, medium, subangular blocky structure; very hard, firm; few roots; light-gray (10YR 7/2) uncoated sand and silt surround many peds; streaks and pockets of uncoated sand and silt, 1/8 to 1 inch in diameter and 2 to 5 inches long, make up about 20 percent of layer; few clay films; very strongly acid; abrupt, wavy boundary.
- B23t—42 to 59 inches, gray (10YR 6/1) clay; many, medium, prominent red (2.5YR 4/6) and common, medium, faint, light brownish-gray (10YR 6/2) and distinct yellowish-brown (10YR 5/4) mottles; weak, coarse, prismatic structure parting to moderate, medium, blocky; very hard, firm; few roots; few thin streaks of uncoated sand grains; few clay films; few pressure faces; very strongly acid diffuse, wavy boundary.
- B24t—59 to 70 inches, mottled, gray (10YR 6/1), brownish-yellow (10YR 6/6), and red (2.5YR 4/6) clay; weak, coarse, prismatic structure parting to moderate, medium, blocky; very hard, firm; few roots; some peds are covered with light gray (10YR 7/2); few clay films; few pressure faces; strongly acid; gradual, wavy boundary.
- B3—70 to 90 inches, gray (10YR 6/1) sandy clay loam; many, coarse, distinct yellowish-brown (10YR 5/6) mottles; weak, prismatic structure parting to weak, medium and coarse, blocky; very hard, firm; few roots; surfaces of peds are coated with light gray (10YR 7/2) clay; few masses of white crystals; few black concretions; medium acid.

The solum is 60 to more than 100 inches thick. The A horizon is loam or fine sandy loam. It is strongly acid to slightly acid. This horizon is dark yellowish brown, yellowish brown, brown, and dark grayish brown.

The B1 horizon is loam or sandy clay loam. It is very strongly acid to slightly acid. Colors in this horizon range from strong brown to very pale brown. The B21t and A'2 horizon is loam, sandy clay loam, or clay loam. The upper 4 to 12 inches is 18 to 30 percent clay. Reaction in the B21t and A'2 horizon is very strongly acid or strongly acid. This horizon is yellowish brown, strong brown, yellowish red, or red. It is mottled in these colors and in other colors in shades of brown, red, and gray. The B22t and A'2 and lower Bt horizons are 40 to 60 percent clay. They are mottled in shades of red, gray, brown, and yellow. Reaction ranges from very strongly acid in the B22t and A'2 horizon to mildly alkaline in the B3 horizon. The B3 horizon is sandy clay loam, clay loam, or clay. It is red, gray, brown, and yellow.

## Wilson Series

The Wilson series consists of deep, nearly level to

gently sloping, loamy soils on uplands. These soils formed in alkaline clay under prairie grasses.

In a representative profile the surface layer is a very dark gray clay loam about 5 inches thick. The subsoil is a clay about 61 inches thick. The upper 35 inches is very dark gray and has dark grayish-brown mottles. Below this, to a depth of 54 inches, the subsoil is dark grayish brown and has olive-brown mottles. The next lower layer is a mottled, gray, strong-brown, and dark-gray clay about 12 inches thick. The underlying material, to a depth of 82 inches, is gray and strong-brown stratified shale and clay.

Wilson soils are somewhat poorly drained. Permeability is very slow, and available water capacity is high in these soils. They are used mainly for pasture.

Representative profile of Wilson clay loam, 0 to 2 percent slopes, 13 miles west of Sulphur Springs on Texas Highway 11, 1.1 miles north on Farm Road 3134, and 100 feet west of road:

- Ap—0 to 5 inches, very dark gray (10YR 3/1) clay loam; weak, very fine, subangular blocky structure; extremely hard, firm; few roots; many pores; slightly acid; abrupt, wavy boundary.
- B21tg—5 to 22 inches, very dark gray (10YR 3/1) clay; moderate, coarse, blocky structure parting to very fine blocky; extremely hard, very firm; few roots; many clay films; common pressure faces; slightly acid; gradual, wavy boundary.
- B22tg—22 to 40 inches, very dark gray (10YR 3/1) clay; few, fine, faint, olive-brown (2.5Y 4/4) and dark grayish-brown (10YR 4/2) mottles; moderate, fine and medium, blocky structure; extremely hard, very firm; few roots; many clay films; common slickensides; few black concretions; mildly alkaline; gradual, wavy boundary.
- B23tg—40 to 54 inches, dark grayish-brown (2.5Y 4/2) clay; common, fine, faint, olive-brown (2.5Y 4/4) mottles; moderate, fine, blocky structure; extremely hard, very firm; common slickensides; few calcium carbonate concretions and soft masses; few black concretions; moderately alkaline; gradual boundary.
- B3g—54 to 66 inches, prominently mottled gray (10YR 5/1), strong-brown (7.5YR 5/8), and dark-gray (10YR 4/1) clay; weak, fine, blocky structure; extremely hard, very firm; few slickensides; common shale fragments; few calcium carbonate concretions and soft masses; few black concretions; moderately alkaline; gradual boundary.
- Cg—66 to 82 inches, gray (10YR 6/1) and strong-brown (7.5YR 5/8) stratified shale and clay; massive; very hard, very firm; few calcium carbonate concretions; moderately alkaline.

The solum is 40 to 75 inches in thickness. Reaction in the Ap or A1 horizon is medium acid to slightly acid. Colors are very dark gray, dark gray, or dark grayish brown. The Ap or A1 horizon is 3 to about 10 inches in thickness.

The Bg horizon is clay or clay loam that is 35 to 50 percent clay. Reaction ranges from medium acid to moderately alkaline.

The B21tg and B22tg horizons are very dark gray or dark gray. They have few to common mottles in shades of gray, olive, or brown. The lower Bg horizons are mottled in shades of olive, yellow, gray, and brown.

Calcium carbonate concretions and soft masses range from none to few in the lower part of the Bg and C horizons.

The C horizon is mottled in shades of gray, brown, and yellow. This is shaly clay or stratified layers of shale, clay, and clay loam.

**WcB—Wilson clay loam, 0 to 2 percent slopes.** This nearly level to gently sloping soil occupies broad inter-

stream divides. Mapped areas are irregular in shape, and they range from about 20 to 400 acres in size.

Included with this soil in mapping are small areas of Crockett soils. These are on small low mounds or ridges and are less than 3 acres in size. The Crockett soils make up less than 5 percent of the mapped areas.

Runoff is slow to very slow on this Wilson soil. The erosion hazard is slight.

This soil is used mainly for pastures of native and improved grasses, but in places areas of it are cultivated. Corn, grain sorghum, cotton, small grains, and hay are grown on this soil.

Some adapted grasses and legumes are grown. Examples of these are bahiagrass, bermudagrass, lovegrass, King Ranch bluestem, vetch, hop clover, and burclover.

Seedbed preparation and grass establishment are difficult because of surface crusting. Leaving crop residue near the surface helps to maintain soil tilth and control erosion. Surface drainage systems help the removal of excess water. Capability unit IIIw-1; pasture and hayland group 7H.

### Wolfpen Series

The Wolfpen series consists of deep, gently sloping, sandy soils on uplands. These soils formed in lenticular sands under a mixture of hardwood and pine trees.

In a representative profile the surface layer, to a depth of 27 inches, is loamy fine sand. The upper part is brown, and the lower part is pale brown. The subsoil, to a depth of 100 inches, is sandy clay loam. The upper part is yellowish brown, and the lower part is mottled, gray, red, and yellowish brown.

These soils are well drained. Permeability is moderate, and available water capacity is medium. These soils are used mainly for pasture.

Representative profile of Wolfpen loamy fine sand, 1 to 5 percent slopes, 12 miles east of Sulphur Springs on Interstate 30, 3.2 miles south on Farm Road 269, and 275 feet west of road:

- A1—0 to 6 inches, brown (10YR 4/3) loamy fine sand; weak, medium, granular structure; loose; many roots; medium acid; clear, wavy boundary.
- A2—6 to 27 inches, pale-brown (10YR 6/3) loamy fine sand; single grained; loose; many roots; slightly acid; clear, wavy boundary.
- B21t—27 to 31 inches, yellowish-brown (10YR 5/6) sandy clay loam; common, medium, faint, yellowish-brown (10YR 5/4) and dark yellowish-brown (10YR 3/4) mottles; moderate, medium, subangular blocky structure; very hard, friable; common roots; common clay films; dark yellowish-brown (10YR 4/4) coatings on faces of peds; slightly acid; clear, wavy boundary.
- B22t—31 to 38 inches, yellowish-brown (10YR 5/4) sandy clay loam; common, medium and coarse, faint strong-brown (7.5YR 5/6) and few, fine, medium, distinct grayish-brown (10YR 5/2) and yellowish-red (5YR 4/8) mottles; moderate, medium, subangular blocky structure; very hard, friable; common roots; common clay films; dark yellowish-brown (10YR 4/4) coatings on faces of peds; strongly acid; gradual, wavy boundary.
- B23t—38 to 45 inches, yellowish-brown (10YR 5/8) sandy clay loam; few, medium, faint strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky

structure; very hard, friable; common roots; common clay films; dark yellowish-brown (10YR 4/4) coatings on faces of peds; medium acid; gradual, wavy boundary.

- B24t & A 2—45 to 83 inches, yellowish-brown (10YR 5/6) sandy clay loam; common, coarse, distinct red (2.5YR 4/6) mottles; moderate, coarse, subangular blocky structure; very hard, friable; common roots; vertical streaks, 1/2 to 1 1/2 inches wide, of light-gray (10YR 7/2), uncoated sand grains extend through layer and are 8 to 14 inches apart; few pockets of uncoated sand grains in lower part; few black concretions; slightly acid; gradual, wavy boundary.

- B3t—83 to 100 inches, prominently mottled, gray (10YR 6/1), red (2.5YR 4/6), and yellowish-brown (10YR 5/8) sandy clay loam; weak, medium, subangular blocky structure; very hard, firm; few roots; few patchy clay films; slightly acid.

The solum is 70 to more than 100 inches in thickness. The A horizon is medium acid to neutral. The A1 horizon is brown, dark yellowish brown, or dark grayish brown. The A2 horizon is pale brown, light yellowish brown, very pale brown, or yellowish brown. The A horizon is 20 to 40 inches in thickness.

The Bt horizon is sandy clay loam, clay loam, or loam. The upper 20 inches is 20 to 30 percent clay. Reaction is very strongly acid to slightly acid in this horizon. Colors are yellowish brown and strong brown, and the material is mottled in shades of red, brown, gray, and yellow.

**WoC—Wolfpen loamy fine sand, 1 to 5 percent slopes.** This gently sloping soil is on ridges and interstream divides. Mapped areas are oval in shape and range from about 20 to 200 acres in size.

Included with this soil in mapping are spots of Pickton soils. These inclusions are mostly on the top of ridges. They are 1 to 5 acres in size and make up about 10 percent of the mapped areas.

Runoff is slow on this Wolfpen soil.

Although this soil is used mainly for pasture and hay meadows (fig. 7) of improved grasses, areas are cultivated in places and used for truck crops and corn.

In places adapted grasses and legumes are grown in this soil. Examples of these are bermudagrass, bahiagrass, lovegrass, vetch, and arrowleaf clover.

This soil does not retain its fertility well. Frequent application of fertilizers in small amounts is more beneficial than infrequent applications in large amounts. Leaving crop residue on the surface helps to maintain content of organic matter and control soil blowing. Lime is needed for certain crops. Capability unit IIIs-2; pasture and hayland group 9A.

### Woodtell Series

The Woodtell series consists of deep, gently sloping to strongly sloping, loamy soils on uplands. These soils formed in stratified loamy and clayey sediment under a plant community of mixed hardwood and native grass.

In a representative profile the surface layer is loam about 9 inches thick. The upper 3 inches is very dark grayish brown, and the lower 6 inches is yellowish brown. The subsoil is a clay about 37 inches thick. The upper 8 inches is yellowish red with grayish-brown mottles; the middle 7 inches is red with gray that has yellowish-brown mottles; and the lower 22 inches is gray with red and yellowish-brown mottles. The next



Figure 7.—Coastal hay in large round bales on Wolfpen loamy fine sand, 1 to 5 percent slopes.

lower layer, to a depth of 58 inches, is light-gray clay with red and brownish-yellow mottles. The underlying material, to a depth of 72 inches, is light olive-brown clay loam and shale that has variegated layers of gray and yellow.

Woodtell soils are moderately well drained. Permeability is very slow and available water capacity is high.

These soils are used mainly for pasture.

Representative profile of Woodtell loam, 5 to 12 percent slopes, 12.7 miles south of Sulphur Springs on Texas Highway 154, 2 miles west on county road, 0.4 mile north on private road, and 5 feet east of road:

- A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) loam; moderate, fine, granular structure; hard, very friable; many roots; slightly acid; clear, smooth boundary.
- A2—3 to 9 inches, yellowish-brown (10YR 5/4) loam; weak, fine, subangular blocky structure; hard, very friable; many roots; strongly acid; abrupt, wavy boundary.
- B21t—9 to 17 inches, yellowish-red (5YR 4/8) clay; common, fine, distinct, grayish-brown (10YR 5/2) mottles; moderate, fine and medium, blocky structure; extremely hard, very firm; many roots; many clay films; common small slickensides; very strongly acid; gradual, wavy boundary.
- B22t—17 to 24 inches, red (2.5YR 4/6) clay; many, medium, distinct gray (10YR 5/1) mottles; few, fine, distinct yellowish-brown (10YR 5/4) mottles; moderate, fine and medium, blocky structure; extremely

hard, very firm; many roots; many clay films; common slickensides; very strongly acid; gradual, wavy boundary.

- B23t—24 to 46 inches, gray (10YR 5/1) clay; common, fine, distinct red (2.5YR 4/6) and yellowish-brown (10YR 5/4) mottles; moderate, medium, blocky structure; extremely hard, very firm; common roots; many clay films; common slickensides; very strongly acid; gradual, wavy boundary.

- B3—46 to 58 inches, light-gray (10YR 7/1) clay; common, fine and medium, distinct brownish-yellow (10YR 6/6) and few, fine, prominent red (2.5YR 4/6) mottles; weak, coarse, blocky structure; extremely hard, very firm; few roots; few masses of neutral salts; strongly acid; gradual, wavy boundary.

- C—58 to 72 inches, light olive-brown (2.5Y 5/4) clay loam and shale that has layers of variegated gray (10YR 5/1) and yellow (10YR 7/6); massive with evident bedding planes; extremely hard, extremely firm; few roots between layers; few masses of neutral salts; neutral.

The solum ranges from 36 to about 65 inches in thickness. The A horizon is very strongly acid to slightly acid. The A1 horizon is very dark grayish brown, grayish brown, dark brown, brown, or dark yellowish brown. It is 3 to 6 inches thick. The A2 horizon is grayish brown, brown, or yellowish brown. The total thickness of the A horizon is 4 to 9 inches.

The B21t and B22t horizons are very strongly acid or strongly acid. They are red and yellowish red and have few to common mottles in shades of red, yellow, gray, or brown. The lower Bt and B3 horizons are clay, clay loam, or sandy clay loam. Reaction is very strongly acid to slightly acid in these horizons. They are gray, light gray, yellowish brown, or grayish brown and have few to many mottles

in these colors and in shades of red and yellow.

The C horizon is loam, shale, sandy clay loam, clay loam, or shaly clay. It is mottled in shades of red, gray, yellow, brown, or olive. Reaction is strongly acid to neutral in the C horizon.

**WtC—Woodtell loam, 2 to 5 percent slopes.** This gently sloping soil is along sides of small drainageways and on oblong, convex ridges. Mapped areas are irregular in shape. They range from about 15 to 200 acres in size, but the average size is about 30 acres.

In a representative profile the surface layer is loam about 8 inches thick. The upper 3 inches is brown and the lower 5 inches is yellowish brown. The subsoil is clay about 42 inches thick. The upper part is red and has a few strong-brown mottles, and the lower part is yellowish red and red and also has mottles. The underlying material, to a depth of 72 inches, is variegated layers of strong-brown, light-gray, and yellowish-red sandy clay loam and shaly clay.

Included with this soil in mapping are small areas of Raino and Lufkin soils. The Raino soils are on small, low mounds. The Lufkin soils are in low wet spots. These included soils make up less than 15 percent of the total acreage of the mapped areas.

Runoff is medium on this Woodtell soil. The hazard of erosion is severe.

This soil is used for pasture (fig. 8) of improved and

native grasses. About 25 percent of the acreage is in oak trees that have an understory of native grasses. A few small areas are cultivated and are used to grow truck crops and corn.

In places adapted grasses and legumes are grown in this soil. Examples are bermudagrass, bahiagrass, lovegrass, crimson clover, vetch, and arrowleaf clover. Leaving crop residue on the surface helps to maintain soil tilth and control erosion. Terracing, contour farming, and keeping grass on waterways help to control erosion. Lime is needed for certain crops. Capability unit IIIe-2; pasture and hayland group 8A.

**WtD—Woodtell loam, 5 to 12 percent slopes.** This sloping to strongly sloping soil is along sides of drainageways. Mapped areas are long and narrow. They range from about 20 to 300 acres in size, and the average size is about 50 acres.

This soil has the profile described as representative for the Woodtell series. Included in mapping are areas of eroded Woodtell soils that are 5 to 20 acres in size. They make up about 20 percent of the total acreage.

Runoff is rapid in this soil. The hazard of erosion is very severe.

This soil is used for pasture of improved and native grasses (fig. 9). About half the acreage is in oak trees that have an understory of native grasses.



**Figure 8.**—A good stand of grass and an available source of water help keep cattle contented. The soil is Woodtell loam, 2 to 5 percent slopes.



**Figure 9.**—A good stand of bermudagrass which will be used for hay. The soil is Woodtell loam, 5 to 12 percent slopes.

In places adapted grasses and legumes are grown on this soil. Examples of these are bermudagrass, bahiagrass, lovegrass, crimson clover, arrowleaf clover, and singletary peas. This soil is not suited to crops because of slope and the hazard of erosion. Lime is needed for some legumes. Capability unit VIe-1; pasture and hayland group 8B.

**WwC—Woodtell stony loam, 1 to 5 percent slopes.** This gently sloping soil occupies oval, convex ridges that are in a chainlike pattern. Mapped areas range from about 15 to 100 acres in size. Large, rough-surfaced, boulderlike stones are exposed on the surface of this soil (fig. 10). These huge concretionary stones are not attached to any underlying bedrock. They range in size from 6 to 8 inches across the long axis (fragments) to 20 feet across this axis. Most of the stones, however, are 3 to 10 feet across the long axis, 2 to 8 feet wide, and 1 to 2 feet thick. Typically, stones occupy about 40 percent of the surface area.

In a representative profile the surface layer is a loam about 7 inches thick. The upper 3 inches is grayish brown, and the lower 4 inches is yellowish brown. The subsoil is a clay about 35 inches thick. The upper part is red and has common yellowish-brown mottles, and the lower part is yellowish red and has a few yellowish-brown mottles. The underlying material, to a depth

of 72 inches, is layers of yellowish-brown, brownish-yellow, and grayish-brown shale.

Runoff is medium on this soil. The hazard of erosion is moderate. A cover of plants should be kept on this soil to control erosion.

This soil is used for native pasture and wildlife habitat. Capability unit VIIs-1; not assigned to a pasture and hayland group.

### *Use and Management of the Soils*

In this section the capability grouping of soils is explained, and yields of crops under a high level of management are estimated. Also, a brief discussion of general soil management is presented, and use of the soils for pasture and hayland, range or grazing native grasslands, woodland, wildlife habitat, recreation, and engineering are discussed.

### **Cropland**<sup>2</sup>

Cropland makes up about 11 percent of Hopkins and Rains Counties. It is mainly in the western part of the survey area.

<sup>2</sup> ALFRED L. PACE, agronomist, Soil Conservation Service, assisted in the preparation of this section.

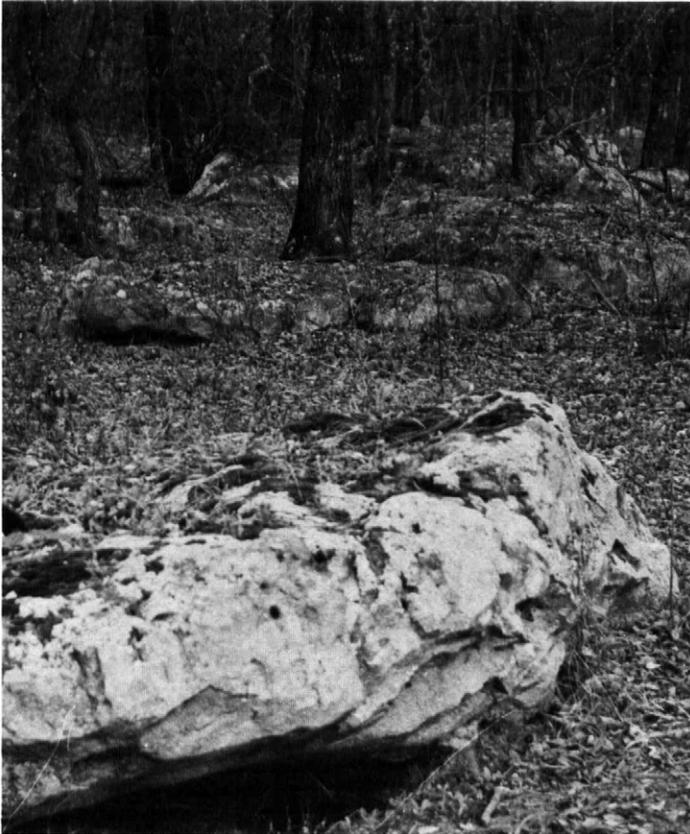


Figure 10.—Large stones exposed on surface of Woodtell stony loam, 1 to 5 percent slopes.



Figure 11.—Corn on Pickton loamy fine sand.

The principal crops grown are cotton, corn (fig. 11), grain sorghum, truck crops (fig. 12), and small grains.

In Hopkins and Rains Counties, management is needed mainly to control erosion, maintain soil tilth, and maintain soil fertility. The four most important practices used to accomplish these are discussed in the following paragraphs.

*Use of crop residue.*—Leaving a sufficient amount of residue on or just below the surface of the soil helps to maintain the content of organic matter and maintain soil tilth. It also helps to control water erosion and conserve moisture. All soils in the two counties benefit from proper use of crop residue.

*Terraces farmed on contour.*—Where slopes on terraces exceed about 1 percent, cultivating on the contour helps to decrease the hazard of erosion.

*Use of cover crops.*—Crops that cover the soil will protect against erosion during the period between the time a crop is harvested and the time the next crop is planted. Among crops suited to this purpose for most soils in the two counties are small grains, vetch, and mixtures of annual grasses and legumes.

*Maintenance of soil fertility.*—Crops in Hopkins and Rains Counties respond to fertilizers. Fertility can be maintained if proper amounts of fertilizers are applied and other soil management practices are used. The needs of soils for different kinds and amounts of fertilizer vary in different parts of the survey area. Therefore, the use of fertilizer should be based on the need of the

crop and should be determined by soil test. Information on soil testing and fertilizer application is provided by the Soil Conservation Service or the Agricultural Extension Service.

#### *Capability grouping*

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. 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 rice, 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. This classification, however, is



Figure 12.—Sweetpotatoes on Freestone fine sandy loam.

not a substitute for interpretations designed to show suitability and limitations for range, for forest trees, 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 land forms so rough, 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, range, 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, require about the same management, and have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIs-3.

The classes, subclasses, and units in the capability system that are applicable to Hopkins and Rains Counties are described in the list that follows. The unit designation is given in the Guide to Mapping Units.

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

Subclass IIe. Soils subject to moderate erosion unless protected.

Unit IIe-1. Deep, gently sloping, well-drained fine sandy loams on uplands.

Unit IIe-2. Deep, gently sloping, moderately well drained fine sandy loams on uplands.

Unit IIe-3. Deep, gently sloping, moderately well drained clays on uplands.

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

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Unit IIIe-1. Deep, gently sloping, moderately well drained, slightly acid loams on uplands.

Unit IIIe-2. Deep, gently sloping, moderately well drained, strongly acid on uplands.

Unit IIIe-3. Deep, gently sloping, well drained and moderately well drained clays on uplands.

Subclass IIIs. Soils severely limited for cultivation because of very slow permeability, a thick sandy surface layer, or low available water capacity.

Unit IIIs-1. Deep, nearly level, moderately well drained loams on uplands.

Unit IIIs-2. Deep, gently sloping, well-drained loamy fine sands that have medium available water capacity; on uplands.

Unit IIIs-3. Deep, gently sloping, well-drained loamy fine sands that have low available water capacity; on uplands.

Subclass IIIw. Soils severely limited for cultivation because of excess water.

Unit IIIw-1. Deep, nearly level to gently sloping, somewhat poorly drained clay loams on uplands.

Unit IIIw-2. Deep, nearly level, somewhat poorly drained to moderately well drained loams on uplands.

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

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Unit IVe-1. Deep and moderately deep, gently sloping, well drained to moderately well drained loams and clay loams on uplands.

Unit IVe-2. Deep, gently sloping to sloping, well-drained gravelly fine sandy loams on uplands.

Class V. Soils that are subject to little or no erosion but have other limitations, impractical to remove, which limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass Vw. Soils that are too wet for cultivation and are frequently flooded.

Unit Vw-1. Deep, nearly level, somewhat poorly drained clay loams to silty clay loams on flooded plains.

Unit Vw-2. Deep, nearly level, somewhat poorly drained and poorly drained clays on flood plains.

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

Subclass VIe. Soils severely limited, chiefly by

risk of erosion, unless protective cover is maintained.

Unit VIe-1. Deep and moderately deep, sloping to strongly sloping, well drained and moderately well drained loams and clay loams on uplands.

Unit VIe-2. Moderately deep, sloping to strongly sloping, well-drained clays on uplands.

Unit VIe-3. Moderately deep, gently sloping and sloping, well-drained soils on uplands.

Class VII. Soils having very severe limitations that make them unsuited to cultivation and restrict their use largely to range, woodland, or wildlife food and cover.

Subclass VIIs. Soils very severely limited, chiefly by stones.

Unit VIIs-1. Deep, gently sloping, moderately well drained stony loams on uplands.

### **Predicted yields**

Predicted yields of principal crops grown in the survey area are listed in table 2. These are average yields per acre expected from good commercial farms managed at a level that tends to produce the highest economic returns. Predictions are based on information derived from research data and on estimates made primarily by farmers and soil scientists.

The yields are given for dryland soils. Not included in this table, however, are soils that are used only for range or recreation.

Predicted yields of crops other than those shown in table 2 are not included either because their acreage is small or because reliable data on yields are not available.

The predicted yields in table 2 can be expected if rainfall is effectively used and conserved; surface drainage systems, subsurface drainage systems, or both are installed; crop residue is returned to the soil to maintain tilth; minimum but timely tillage is used; insect-, disease-, and weed-control measures are consistently used; fertilizer is applied according to soil tests and crop needs; and adapted crop varieties are used at recommended seeding rates.

### **Pasture and Hayland<sup>3</sup>**

The major management practices for productive pasture and hayland are discussed in this section.

The livestock industry, the main agricultural enterprise in Hopkins and Rains Counties, is important to the economy of these counties. Most of the soils are used to produce forage for livestock (fig. 13). The predicted yields of individual soils under a high level of management are given in table 2.

Pastures in Hopkins and Rains Counties are largely warm-season grasses and cool-season legumes, but cool-season perennial grasses are used to a lesser extent.

<sup>3</sup> ALFRED L. PACE, agronomist, Soil Conservation Service, assisted in the preparation of this section.

TABLE 2.—*Predicted average yields of principal crops*

[Absence of data indicates that the crop is not suited to the soil or generally is not grown on it]

| Soil  | Corn           | Cotton lint    | Grain sorghum  | Coastal bermuda-grass   | Common bermuda-grass    | Pensacola bahiagrass    | Lovegrass               |
|---|----------------|----------------|----------------|-------------------------|-------------------------|-------------------------|-------------------------|
|   | <i>Bu/acre</i> | <i>Lb/acre</i> | <i>Bu/acre</i> | <i>AUM</i> <sup>1</sup> | <i>AUM</i> <sup>1</sup> | <i>AUM</i> <sup>1</sup> | <i>AUM</i> <sup>1</sup> |
| Annona-Raino complex .....                                      | ---            | ---            | ---            | 7.0                     | 6.0                     | 6.0                     | 7.0                     |
| Bazette clay loam, 3 to 5 percent slopes .....                  | 60             | ---            | 60             | 7.0                     | 6.0                     | 6.0                     | 7.0                     |
| Bazette clay loam, 5 to 12 percent slopes .....                 | ---            | ---            | ---            | 6.0                     | 5.0                     | 5.0                     | 6.0                     |
| Bernaldo fine sandy loam, 1 to 3 percent slopes .....           | 65             | 400            | 65             | 8.0                     | 7.0                     | 7.0                     | 8.0                     |
| Crockett loam, 0 to 1 percent slopes .....                      | 45             | 400            | 60             | 7.5                     | 6.5                     | 6.5                     | 7.5                     |
| Crockett loam, 1 to 3 percent slopes .....                      | 40             | 350            | 55             | 7.5                     | 6.5                     | 6.5                     | 7.5                     |
| Crockett loam, 3 to 5 percent slopes .....                      | ---            | ---            | ---            | 6.5                     | 5.5                     | 5.5                     | 6.5                     |
| Crockett loam, 2 to 5 percent slopes, eroded .....              | ---            | ---            | ---            | 5.5                     | 5.0                     | 5.0                     | 5.5                     |
| Ellis clay, 5 to 12 percent slopes .....                        | ---            | ---            | ---            | 5.0                     | 4.0                     | ---                     | 5.0                     |
| Ferris clay, 5 to 12 percent slopes, eroded .....               | ---            | ---            | ---            | 5.0                     | 4.0                     | ---                     | 5.0                     |
| Freestone fine sandy loam, 1 to 3 percent slopes .....          | 60             | 400            | 60             | 9.0                     | 8.0                     | 8.0                     | 9.0                     |
| Gladewater clay .....   | ---            | ---            | ---            | 7.0                     | 6.0                     | 6.0                     | ---                     |
| Heiden clay, 3 to 5 percent slopes, eroded .....                | 45             | 350            | 50             | 6.0                     | 5.0                     | ---                     | 6.0                     |
| Hopco silty clay loam .....                                     | ---            | ---            | ---            | 10.0                    | 8.0                     | 7.0                     | ---                     |
| Kaufman clay .....  | ---            | ---            | ---            | 8.0                     | 7.0                     | ---                     | ---                     |
| Kirvin gravelly fine sandy loam,<br>3 to 8 percent slopes ..... | 50             | ---            | ---            | 8.0                     | 7.0                     | 7.0                     | 8.0                     |
| Kirvin soils, 3 to 8 percent slopes .....                       | ---            | ---            | ---            | 6.0                     | 5.0                     | 5.0                     | 6.0                     |
| Leson clay, 1 to 3 percent slopes .....                         | 45             | 450            | 80             | 7.0                     | 6.0                     | ---                     | 7.0                     |
| Leson clay, 3 to 5 percent slopes .....                         | 40             | 300            | 55             | 6.0                     | 5.0                     | ---                     | 6.0                     |
| Lufkin-Raino complex .....                                      | ---            | ---            | ---            | 5.5                     | 5.0                     | 5.0                     | 5.5                     |
| Nahatche soils .....  | ---            | ---            | ---            | 9.0                     | 7.0                     | 8.0                     | 9.0                     |
| Pickton loamy fine sand, 1 to 5 percent slopes .....            | 60             | ---            | ---            | 6.5                     | ---                     | ---                     | 6.5                     |
| Wilson clay loam, 0 to 2 percent slopes .....                   | 35             | 300            | 55             | 6.0                     | 5.5                     | 5.5                     | ---                     |
| Wolfpen loamy fine sand, 1 to 5 percent slopes .....            | 70             | ---            | ---            | 7.0                     | 6.0                     | 6.0                     | 7.0                     |
| Woodtell loam, 2 to 5 percent slopes .....                      | 45             | 250            | 70             | 7.5                     | 6.5                     | 6.5                     | 7.5                     |
| Woodtell loam, 5 to 12 percent slopes .....                     | ---            | ---            | ---            | 6.0                     | 5.0                     | 5.0                     | 5.5                     |
| Woodtell stony loam, 1 to 5 percent slopes .....                | ---            | ---            | ---            | ---                     | ---                     | ---                     | ---                     |

<sup>1</sup> Animal-Unit-Month (AUM) is a term used to express the carrying capacity of pasture. It is the amount of forage or feed required to maintain one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.



Figure 13.—Brahma cattle and common bermudagrass pasture on Freestone fine sandy loam.

Common and Coastal bermudagrass, pensacola bahiagrass, lovegrass, and fescue are the most commonly used grasses. The bermudagrasses are the most widely used, and they are adapted to most of the soils. Pensacola bahiagrass is adapted to most of the soils but not to calcareous soils. Lovegrass is better adapted to well-drained soils than it is to those that are not well drained. Fescue is better adapted to soils on flood plains than to soils in other areas.

The most widely used legumes in pastures are crimson, white, and arrowleaf clovers. Vetch, lespedeza, singletary peas, and hop clover are also used. Crimson and arrowleaf clovers are better adapted to noncalcareous soils on uplands than to calcareous soils in other areas. White clover is better adapted to soils on flood plains than it is to soils in other areas. The legumes are mostly overseeded on established stands of bermudagrass or fescue.

The main management practices needed for pasture are fertilization, weed control, and controlled grazing. Fertilization should be according to a current soil analysis which would take into account plant needs and the level of production desired. Weeds can be controlled by shredding or mowing or by using weed herbicides. A good stand of well-managed grass will crowd out weeds. Pastures that are overgrazed have more weeds, produce less grass, and are susceptible to increased soil compaction by animals.

A good cover on the pasture in winter will curtail erosion and protect the grass from the cold.

Temporary pasture plants are often used to supplement perennial ones. Sudangrass, johnsongrass, and Sudan-sorghum hybrids are good supplemental plants for summer pasture. Small grains provide good supplemental plants for winter pasture.

A well-managed hay meadow has soils fertilized, weeds controlled, and forages cut at proper intervals and heights to obtain a high-quality hay and maintain plant vigor. Generally such sod-forming grasses as bermudagrass can be cut lower than bluestems or other bunchgrasses. Cutting too close or too often not only reduces the amount of grass in the stand, but decreases the amount of future production.

#### **Pasture and hayland groups**

The soils are placed in pasture and hayland groups according to their suitability for the production of forage. The soils in each group are enough alike to be suited to the same grasses, have similar limitations and hazards, require similar management, and have similar productivity and other responses to management. The pasture and hayland groups in Hopkins and Rains Counties are identified by numerals and uppercase letters; for example, 1A. Although the numbers are assigned locally, they are a part of a statewide system. Not all the groups in the system are represented by the soils of Hopkins and Rains counties; therefore, the numbers are not consecutive.

The names of the soils in any group can be found by referring to the "Guide to Mapping Units" at the back of this soil survey.

#### **Range<sup>4</sup>**

Range is land on which the native vegetation, whether climax or natural potential, is dominated by grasses, grasslike plants, forbs, and shrubs. These are suitable for grazing and are present in sufficient quantity to justify grazing use. Included with these are natural grasslands, savannahs, many wetlands, and certain forb and shrub communities. These native grazing lands consist of many species and receive no cultural treatment. The composition and production of forage plants are largely determined by kind of soil, climate, overstory canopy, and past and present grazing management.

Three distinct kinds of native grazing lands are in the survey area: claypan prairies in the northern and western part, hardwood bottom lands of the Sabine and Sulphur Rivers and their tributaries, and post oak savannahs. Such grazing lands make up 136,000 acres of the survey area.

When Hopkins and Rains Counties were first settled, the claypan prairies were a grassy, nearly treeless plain. Big bluestem, indiangrass, little bluestem, and tall dropseeds dominated the prairie vegetation. The prairies were an excellent range for cattle. By 1900, however, most areas of the prairie had been cleared and cultivated.

Native grasslands with scattered trees, either as individuals or motts, are known as *savannahs*. They are plains that are transitional between true prairies and forests. Savannahs occur on sandy outliers on bottom lands where soil moisture is adequate to grow trees and shrubs along with the dominant grasses of the prairie. Activities by man and his livestock caused the native woody plants to increase on the savannahs of the survey area until they presently resemble a forest. The woody plants, however, have little commercial value, and the area is used primarily to grow forage for livestock and wildlife.

Dairying and livestock farming are important enterprises in Hopkins and Rains Counties. In 1969 more than 600 grade A dairies were in operation. Approximately 137,000 dairy and beef cattle grazed on grasslands of the survey area at that time.

The principal source of forage for cattle is from tame pasture. These pastures are mostly monocultures of introduced species. They receive regular cultural treatment such as fertilization, weed control, and overseeding with legumes and winter grasses to insure high production. Many farms and ranches, however, also have native grazing lands which contribute significantly to the total forage needs of livestock and big game.

Vegetation, both native and introduced, is produced mainly in two distinct growth periods. Approximately two-thirds of the annual growth is produced in April, May, and June when rainfall and temperature are most favorable for growth of warm-season plants. A secondary growth period occurs during September and October. Texas wintergrass grows mostly on the Black-

<sup>4</sup> DON PENDLETON, range conservationist, Soil Conservation Service, assisted in the preparation of this section.

land range site, and it is valuable winter forage. Short droughts are common in midsummer, and lengthy droughts occur about one year in five.

#### **Range sites and condition classes**

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of range that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasesers are plants in the climax vegetation that increase in relative amount as the more desirable decreaseer plants are reduced by close grazing. They are commonly shorter than decreaseers and are generally palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increaseers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep the range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing

important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

#### **Descriptions of range sites**

In the following paragraphs, the range sites of Hopkins and Rains Counties are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

##### BLACKLAND RANGE SITE

In this site are gently sloping, deep, clayey soils in virgin areas that often exhibit microridges and valleys extending up and down slope. The flatter areas have mostly a microrelief of knolls and depressions. Permeability is slow, and available water capacity is high in soils of this site.

The climax plant community is a tall-grass prairie. Approximate species composition, by weight, is big bluestem and indiangrass, 35 percent; eastern gama and little bluestem, 15 percent each; dropseeds, Texas wintergrass, longspike tridens, silver bluestem, and buffalograss, 5 percent each; and such trees as hackberry, elm, osageorange, honeylocust, and other woody plants, less than 5 percent. Indigenous perennial forbs such as Englemann daisy, Maximilian and hairy sunflower, button-snakeroot, gayfeathers, coneflower, indianplantain, bundleflower, and prairie-clover make up 40 percent of the annual yield.

Total annual yield on a site in excellent condition ranges approximately from 4,000 to 7,000 pounds of air-dry vegetation per acre, depending on rainfall and growing conditions. About 95 percent of this yield is plants that provide forage for cattle. Abandoned cropland is characteristically in Texas wintergrass, meadow dropseed, and silver bluestem. In places the climax plant community deteriorates to buffalograss and Texas wintergrass under prolonged overgrazing by cattle. Mesquite trees often invade the areas.

##### CLAYEY BOTTOMLAND SITE

In this site are deep, nearly level clayey soils on flood plains of major rivers and some of their larger tributaries. These soils receive additional water because of runoff from higher adjacent sites and overflow. They are frequently flooded. Permeability is very slow, and available water capacity is high in the soils of this site.

The climax plant community consists of savannah of oaks, elm, osageorange, hackberry, sycamore, cottonwood, ash, willow, and other hardwoods. Underbrush

includes hawthorns, plums, Texas sophora, Alabama supplejack, peppervine, trumpetcreeper, grapes, and greenbrier. The herbaceous understory is dominated by sedges and Virginia wildrye. Approximate species composition, by weight, is sedges and wildrye, 35 percent; uniola, beaked panicum, and eastern gama, 10 percent each; combinations of nimblewill, redtop, and low panicums, 10 percent; woody plants, 20 percent; and forbs, 5 percent. Making up about 20 percent of the native forbs are ironweed, blood ragweed, white crownbeard, lespedezas, and tickclover.

Total annual yield if the site is in excellent condition ranges approximately from 4,000 to 7,500 pounds of air-dry vegetation per acre, depending upon overstory canopy, overflow, rainfall, and other growing conditions. About 80 percent of the yield is plants that provide forage for livestock.

This site is a preferred grazing area because of the palatable and nutritious forage produced on the site, the presence of large shade trees, and its proximity to water. As a result, it is one of the first to be heavily grazed. While retrogression occurs, trees and shrubs increase to form a dense canopy. As the canopy thickens, up to a point, such shade-tolerant grasses as sedges, uniola, wildrye, and low panicums become more prominent. A dense canopy severely restricts production of all herbaceous plants.

Bermudagrass and dallisgrass often occupy closely grazed open areas. Broomsedge bluestem, cocklebur, smallhead sneezeweed, white crownbeard, blood ragweed, fogfruit, coneflower, and sumpweed often invade if a site is in a deteriorated condition.

#### CLAYPAN PRAIRIE SITE

On this site are nearly level to strongly sloping, deep and moderately deep, loamy soils. Available water capacity is medium to high, and permeability is slow to very slow.

The climax plant community consists predominately of tall grasses. Sparse woody inhabitants are elm, hackberry, osageorange, honeylocust, and pricklyash. Large oak trees are widely spaced over the site, because new oak trees usually do not re-establish once they have been removed. Approximate species composition, by weight, is indiagrass and big bluestem, 30 percent; little bluestem, 20 percent; tall dropseed, 10 percent; Texas wintergrass, wildrye, and sedges, 10 percent; longspike tridens and Florida paspalum, 10 percent; other grasses, 10 percent; woody plants, 5 percent; and such climax forbs as Englemann daisy, Maximilian sunflower, gayfeather, sensitivebriar, bundleflower, neptunia, prairieclover, scurfpea, groundplum, 5 percent.

Total annual yield on a site in excellent condition ranges approximately from 3,000 to 6,000 pounds of air-dry vegetation per acre, depending upon growing conditions. Approximately 85 percent of the yield is produced from plants that provide forage for livestock.

Abandoned cropland that initially supported broomsedge bluestem and low panicums has been mostly replaced by Texas wintergrass, meadow dropseed, and silver bluestem. Mesquite trees often invade the areas.

#### CLAYPAN SAVANNAH SITE

In this site are nearly level to strongly sloping, deep, loamy soils that have very slow permeability and high available water capacity.

The climax plant community is a post oak-blackjack oak savannah. Associated woody plants include red oak, hickory, hackberry, elm, hawthorn, yaupon, American beauty, greenbrier, grapevines, and berryvines. Tall and mid grasses dominate the understory. Approximate species composition, by weight, is little bluestem, 25 percent; indiagrass and big bluestem, 20 percent; beaked panicum, 10 percent; longleaf uniola, 10 percent; purpletop, 5 percent; low paspalums and panicums, 5 percent; woody plants, 20 percent; and such indigenous forbs as, lespedezas, tickclover, snoutbeans, tephrosia, milkpea, butterflypea, and sensitivebriar, 5 percent.

Total annual yield if the site is in excellent condition ranges approximately from 2,500 to 5,000 pounds of air-dry vegetation per acre, depending on overstory canopy, leaf and litter build-up, rainfall, and other growing conditions. Approximately 80 percent of the yield is plants that provide forage for livestock.

The plant-soil-moisture relationship and acid reaction of these soils favor growth of woody vegetation. In climax condition, the dense growth of grass and forbs, together with periodic fires, held the woody plants in check and maintained the savannah aspect of the site. Prolonged heavy grazing weakens and thins the herbaceous plants which, therefore, cannot successfully compete with woody plants for space, sunlight, moisture, and minerals. In this condition the site is immune to fire, and woody plants increase to resemble a hardwood forest. Shade-tolerant grasses and forbs, such as longleaf uniola, low panicums, and sedges, increase along with the thickening canopy until the shade becomes too dense. A dense canopy severely restricts production of all herbaceous plants.

#### DEEP SAND SITE

In this site are deep and gently sloping, sandy soils. Infiltration is rapid in these soils, but available water capacity is low and permeability is only moderate. The surface layer is thick and sandy, and the soils are droughty. Frequent rainfall is needed for optimum plant growth. Fertility is low, and forage production is poor compared to that of associated sites.

The climax vegetation is post oak-blackjack oak savannah. Associated woody plants are hickory, red oak, hackberry, bluejack oak, sassafras, persimmon, American beauty, yaupon, greenbrier, grapevines, and berry vines. Approximate species composition, by weight, is little bluestem, 25 percent; indiagrass, big bluestem, and beaked panicum, 10 percent each; purpletop, sand lovegrass, and longleaf uniola, 5 percent each; low panicums and paspalums, 5 percent; woody plants, 20 percent; forbs, 5 percent. Lespedezas, tickclover, snoutbean, vetch, partridgepea, spiderwort, dayflower, bullnettle, and croton make up about 30 percent of the native forbs.

Total annual yield when the site is in excellent condition ranges approximately from 2,500 to 4,000 pounds of air-dry vegetation per acre, depending upon

overstory canopy, leaf and mulch buildup, rainfall, and other growing conditions. About 90 percent of this yield is plants that provide forage for livestock.

The plant-soil-moisture relationship, acid reaction, and low fertility of the site are conducive to growth of woody vegetation.

#### ERODED BLACKLAND SITE

In this site are sloping to strongly sloping, deep, clayey soils. Permeability is very slow in these soils, and available water capacity is medium.

The climax plant community is a tall-grass prairie. In excellent condition approximate species composition, by weight, is indiagrass, 25 percent; big bluestem, 25 percent; little bluestem, 25 percent; meadow dropseed, 5 percent; Texas wintergrass, 5 percent; Carolina jointtail, 5 percent; and such forbs and woody plants as Englemann daisy, Maximilian sunflower, indian plantain, Texas parsley, button-snakeroot, sensitive brier, groundplum, sumac, bumelia, hackberry, coralberry, coral honeysuckle, pricklyash, and osage orange, 10 percent.

Total annual yield if the site is in excellent condition ranges approximately from 3,000 to 5,000 pounds of air-dry vegetation per acre, depending upon rainfall and growing conditions. About 90 percent of this yield is plants that provide forage for livestock.

Deterioration caused by prolonged overgrazing is marked by a decrease in big bluestem, indiagrass, little bluestem, wildrye, and palatable forbs. This in turn results in an increase of meadow dropseed, Texas wintergrass, silver bluestem, and less palatable forbs.

#### LOAMY BOTTOMLAND SITE

In this site are deep, nearly level, loamy soils on flood plains of large streams and their tributaries. They receive extra water from overflow or as runoff from higher adjacent sites. Permeability is moderate to moderately slow in these soils, and available water capacity is high.

The climax plant community is a savannah of pecan, oaks, hackberry, elm, ash, cottonwood, sycamore, black willow, and other hardwood trees. Underbrush includes hawthorns, Alabama supplejack, Texas sophora, greenbrier, grape, peppervine, trumpet creeper, and honeysuckle. The herbaceous understory is predominantly Virginia wildrye and sedges. Approximate species composition, by weight, is sedges and wildrye, 25 percent; switchgrass, eastern gama, and beaked panicum, 10 percent each; switchcane, plume grass, low panicums, and buffalograss, 5 percent each; woody plants, 20 percent; and forbs, 5 percent. Making up 35 percent of the indigenous forbs are ironweed, blood ragweed, white crownbeard, tickclover, lespedezas, wildbean, and gayfeather.

Total annual yield if the site is in excellent condition ranges approximately from 4,000 to 7,500 pounds of air-dry vegetation per acre, depending upon overstory canopy, overflow, rainfall, and other growing conditions. About 80 percent of this yield is plants that provide forage for livestock.

This site is generally preferred for grazing because

of the palatable and nutritious forage, the presence of large shade trees, and the proximity of the site to water. Because it is so desirable, it is one of the first to be overgrazed. As range condition deteriorates, trees, shrubs, and woody vines increasingly invade the areas to form a dense canopy. As the canopy thickens (up to a point), the percent of such shade-tolerant herbs as sedges, wildrye, and low panicums increases. As the overstory continues to close in, production by herbaceous plants is reduced proportionately.

#### SANDY SITE

In this site are deep, gently sloping, sandy soils that have moderate permeability, medium available water capacity, and low fertility. The soils are droughty, and frequent rainfall is needed for optimum plant growth. The quality of forage produced on the site is not so poor as that produced on associated sites.

The climax condition consists of a post oak-blackjack oak savannah. Associated woody plants are hickory, red oak, elm, hackberry, American beauty, yaupon, sassafras, greenbrier, peppervine, grapevines, and berry vines. Approximate species composition, by weight, is little bluestem, 25 percent; indiagrass, big bluestem, and beaked panicum, 10 percent; purpletop, sand lovegrass, and longleaf uniola, 5 percent each; low panicums, 5 percent; woody plants, 20 percent; and forbs, 5 percent. Native forbs include lespedezas, tickclover, snoutbean, vetch, tephrosia, milkpea, butterflypea, partridgepea, spiderwort, dayflower, bullnettle, and croton. They make up 30 percent of the total forb content.

Total annual yield if the site is in excellent condition ranges approximately from 3,000 to 5,500 pounds of air-dry vegetation per acre, depending upon overstory canopy, leaf and mulch buildup, rainfall and other growing conditions. About 85 percent of this yield is plants that provide forage for livestock.

The plant-soil-moisture relationship, acid reaction, and low fertility of the site are conducive to growth of woody vegetation. Ecologically, the dense herbaceous understory, coupled with periodic fires, has held the woody plants in check and maintained the savannah aspect. Prolonged heavy grazing weakens and thins the herbaceous understory to the extent where it cannot successfully compete with the woody vegetation for space, light, moisture, and minerals. In this condition the site is essentially immune to fire. Consequently, trees, shrubs, and woody vines generally increase and invade the areas to form dense thickets. As the canopy thickens, longleaf uniola and low panicums increase and light-tolerant plants decrease. Red lovegrass, yankeeweed, bullnettle, sandbur, and splitbeard bluestem are characteristic of the site in a deteriorated condition.

#### SANDY LOAM SITE

In this site are deep, gently sloping to sloping, loamy to gravelly loamy soils. Permeability is moderate to slow in these soils, and the available water capacity is medium to high.

The climax plant community is a post oak-blackjack oak savannah. Associated woody plants include red

oak, elm, hackberry, hickory, American beauty, yaupon, hawthorns, greenbrier, grape, and berryvines. The understory consists of tall and mid grasses.

Approximate species composition, by weight, is indiangrass and big bluestem, 20 percent; little bluestem, 20 percent; beaked panicum, 10 percent; longleaf uniola, 10 percent; purpletop, 5 percent; woody plants, 20 percent; and such native forbs as lespedezas, tickclovers, snoutbean, tephrosia, butterflypea, milkpea, wildbean, partridgepea, sensitivebriar, and croton, 5 percent.

Total annual yield if the site is in excellent condition ranges approximately from 3,500 to 6,000 pounds of air-dry vegetation per acre, depending upon overstory canopy, leaf and litter buildup, rainfall, and other growing conditions. About 80 percent of this yield is plants that provide forage for livestock.

The plant-soil-moisture relationship and acid reaction of these soils favor growth of woody vegetation. Before the advent of abusive grazing by domestic animals, the dense herbaceous understory, together with periodic fires, held the woody plants in check and maintained the savannah aspect of the site. As the site is subjected to prolonged heavy grazing, big and little bluestem, indiangrass, and beaked panicum decrease

in the plant community. As these and other herbaceous plants are weakened and thinned, they cannot compete successfully with woody plants for space, light, moisture, and minerals. In this condition the site is essentially immune to fire. Consequently, oaks, elm, hickory, hawthorns, American beauty, and associated woody species generally increase and resemble hardwood forest. Shade-tolerant herbaceous plants such as longleaf uniola, sedges, and low panicums generally increase along with the thickening canopy until the shade becomes too dense for them. Under a dense canopy, production of all herbaceous species is severely restricted.

### Woodland

This section has been provided to explain how soils affect tree growth and management in the County.

The woodland part of the survey area is confined mainly to the southeastern part of Hopkins County and the eastern part of Rains County. Approximately 15 percent of the total land area in the two counties is woodland. The trees are primarily species of oak. Loblolly and shortleaf pine, however, they are in scattered clumps and small plantations (fig. 14).



Figure 14.—Plantation of loblolly pine on Pickton loamy fine sand.

Potential productivity and management concerns for the soils in Hopkins and Rains Counties are listed in table 3. In the first column the soils are listed by their mapping unit symbols under the series name to which they belong. If a mapping unit contains the name of two series, as in a complex, the component soils are listed and evaluated separately under each series name. Soils not suited to woodland are not included in the table.

The next column gives the woodland group. Each group is made up of soils that are suited to the same kinds of trees, that need about the same kind of management to produce these trees, and that have about the same potential productivity. Each woodland group is identified by a 3-part symbol. These parts are explained in the following paragraphs.

The first part of the symbol indicates the relative productivity of the soils: 1 means very high; 2, high; 3, moderately high; 4, moderate; and 5, low.

The second part of the symbol, a letter, indicates the important soil property that imposes a moderate or severe hazard or limitation in managing the soils for wood production. The letter *w* shows that excessive water in or on the soil is the chief limitation; *c* shows that clay in the upper part of the soil is a limitation; *s* shows that the soils are sandy; *f* shows that the soils have large amounts of coarse fragments; and *o* shows that the soils have no significant restrictions or limitations for woodland use or management.

The third part of the symbol indicates the degree of management problems and the general suitability of the soils for certain kinds of trees.

In the third column is a list of some of the commercially important trees adapted to the soil. These are the trees that woodland managers will generally favor in intermediate or improvement cuttings. Given in the fourth column is the potential productivity of these trees in terms of site index. The site index is the average height of dominant trees in feet at age 30 for cottonwood, and in feet at age 50 for all other species or types.

Listed in the fifth column are important species in the understory. The potential productivity of these species—grasses, forbs, or low shrubs—for a medium tree canopy class (36 to 55 percent) is given in the sixth column. Productivity is expressed in pounds of air-dry forage per acre. Where yield data are not available and estimates cannot be made, the species are listed in order of their productivity.

The management concerns evaluated in columns 7, 8, and 9 are erosion hazard, equipment limitations, and seedling mortality. Erosion hazard measures the risk of soil losses in well-managed woodland. Erosion hazard is *slight* if expected soil loss is small, *moderate* if some measures to control erosion are needed in logging and construction, and *severe* if intensive treatment or special equipment and methods are needed to prevent excessive soil losses.

Equipment limitation ratings reflect the soil conditions that restrict the use of equipment normally used in woodland management or harvesting. *Slight* ratings indicate equipment use is not limited to kind or time of year. A rating of *moderate* indicates a seasonal limita-

tion or need for modification in methods or equipment. *Severe* limitations indicate the need for specialized equipment or operations.

Seedling mortality ratings indicate the degree of expected mortality of planted seedlings when plant competition is not a limiting factor. Normal rainfall, good planting stock, and proper planting are assumed. A *slight* rating indicates expected mortality is less than 25 percent, and a *moderate* rating indicates a 25 to 50 percent loss. A *severe* rating indicates more than a 50 percent loss of seedlings.

Plant competition reflects the rate of invasion by unwanted trees and shrubs on different kinds of soils when openings are made in the canopy. A rating of *slight* indicates that the understory plants would not prevent the establishment or normal development of a new stand of desirable trees. A *moderate* rating indicates that establishment or development of a new stand of desirable trees may be delayed by plant competition. A rating of *severe* indicates that adequate establishment and development would be prevented without intensive site preparation or special management practices.

In the last column is a list of suitable species of trees to plant for commercial wood production.

### Wildlife Habitat

Soils directly influence kinds and amounts of vegetation and amounts of water available. In this way they indirectly influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are thickness of soil useful to crops, surface texture, available water capacity to a 40 inch depth, wetness, surface stoniness or rockiness, flood hazard, slope, and permeability of the soil to air and water.

In table 4 soils of this survey area are rated for the production of eight elements of wildlife habitat and for their suitability for three groups, or kinds, of wildlife. The ratings indicate relative suitability for various elements. A rating of *good* means the element of wildlife habitat and habitats generally are easily created, improved, and maintained. Few or no limitations affect management in this category. Satisfactory results are expected when the soil is used for the prescribed purpose.

A rating of *fair* means the element of wildlife habitat, and habitats can be created, improved, or maintained in most places. Nevertheless, moderate intensity of management and fairly frequent attention may be required for satisfactory results.

A rating of *poor* means the element of wildlife and limitations for the designated use are rather severe. Habitats can be created, improved, or maintained in most places, but management is difficult and requires intensive effort.

A rating of *very poor* means the elements of wildlife habitat are very severe and that unsatisfactory results are to be expected. It is either impossible or impractical to create, improve, or maintain habitats on soil in this category.

The significance of each subheading under "Wildlife

TABLE 3.—*Suitability of*

| Soil series and symbols                                      | Woodland group | Potential productivity of important trees |            |
|--|----------------|---|------------|
|  |                | Species                                   | Site index |
| Annona: Ar .....<br>For Raino part see Raino series.         | 4c2            | Loblolly pine .....                       | 70         |
|  |                | Shortleaf pine .....                      | 60         |
| Bernaldo: BeB .....  | 2o7            | Loblolly pine .....                       | 90         |
|  |                | Shortleaf pine .....                      | 80         |
|  |                | Southern redoak .....                     | 80         |
|  |                | Sweetgum .....                            | 90         |
| Freestone: FrB .....   | 3w8            | Loblolly pine .....                       | 80         |
|  |                | Shortleaf pine .....                      | 70         |
|  |                | Sweetgum .....                            | 80         |
| Gladewater: Gw .....   | 2w6            | Water oak .....                           | 90         |
|  |                | Willow oak .....                          | 90         |
| Hopco: Ho .....  | 1w5            | Water oak .....                           | 100        |
|  |                | Willow oak .....                          | 100        |
|  |                | Cottonwood .....                          | 110        |
| Kaufman: Ka .....  | 1w6            | Cottonwood .....                          | 110        |
|  |                | Water oak .....                           | 100        |
| Kirvin:<br>KnD .....   | 4f2            | Loblolly pine .....                       | 70         |
|  |                | Shortleaf pine .....                      | 60         |
| KvD .....  | 4c2            | Loblolly pine .....                       | 70         |
|  |                | Shortleaf pine .....                      | 60         |
| Lufkin: Lr .....   | 4w3            | Loblolly pine .....                       | 70         |
|  |                | Shortleaf pine .....                      | 60         |
| For Raino part, see Raino series.                            |                |   |            |
| Nahatche: Na .....   | 1w6            | Water oak .....                           | 100        |
|  |                | Willow oak .....                          | 100        |
| Pickton: PkC .....   | 3s2            | Loblolly pine .....                       | 80         |
|  |                | Shortleaf pine .....                      | 70         |
| Raino<br>Mapped only in complexes with Annona<br>and Lufkin. | 3w2            | Loblolly pine .....                       | 80         |
|  |                | Shortleaf pine .....                      | 70         |
| Wolfpen: WoC .....   | 3s2            | Loblolly pine .....                       | 80         |
|  |                | Shortleaf pine .....                      | 70         |
| Woodtell: WtC, WtD .....                                     | 4c2            | Loblolly pine .....                       | 70         |
|  |                | Shortleaf pine .....                      | 60         |

habitat elements" and "Kinds of wildlife" in table 4 is given in the following paragraphs.

#### *Elements of wildlife habitat*

Each soil is rated in table 4 according to its suitability for producing various kinds of plants and other elements that make up wildlife habitats. The ratings mainly take into account the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason, selection of a site for develop-

ment as a habitat for wildlife requires inspection at the site.

**Grain and seed crops.** These crops are annual grain-producing plants, such as corn, sorghum, millet, and soybeans.

**Grasses and legumes.** Making up the group are domestic grasses and legumes that are established by planting. They provide food and cover for wildlife. Grasses include bahiagrass, ryegrass, and panicgrass; legumes include annual lespedeza, shrub lespedeza, and other clovers.

**Wild herbaceous upland plants.** This group consists

*the soils for woodland*

| Potential productivity of important plants in understory                         |                        | Management concerns |                       |                    |                   | Trees to plant                             |
|--|------------------------|---------------------|-----------------------|--------------------|-------------------|--|
| Species  | Air-dry forage         | Erosion hazard      | Equipment limitations | Seedling mortality | Plant competition | Suitable species                           |
| Bluestems, uniola, purpletop, sedges, low panicums.                              | <i>Lb/acre</i><br>2000 | Slight .....        | Moderate .....        | Moderate .....     | Moderate .....    | Loblolly pine.                             |
| Bluestems, uniola, beaked panicums, purpletop, low panicums.                     | 2000                   | Slight .....        | Slight .....          | Slight .....       | Slight .....      | Loblolly pine, slash pine, sweetgum.       |
| Bluestems, uniola, beaked panicums, purpletop, sedges, low panicums.             | 2000                   | Slight .....        | Moderate .....        | Slight .....       | Moderate .....    | Loblolly pine, shortleaf pine, slash pine. |
| Uniola, sedges, beaked panicums, Virginia wildrye.                               | 3000                   | Slight .....        | Severe .....          | Moderate .....     | Severe .....      | Water oak.                                 |
| Sedges, Virginia wildrye, beaked panicums, switchgrass, indian grass, paspalums. | 4000                   | Slight .....        | Moderate .....        | Moderate .....     | Moderate .....    | Cottonwood, water oak.                     |
| Virginia wildrye, beaked panicums, uniola, sedges.                               | 4000                   | Slight .....        | Severe .....          | Moderate .....     | Severe .....      | Cottonwood, water oak.                     |
| Purpletop, uniola, bluestems, low panicums, paspalums, weeds.                    | 2000                   | Moderate .....      | Moderate .....        | Slight .....       | Slight .....      | Loblolly pine.                             |
| Purpletop, uniola, bluestems, low panicums, weeds.                               | 2000                   | Moderate .....      | Moderate .....        | Moderate .....     | Moderate .....    | Loblolly pine.                             |
| Uniola, sedges, bluestems, low panicums, forbs.                                  | 1250                   | Slight .....        | Moderate .....        | Moderate .....     | Severe .....      | Loblolly pine.                             |
| Beaked panicums, Virginia wildrye, uniola, sedges, low panicums, paspalums.      | 4000                   | Slight .....        | Severe .....          | Moderate .....     | Severe .....      | Water oak, cottonwood.                     |
| Purpletop, uniola, red lovegrass, low panicums, weeds.                           | 1000                   | Slight .....        | Moderate .....        | Moderate .....     | Moderate .....    | Loblolly pine, slash pine, shortleaf pine. |
| Bluestems, beaked panicums, uniola, purpletop.                                   | 2000                   | Slight .....        | Moderate .....        | Slight .....       | Moderate .....    | Loblolly pine, shortleaf pine.             |
| Uniola, purpletop, bluestem, red and sand lovegrass, low panicums, paspalums.    | 1500                   | Slight .....        | Moderate .....        | Moderate .....     | Moderate .....    | Loblolly pine, shortleaf pine.             |
| Bluestems, uniola, purpletop, beaked panicums.                                   | 2000                   | Slight .....        | Moderate .....        | Moderate .....     | Moderate .....    | Loblolly pine.                             |

of native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Beggarweed, perennial lespedeza, wild bean, pokeweed, and cheatgrass are typical examples. Upland range typical plants are bluestem, grama, perennial forbs, and legumes.

Hardwood trees, shrubs, and vines. These plants are nonconiferous trees, shrubs, and woody vines that produce wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be planted and developed through wildlife management programs. Typi-

cal species in this category are oak, beech cherry, dogwood, maple, viburnum, grape, honeysuckle, greenbrier, and silverberry.

Wetland food and cover plants. In this group are annual and perennial herbaceous plants that grow wild on moist and wet sites. They furnish food and cover mostly for wetland wildlife. Typical examples of plants are smartweed, wild millet, spikerush, and other rushes, sedges, burreed, tearthumb, and anilema. Submerged and floating aquatics are not included in this category.

Shallow-water developments. These developments are impoundments or excavations for controlling water,

TABLE 4.—*Soil interpretations for wildlife*

| Soil series and symbols                               | Wildlife habitat elements |                   |                         |
|---|---------------------------|-------------------|-------------------------|
|   | Grain and seed crops      | Grass and legumes | Wild herba-ceous plants |
| Annona: Ar .....<br>For Raino part, see Raino series. | Fair                      | Good              | Good                    |
| Bazette:<br>BaC .....                                 | Fair                      | Good              | Fair                    |
| BaD .....   | Poor                      | Fair              | Fair                    |
| Bernaldo: BeB .....                                   | Good                      | Good              | Good                    |
| Crockett: CrA, CrB, CrC, CrC2 .....                   | Fair                      | Good              | Good                    |
| Ellis: EsD .....                                      | Poor                      | Fair              | Poor                    |
| Ferris: FeD2 .....                                    | Poor                      | Fair              | Fair                    |
| Freestone: FrB .....                                  | Good                      | Good              | Good                    |
| Gladewater: Gw .....                                  | Very poor                 | Poor              | Fair                    |
| Heiden: HeC2 .....                                    | Fair                      | Good              | Fair                    |
| Hopco: Ho .....                                       | Very poor                 | Poor              | Fair                    |
| Kaufman: Ka .....                                     | Poor                      | Fair              | Fair                    |
| Kirvin:<br>KnD .....                                  | Fair                      | Good              | Good                    |
| KvD .....   | Poor                      | Fair              | Good                    |
| Leson: LeB, LeC .....                                 | Good                      | Good              | Poor                    |
| Lufkin: Lr .....                                      | Fair                      | Fair              | Good                    |
| For Raino part, see Raino series.                     |                           |                   |                         |
| Nahatche: Na .....                                    | Very poor                 | Poor              | Fair                    |
| Pickton: PkC .....                                    | Poor                      | Fair              | Good                    |
| Raino .....   | Fair                      | Good              | Good                    |
| Mapped only in complex with Ar and Lr.                |                           |                   |                         |
| Wilson: WcB .....                                     | Fair                      | Fair              | Good                    |
| Wolfpen: WoC .....                                    | Poor                      | Fair              | Good                    |
| Woodtell:<br>WtC .....                                | Good                      | Good              | Good                    |
| WtD .....   | Fair                      | Good              | Good                    |
| WwC .....   | Poor                      | Poor              | Poor                    |

generally not more than 5 feet deep. They provide habitats that are suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submersed aquatics.

#### **Kinds of wildlife**

Table 4 rates soils according to their suitability as habitat for the three kinds of wildlife in the county—open land, woodland, and wetland. These ratings are

related to those made for the elements of habitat. For example, soils rated very poor for shallow-water developments are also rated very poor for wetland wildlife.

Open land wildlife are birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, doves, meadowlarks, field sparrows, cottontail rabbits, and foxes are common examples of open-land wildlife.

*habitat elements and kinds of wildlife*

| Wildlife habitat elements—continued |                               |                           | Kinds of wildlife |          |            |
|-------------------------------------|-------------------------------|---------------------------|-------------------|----------|------------|
| Hardwood trees, shrubs, and vines   | Wetland food and cover plants | Shallow-water development | Open land         | Woodland | Wetland    |
| Good                                | Fair                          | Fair                      | Good              | Good     | Fair.      |
| Good                                | Poor                          | Very poor                 | Fair              | Good     | Very poor. |
| Good                                | Poor                          | Very poor                 | Fair              | Good     | Very poor. |
| Good                                | Poor                          | Very poor                 | Good              | Good     | Very poor. |
| Good                                | Poor                          | Poor                      | Good              | Good     | Poor.      |
| Fair                                | Very poor                     | Very poor                 | Poor              | Fair     | Very poor. |
| Fair                                | Very poor                     | Very poor                 | Fair              | Fair     | Very poor. |
| Good                                | Poor                          | Poor                      | Good              | Good     | Poor.      |
| Fair                                | Poor                          | Good                      | Poor              | Fair     | Fair.      |
| Fair                                | Poor                          | Very poor                 | Fair              | Fair     | Very poor. |
| Good                                | Poor                          | Poor                      | Poor              | Fair     | Poor.      |
| Good                                | Poor                          | Fair                      | Fair              | Good     | Poor.      |
| Good                                | Poor                          | Very poor                 | Good              | Good     | Very poor. |
| Good                                | Poor                          | Very poor                 | Fair              | Good     | Very poor. |
| Poor                                | Very poor                     | Very poor                 | Fair              | Poor     | Very poor. |
| Good                                | Fair                          | Fair                      | Fair              | Good     | Fair.      |
| Good                                | Fair                          | Fair                      | Poor              | Fair     | Fair.      |
| Fair                                | Poor                          | Very poor                 | Fair              | Fair     | Very poor. |
| Good                                | Fair                          | Fair                      | Good              | Good     | Fair.      |
| Fair                                | Fair                          | Fair                      | Fair              | Fair     | Fair.      |
| Good                                | Poor                          | Very poor                 | Fair              | Good     | Very poor. |
| Good                                | Poor                          | Very poor                 | Good              | Good     | Poor.      |
| Good                                | Very poor                     | Very poor                 | Good              | Good     | Very poor. |
| Fair                                | Very poor                     | Very poor                 | Poor              | Fair     | Very poor. |

Woodland wildlife are birds and mammals that normally live in wooded areas of hardwood trees, coniferous trees, and shrubs. Woodcocks, thrushes, wild turkeys, vireos, deer, squirrels, and raccoons are common examples of woodland wildlife.

Wetland wildlife are birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, shore birds, herons, minks, and muskrats are common examples of wetland wildlife.

**Recreation**

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 5 the soils of Hopkins and Rains Counties are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails (fig. 15).

In table 5 the soils are rated as having slight, moder-



Figure 15.—Recreational facilities on Lake Tawakoni. The soil is Bazette clay loam.

ate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. *Slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. *Moderate* means that the limitations can be overcome or modified by planning, by design, or by special maintenance. *Severe* means that the degree of limitation warrants costly soil reclamation, special design, intense maintenance, or a combination of these.

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

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

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

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

### Engineering <sup>5</sup>

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.

<sup>5</sup> BEN J. PECENA, civil engineer, Soil Conservation Service, Mt. Pleasant, Texas, assisted in the preparation of this section.

TABLE 5.—*Soil interpretations for recreation*

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

| Soil series and map symbols                                      | Degree and kind of limitations for selected uses |                                |  |                                |
|--|--|--------------------------------|--|--------------------------------|
|  | Camp areas                                       | Picnic areas                   | Playgrounds                              | Paths and trails               |
| Annona: Ar<br>For Raino part, see Raino series.                  | Severe: percs slowly; wetness.                   | Moderate: wetness              | Severe: percs slowly; wetness.           | Moderate: wet.                 |
| Bazette: BaC, BaD  | Moderate: too clayey.                            | Moderate: too clayey.          | Severe: slope                            | Moderate: too clayey.          |
| Bernaldo: BeB  | Slight   | Slight                         | Slight                                   | Slight.                        |
| Crockett: CrA, CrB, CrC, CrC2.                                   | Severe: percs slowly.                            | Slight                         | Severe: percs slowly.                    | Slight.                        |
| Ellis: EsD   | Severe: too clayey; percs slowly.                | Severe: too clayey             | Severe: too clayey; percs slowly; slope. | Severe: too clayey.            |
| Ferris: FeD2   | Severe: too clayey; percs slowly.                | Severe: too clayey             | Severe: too clayey; percs slowly; slope. | Severe: too clayey.            |
| Freestone: FrB   | Moderate: wetness; percs slowly.                 | Moderate: wetness              | Moderate: wetness; percs slowly.         | Slight.                        |
| Gladewater: Gw   | Severe: too clayey; floods.                      | Severe: too clayey; floods.    | Severe: too clayey; floods.              | Severe: too clayey; floods.    |
| Heiden: HeC2   | Severe: too clayey; percs slowly.                | Severe: too clayey             | Severe: too clayey; percs slowly.        | Severe: too clayey.            |
| Hopco: Ho  | Severe: floods                                   | Moderate: floods               | Severe: floods                           | Moderate: floods.              |
| Kaufman: Ka  | Severe: too clayey; floods.                      | Severe: too clayey; floods     | Severe: too clayey; floods.              | Severe: too clayey; floods.    |
| Kirvin:<br>KnD   | Moderate: percs slowly.                          | Slight                         | Severe: small stones.                    | Moderate: small stones.        |
| KvD  | Moderate: percs slowly.                          | Slight                         | Moderate: percs slowly.                  | Slight.                        |
| Leson: LeB, LeC  | Severe: percs slowly; too clayey.                | Severe: too clayey             | Severe: too clayey; percs slowly.        | Severe: too clayey.            |
| Lufkin: Lr<br>For Raino part, see Raino series.                  | Severe: wetness; percs slowly.                   | Moderate: wetness              | Severe: wetness; percs slowly.           | Moderate: wetness.             |
| Nahatche: Na   | Severe: floods; wetness.                         | Moderate: floods; wetness.     | Severe: floods; wetness.                 | Moderate: floods; wetness.     |
| Pickton: PKC   | Moderate: too sandy.                             | Moderate: too sandy.           | Moderate: too sandy.                     | Moderate: too sandy.           |
| Raino<br>Mapped only in complexes with Annona and Lufkin series. | Severe: percs slowly.                            | Moderate: wetness              | Severe: percs slowly.                    | Moderate: wetness.             |
| Wilson: WcB  | Severe: percs slowly; wetness.                   | Moderate: too clayey; wetness. | Severe: percs slowly.                    | Moderate: wetness; too clayey. |
| Wolfpen: WoC   | Moderate: too sandy.                             | Moderate: too sandy.           | Moderate: too sandy.                     | Moderate: too sandy.           |
| Woodtell:<br>WtC   | Severe: percs slowly.                            | Slight                         | Severe: percs slowly.                    | Slight.                        |
| WtD  | Severe: percs slowly.                            | Moderate: slope                | Severe: percs slowly.                    | Slight.                        |
| WwC  | Severe: large stones; percs slowly.              | Severe: large stones.          | Severe: large stones; percs slowly.      | Severe: large stones.          |

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. In various degrees and combinations, these properties 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. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting the performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8. These tables delineate, 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 other useful maps and to make interpretations in addition to those given in tables 5 and 7.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works. Further investigation is especially needed before works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Since some of the terms used in this soil survey have specialized meaning to soil scientists but are not known to all engineers, a Glossary has been provided to define and clarify many of these terms commonly used in soil science.

#### **Engineering soil classification systems**

Two systems are usually used in classifying samples of soils for engineering. One system is the Unified Soil Classification System (3) used by the SCS engineers, Department of Defense engineers, and other techni-

cians. The other system used is the AASHTO system adopted by the American Association of State Highway and Transportation Officials (2).

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

The AASHTO 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. The range of these groups, based on grain-size distribution, liquid limit and plasticity index, is from A-1 through A-7. 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 mineral 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.

#### **Soil properties significant to engineering**

Several estimated soil properties significant in engineering are given in table 6. These estimates are made for representative soil profiles, by layers sufficiently unique to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for the specified soils 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 6.

Hydrologic Groups give the runoff potential from rainfall. Four major soil groups are used. The soils are classified on the basis of intake of water at the end of long-duration storms occurring after prior wetting and opportunity for swelling, and without the protective effects of vegetation.

The major soil groups are:

- A. (Low runoff potential). Soils having high infiltration rates even when thoroughly wetted. These consist chiefly of deep, well-drained to excessively drained sands or gravels. These soils have a high rate of water transmission in that water readily passes through them.
- B. Soils having moderate infiltration rates when thoroughly wetted. These consist chiefly of moderately deep to deep, moderately well drained to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
- C. Soils have slow infiltration rates when thoroughly wetted. These consist chiefly of soils with a layer that impedes downward movement of water or soils with moderately fine to fine

texture. These soils have a slow rate of water transmission.

- D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted. These consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

All soils are deep except Bazette soils, which are 24 to 40 inches to clay and shale.

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

Soil texture is described in table 6 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 contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

The Unified and AASHTO columns are explained in the section "Engineering soil classification systems."

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 a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6. However, in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 6 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

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

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 causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 6, 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. Corrosivity for concrete is influenced by the content of sodium or magnesium sulfate, soil texture, and acidity. Installations of uncoated steel 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 corrosion rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means a high probability of damage warranting protective measures for steel and use of more resistant concrete.

#### Engineering interpretations

The estimated interpretations in table 7 are based on the engineering properties of soils shown in table 6, on test data for soils in this survey area and surrounding areas, and on the experience of engineers and soil scientists with the soils of Hopkins and Rains Counties. In table 7, ratings are used to summarize limitation or suitability of the soils for all listed purposes except drainage for crops and pasture and terraces and diversions. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use and have limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special designs, or intensive maintenance is required.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of the columns in table 7.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects

TABLE 6.—*Estimated soil properties*

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

| Soil series and map symbols                            | Hydrologic group | Depth to seasonal high water table | Depth from surface             | USDA texture  | Classification                               |                    | Percentage less than 3 inches passing sieve— |                 |
|--|------------------|------------------------------------|--------------------------------|---|--|--------------------|--|-----------------|
|  |                  |                                    |                                |   | Unified                                      | AASHTO             | No. 4 (4.7 mm)                               | No. 10 (2.0 mm) |
| *Annona: Ar .....<br>For Raino part, see Raino series. | D                | Inches<br>24-48                    | Inches<br>0-9<br>9-68<br>68-95 | Loam .....  | ML or SM                                     | A-4                | 95-100                                       | 95-100          |
|  |                  |                                    |                                | Clay .....  | CH   | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    |                                | Clay loam .....   | CL or CH                                     | A-7-6              | 95-100                                       | 95-100          |
| Bazette: BaC, BaD .....                                | C                | >120                               | 0-4<br>4-28<br>28-60           | Clay loam .....   | CL   | A-6 or<br>A-7-6    | 95-100                                       | 95-100          |
|  |                  |                                    |                                | Clay .....  | CL or CH                                     | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    |                                | Clay and shale .....                                      | CL or CH                                     | A-6 or<br>A-7-6    | 95-100                                       | 95-100          |
| Bernaldo: BeB .....                                    | B                | 48-72                              | 0-10                           | Fine sandy loam .....                                     | ML, SM,<br>CL-ML,<br>or SM-<br>SC            | A-4                | 100  | 95-100          |
|  |                  |                                    | 10-80                          | Sandy clay loam .....                                     | CL   | A-6                | 100  | 100             |
| Crockett: CrA, CrB, CrC,<br>CrC2.                      | D                | >72                                | 0-9                            | Loam .....  | CL   | A-4 or<br>A-6      | 95-100                                       | 95-100          |
|  |                  |                                    | 9-45                           | Clay .....  | CL or CH                                     | A-7-6              | 90-100                                       | 80-100          |
|  |                  |                                    | 45-84                          | Clay loam and shale.                                      | CL or CH                                     | A-7-6              | 95-100                                       | 95-100          |
| Ellis: EsD .....                                       | D                | >72                                | 0-31                           | Clay and silty clay.                                      | CH   | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    | 31-66                          | Shale and clay .....                                      | CH   | A-7-6              | 95-100                                       | 95-100          |
| Ferris: FeD2 .....                                     | D                | >72                                | 0-4                            | Clay .....  | CH   | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    | 4-36                           | Silty clay .....  | CH   | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    | 36-66                          | Shaly clay .....  | CH   | A-7-6              | 95-100                                       | 95-100          |
| Freestone: FrB .....                                   | C                | 12-36                              | 0-16                           | Fine sandy loam.  | CL, ML,<br>SC, CL-<br>ML,<br>SM, or<br>SM-SC | A-4                | 95-100                                       | 95-100          |
|  |                  |                                    | 16-38                          | Sandy clay loam.  | CL   | A-6 or<br>A-7-6    | 95-100                                       | 95-100          |
|  |                  |                                    | 38-72                          | Clay .....  | CL or CH                                     | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    | 72-90                          | Sandy clay loam.  | CL   | A-6 or<br>A-7-6    | 100  | 95-100          |
|  |                  |                                    |                                |   |  |                    |  |                 |
| Gladewater: Gw .....                                   | D                | >24                                | 0-65                           | Clay .....  | CH   | A-7-6              | 100  | 100             |
| Heiden: HeC2 .....                                     | D                | >120                               | 0-40                           | Clay .....  | CH   | A-7-6              | 95-100                                       | 95-100          |
|  |                  |                                    | 40-60                          | Shaly clay .....  | CH   | A-7-6              | 95-100                                       | 95-100          |
| Hopco: Ho .....  | C                | 36-60                              | 0-48                           | Silty clay loam.  | CL   | A-6 or<br>A-7-6    | 100  | 100             |
|  |                  |                                    | 48-80                          | Clay loam .....   | CL   | A-6 or<br>A-7-6    | 100  | 100             |
| Kaufman: Ka .....                                      | D                | >24                                | 0-84                           | Clay .....  | CH   | A-7-6              | 100  | 100             |
| Kirvin: KnD, KvD .....                                 | C                | >72                                | 0-12                           | Gravelly fine sandy loam.                                 | GM or<br>GM-GC,<br>SM, or<br>SC-SM           | A-1-b or<br>A-2-4  | 55-75  | 40-75           |
|  |                  |                                    | 12-31                          | Clay .....  | CL, CH,<br>ML, or<br>MH                      | A-7-6              | 95-100                                       | 85-100          |
|  |                  |                                    | 31-43                          | Sandy clay loam.  | CL, ML,<br>or SC                             | A-6 or<br>A-7-6    | 95-100                                       | 85-100          |
|  |                  |                                    | 43-64                          | Sandy clay loam, clay loam and weakly cemented sandstone. | SC or<br>SM-SC                               | A-4, A-6<br>or A-2 | 95-100                                       | 85-100          |

*significant to engineering*

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully that appear in the first column of this table. < = less than; > = more than]

| Percentage less than 3 inches passing sieve—<br>Continued |                       | Liquid limit | Plasticity index  | Permeability                  | Available water capacity              | Reaction             | Shrink-swell potential | Corrosivity    |           |
|---|-----------------------|--------------|-------------------|-------------------------------|---------------------------------------|----------------------|------------------------|----------------|-----------|
| No. 40<br>(0.42 mm)                                       | No. 200<br>(0.074 mm) |              |                   |                               |                                       |                      |                        | Uncoated steel | Concrete  |
| 75-95   | 45-70                 | 15-25        | 1-3               | <i>In per hour</i><br>0.6-2.0 | <i>In per in of soil</i><br>0.13-0.18 | <i>pH</i><br>4.5-6.5 | Low                    | Moderate       | Moderate. |
| 90-100  | 75-95                 | 51-70        | 30-45             | <0.06                         | 0.12-0.18                             | 4.5-8.4              | High                   | High           | Moderate. |
| 90-100  | 75-95                 | 41-55        | 25-35             | <0.06                         | 0.12-0.18                             | 6.1-6.5              | High                   | High           | Low.      |
| 85-100  | 60-90                 | 30-43        | 11-21             | 0.06-2.0                      | 0.15-0.20                             | 5.6-7.3              | Low                    | Moderate       | Low.      |
| 90-100  | 80-95                 | 48-66        | 27-40             | 0.06-2.0                      | 0.16-0.18                             | 5.6-7.3              | High                   | High           | Low.      |
| 90-100  | 70-95                 | 40-60        | 20-35             | 0.06-2.0                      | 0.16-0.18                             | 6.1-8.4              | High                   | High           | Low.      |
| 90-100  | 45-65                 | 15-25        | 2-5               | 2.0-6.0                       | 0.11-0.15                             | 5.1-6.5              | Low                    | Low            | Moderate. |
| 90-100  | 51-75                 | 30-40        | 12-24             | 0.6-2.0                       | 0.15-0.20                             | 4.5-6.5              | Moderate               | Moderate       | Moderate. |
| 95-100  | 36-95                 | 15-35        | 8-15              | 0.6-2.0                       | 0.11-0.15                             | 5.6-7.3              | Low                    | Moderate       | Low.      |
| 75-100  | 65-91                 | 45-55        | 25-35             | <0.06                         | 0.14-0.18                             | 5.6-7.8              | High                   | High           | Low.      |
| 90-100  | 65-90                 | 45-57        | 25-36             | 0.06-2.0                      | 0.15-0.20                             | 7.4-8.4              | Moderate               | High           | Low.      |
| 90-100  | 90-100                | 51-70        | 25-40             | <0.06                         | 0.12-0.18                             | 6.1-8.4              | High                   | High           | Low.      |
| 95-100  | 90-100                | 65-90        | 40-65             | <0.06                         | <0.05                                 | 6.6-8.4              | High                   | High           | Low.      |
| 80-95   | 75-95                 | 51-70        | 35-50             | <0.06                         | 0.15-0.18                             | 7.9-8.4              | High                   | High           | Low.      |
| 90-100  | 80-95                 | 51-60        | 35-40             | <0.06                         | 0.15-0.18                             | 7.9-8.4              | High                   | High           | Low.      |
| 80-95   | 75-95                 | 51-70        | 35-50             | <0.06                         | <0.05                                 | 7.9-8.4              | High                   | High           | Low.      |
| 95-100  | 36-55                 | 20-30        | 2-8               | 2.0-6.0                       | 0.11-0.15                             | 5.1-7.3              | Low                    | Moderate       | Low.      |
| 95-100  | 55-70                 | 35-46        | 15-23             | 0.2-0.6                       | 0.12-0.17                             | 4.5-6.5              | Moderate               | High           | Moderate. |
| 90-100  | 80-99                 | 42-70        | 21-44             | 0.06-0.2                      | 0.12-0.18                             | 4.5-6.5              | High                   | High           | Moderate. |
| 90-99   | 55-85                 | 30-46        | 12-23             | 0.2-0.6                       | 0.12-0.17                             | 5.6-7.8              | Moderate               | High           | Moderate. |
| 90-100  | 75-95                 | 51-60        | 35-45             | <0.06                         | 0.15-0.17                             | 5.1-7.3              | High                   | High           | Low.      |
| 80-95   | 75-95                 | 55-80        | 40-50             | <0.06                         | 0.15-0.20                             | 7.9-8.4              | High                   | High           | Low.      |
| 80-95   | 75-95                 | 52-70        | 35-50             | <0.06                         | 0.12-0.15                             | 7.9-8.4              | High                   | High           | Low.      |
| 95-100  | 85-95                 | 35-45        | 15-25             | 0.2-0.6                       | 0.18-0.22                             | 6.6-8.4              | Moderate               | Moderate       | Low.      |
| 90-100  | 70-80                 | 35-45        | 11-25             | 0.2-0.6                       | 0.15-0.20                             | 6.6-8.4              | Moderate               | Moderate       | Low.      |
| 95-100  | 90-95                 | 70-80        | 40-50             | <0.06                         | 0.15-0.20                             | 5.6-7.8              | High                   | High           | Low.      |
| 40-65   | 20-35                 | <25          | <sup>1</sup> NP-4 | 2.0-6.0                       | 0.06-0.08                             | 5.6-7.3              | Low                    | Low            | Moderate. |
| 85-99   | 51-75                 | 41-60        | 15-30             | 0.2-0.6                       | 0.12-0.18                             | <4.5-5.5             | Moderate               | High           | Moderate. |
| 85-99   | 40-60                 | 30-50        | 11-20             | 0.6-2.0                       | 0.12-0.17                             | <4.5-5.5             | Moderate               | Moderate       | High.     |
| 80-90   | 30-49                 | 20-40        | 5-20              | 0.6-2.0                       | 0.10-0.14                             | <4.5-5.0             | Low                    | High           | High.     |

TABLE 6.—Estimated soil properties

| Soil series and map symbols                         | Hydrologic group | Depth to seasonal high water table | Depth from surface      | USDA texture  | Classification                              |                          | Percentage less than 3 inches passing sieve— |                  |
|---|------------------|------------------------------------|-------------------------|---|---|--------------------------|--|------------------|
|   |                  |                                    |                         |   | Unified                                     | AASHTO                   | No. 4 (4.7 mm)                               | No. 10 (2.0 mm)  |
| Leson: LeB, LeC                                     | D                | Inches<br>>120                     | Inches<br>0-60<br>60-80 | Clay  | CH  | A-7-6                    | 98-100                                       | 90-100           |
|   |                  |                                    |                         | Shaly clay  | CH  | A-7-6                    | 98-100                                       | 90-100           |
| *Lufkin: Lr<br>For Raino part, see Raino series.    | D                | 0-12                               | 0-9                     | Loam  | ML or<br>CL-ML                              | A-4                      | 90-100                                       | 85-100           |
|   |                  |                                    | 9-53                    | Clay  | CH  | A-7-6                    | 90-100                                       | 90-100           |
|   |                  |                                    | 53-65                   | Stratified clay,<br>silty clay loam,<br>sandy loam. | CL, CH,<br>or SC                            | A-7-5 or<br>A-7-6        | 70-100                                       | 70-100           |
| Nahatche: Na  | C                | 0-18                               | 0-7                     | Clay loam   | CL  | A-6 or<br>A-7-6          | 100  | 100              |
|   |                  |                                    | 7-13                    | Loam  | CL  | A-4 or<br>A-6            | 100  | 100              |
|   |                  |                                    | 13-65                   | Clay loam   | CL  | A-6 or<br>A-7-6          | 100  | 100              |
| Pickton: PkC  | A                | >72                                | 0-54                    | Loamy fine sand                                     | SM, SM-<br>SC, or<br>SP-SM                  | A-2-4                    | 100  | 95-100           |
|   |                  |                                    | 54-120                  | Sandy clay loam                                     | CL, CL-<br>ML,<br>SC, or<br>SM-SC           | A-4 or<br>A-6            | 100  | 95-100           |
| Raino<br>Mapped only with Annona and Lufkin series. | D                | 12-36                              | 0-35                    | Loam  | CL, ML,<br>SM,<br>CL-ML,<br>SC, or<br>SM-SC | A-4                      | 95-100                                       | 95-100           |
|   |                  |                                    | 35-70<br>70-90          | Clay<br>Sandy clay loam                             | CL or CH<br>CL or CH                        | A-7-6<br>A-7-6           | 95-100<br>95-100                             | 95-100<br>95-100 |
| Wilson: WcB   | D                | 0-12                               | 0-5                     | Clay loam   | CL or<br>CL-ML                              | A-4 or<br>A-6            | 95-100                                       | 85-100           |
|   |                  |                                    | 5-66<br>66-82           | Clay<br>Shale and clay                              | CL or CH<br>CL or CH                        | A-7-6<br>A-7-6           | 90-100<br>95-100                             | 80-100<br>95-100 |
| Wolfpen: WoC  | A                | 50-60                              | 0-27                    | Loamy fine sand                                     | SM, SM-<br>SC, or<br>SP-SM                  | A-2-4                    | 100  | 95-100           |
|   |                  |                                    | 27-100                  | Sandy clay loam                                     | CL or SC                                    | A-4 or<br>A-6            | 100  | 95-100           |
| Woodtell: WtC, WtD, WwC                             | D                | >120                               | 0-9                     | Loam  | ML, CL-<br>ML,<br>SM, or<br>SM-SC           | A-4 or<br>A-2-4          | 90-100                                       | 85-100           |
|   |                  |                                    | 9-58<br>58-72           | Clay<br>Clay loam and<br>shale.                     | CL or CH<br>CL, SC,<br>or CH                | A-7-6<br>A-6 or<br>A-7-6 | 100<br>100                                   | 90-100<br>80-100 |

<sup>1</sup> NP means nonplastic.

difficulty of layout and construction and the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon's floor is nearly level and its sides, or embankments, are made of compacted soil material. The assumption is made that the embankment is compacted to medium density and that the pond is protected from flooding. Proper-

ties that affect the pond floor are permeability, organic matter, and slope. If the floor needs to be leveled, depth to bedrock is an important consideration. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification System and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging

significant to engineering—Continued

| Percentage less than 3 inches passing sieve—Continued |                    | Liquid limit | Plasticity index   | Permeability       | Available water capacity | Reaction  | Shrink-swell potential | Corrosivity    |           |
|---|--------------------|--------------|--------------------|--------------------|--------------------------|-----------|------------------------|----------------|-----------|
| No. 40 (0.42 mm)                                      | No. 200 (0.074 mm) |              |                    |                    |                          |           |                        | Uncoated steel | Concrete  |
| 90-100  | 90-100             | 60-90        | 40-60              | <i>In per hour</i> | <i>In per in of soil</i> | <i>pH</i> |                        |                |           |
| 90-100  | 90-100             | 70-100       | 40-75              | <0.06              | 0.12-0.18                | 6.1-8.4   | High                   | High           | Low.      |
|   |                    |              |                    | <0.06              | 0.12-0.18                | 7.4-8.4   | High                   | High           | Low.      |
| 85-100  | 80-85              | <25          | <sup>1</sup> NP-7  | 0.6-2.0            | 0.11-0.18                | 4.5-6.5   | Low                    | Low            | Moderate. |
| 90-100  | 70-95              | 51-65        | 30-45              | <0.06              | 0.14-0.18                | 4.5-7.8   | High                   | High           | Moderate. |
| 55-100  | 44-90              | 45-86        | 25-55              | <0.06              | 0.10-0.14                | 6.1-8.4   | High                   | High           | Moderate. |
| 90-100  | 70-80              | 30-45        | 15-25              | 0.6-2.0            | 0.15-0.20                | 5.1-7.8   | Moderate               | High           | Moderate. |
| 85-95   | 60-75              | 28-40        | 8-20               | 0.6-2.0            | 0.15-0.20                | 5.1-7.8   | Moderate               | High           | Moderate. |
| 90-100  | 70-80              | 30-45        | 11-25              | 0.6-2.0            | 0.15-0.20                | 5.1-7.8   | Moderate               | High           | Moderate. |
| 85-100  | 10-25              | <25          | <sup>1</sup> NP-7  | 6.0-20.0           | 0.07-0.11                | 5.6-7.3   | Low                    | Low            | Low.      |
| 85-100  | 36-55              | 23-40        | 7-20               | 0.6-2.0            | 0.12-0.17                | 4.5-6.5   | Low                    | Low            | Moderate. |
| 80-100  | 40-80              | <30          | <sup>1</sup> NP-10 | 0.6-2.0            | 0.11-0.20                | 4.5-6.5   | Low                    | Moderate       | Moderate. |
| 80-100  | 55-90              | 46-74        | 24-45              | <0.06              | 0.12-0.18                | 4.5-5.5   | High                   | High           | Moderate. |
| 80-100  | 55-90              | 41-60        | 18-35              | 0.06-0.2           | 0.12-0.18                | 4.5-7.8   | High                   | High           | Moderate. |
| 80-100  | 60-85              | 25-35        | 7-20               | 0.2-0.6            | 0.15-0.20                | 5.6-6.5   | Low                    | Moderate       | Low.      |
| 80-100  | 65-90              | 41-55        | 25-35              | <0.06              | 0.15-0.20                | 5.6-8.4   | High                   | High           | Low.      |
| 90-100  | 70-90              | 41-55        | 25-35              | <0.06              | 0.12-0.15                | 7.9-8.4   | High                   | High           | Low.      |
| 85-100  | 10-30              | <25          | <sup>1</sup> NP-7  | 6.0-20.0           | 0.07-0.11                | 5.6-7.3   | Low                    | Low            | Low.      |
| 85-100  | 36-55              | 25-40        | 8-20               | 0.6-2.0            | 0.12-0.17                | 4.5-6.5   | Low                    | Low            | Moderate. |
| 75-95   | 30-60              | <27          | <sup>1</sup> NP-7  | 0.6-2.0            | 0.10-0.15                | 4.5-6.5   | Low                    | Low            | Moderate. |
| 80-100  | 60-90              | 45-60        | 25-40              | <0.06              | 0.16-0.18                | 4.5-6.5   | High                   | High           | High.     |
| 80-100  | 36-85              | 35-55        | 15-35              | 0.06-0.2           | 0.15-0.20                | 5.1-7.3   | High                   | Moderate       | Moderate. |

or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings without basements, as rated in table 7, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The

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

Sanitary landfills are areas for refuse disposals in dug trenches. The waste is spread in thin layers, com-

TABLE 7.—Engineering

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. the instructions for referring to other series that appear in the first column of this table. "Percs slowly" and some of the other "fair," and other

| Soil series and map symbols  | Degree and kind of limitation for— |                          |                                      |  |                                      |
|--|------------------------------------|--------------------------|--------------------------------------|--|--------------------------------------|
|  | Septic tank absorption fields      | Sewage lagoons           | Shallow excavations                  | Dwellings without basements            | Sanitary landfills                   |
| *Annona: Ar .....<br>For Raino part, see Raino series.                 | Severe: percs slowly; wetness.     | Severe: wetness.         | Severe: wetness; too clayey.         | Severe: shrink-swell; low strength.    | Severe: wetness; too clayey.         |
| Bazette: BaC .....   | Severe: percs slowly.              | Moderate: slope.         | Severe: too clayey.                  | Severe: shrink-swell.                  | Severe: too clayey.                  |
| BaD .....  | Severe: percs slowly.              | Severe: slope            | Severe: too clayey.                  | Severe: shrink-swell.                  | Severe: too clayey.                  |
| Bernaldo: BeB .....  | Moderate: wetness.                 | Moderate: wetness.       | Moderate: wetness.                   | Moderate: low strength.                | Slight .....                         |
| Crockett: CrA, CrB, CrC, CrC2.   | Severe: percs slowly.              | Moderate: slope.         | Severe: too clayey.                  | Severe: shrink-swell.                  | Severe: too clayey.                  |
| Ellis: EsD .....   | Severe: percs slowly.              | Moderate: slope.         | Severe: too clayey.                  | Severe: shrink-swell; low strength.    | Severe: too clayey.                  |
| Ferris: FeD2 .....   | Severe: percs slowly.              | Moderate: slope.         | Severe: too clayey.                  | Severe: shrink-swell; low strength.    | Severe: too clayey.                  |
| Freestone: FrB .....   | Severe: percs slowly; wetness.     | Severe: wetness.         | Severe: wetness; too clayey.         | Severe: shrink-swell; wetness.         | Severe: too clayey; wetness.         |
| Gladewater: Gw .....   | Severe: percs slowly; floods.      | Severe: wetness; floods. | Severe: wetness; floods.             | Severe: shrink-swell; floods.          | Severe: wetness; floods.             |
| Heiden: HeC2 .....   | Severe: percs slowly.              | Moderate: slope.         | Severe: too clayey; cut-banks cave.  | Severe: shrink-swell.                  | Severe: too clayey.                  |
| Hopco: Ho .....  | Severe: percs slowly; floods.      | Severe: floods           | Severe: floods                       | Severe: floods                         | Severe: floods                       |
| Kaufman: Ka .....  | Severe: wetness; floods.           | Severe: wetness; floods. | Severe: wetness; too clayey; floods. | Severe: shrink-swell; wetness; floods. | Severe: wetness; too clayey; floods. |
| Kirvin: KnD, KvD .....   | Severe: percs slowly.              | Moderate: slope.         | Moderate: too clayey.                | Moderate: low strength.                | Moderate: too clayey.                |
| Leson: LeB, LeC .....  | Severe: percs slowly.              | Moderate: slope.         | Severe: too clayey.                  | Severe: shrink-swell.                  | Severe: too clayey.                  |
| *Lufkin: Lr .....<br>For Raino part, see Raino series.                 | Severe: percs slowly; wetness.     | Slight .....             | Severe: too clayey; wetness.         | Severe: shrink-swell; wetness.         | Severe: too clayey; wetness.         |
| Nahatche: Na .....   | Severe: floods; wetness.           | Severe: floods; wetness. | Severe: floods; wetness.             | Severe: floods; wetness.               | Severe: floods; wetness.             |
| Pickton: PkC .....   | Slight .....                       | Severe: seepage.         | Moderate: too sandy.                 | Slight .....                           | Moderate: too sandy.                 |
| Raino .....<br>Mapped only in complexes with Annona and Lufkin series. | Severe: percs slowly; wetness.     | Slight .....             | Severe: too clayey; wetness.         | Moderate: shrink-swell; low strength.  | Severe: wetness.                     |

*interpretations*

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," terms used to rate soils]

| Degree and kind of limitation for—Continued |                      |  | Suitability as source of—         |                            | Soil features affecting—       |                         |
|---|----------------------|--|-----------------------------------|----------------------------|--------------------------------|-------------------------|
| Local roads and streets                     | Pond reservoir areas | Dikes, levees, and other embankments     | Road fill                         | Topsoil                    | Drainage for crops and pasture | Terraces and diversions |
| Severe: shrink-swell; low strength.         | Slight .....         | Moderate: low strength.                  | Poor: shrink-swell; low strength. | Fair: thin layer.          | Percs slowly .....             | Percs slowly.           |
| Severe: low strength; shrink-swell.         | Slight .....         | Moderate: compressible; unstable fill.   | Poor: low strength.               | Poor: thin layer.          | Slope .....                    | Slope; percs slowly.    |
| Severe: low strength; shrink-swell.         | Slight .....         | Moderate: compressible; unstable fill.   | Poor: low strength.               | Poor: thin layer.          | Slope .....                    | Slope; percs slowly.    |
| Moderate: low strength.                     | Moderate: seepage.   | Moderate: piping; erodes easily.         | Fair: low strength.               | Fair: thin layer.          | Not needed .....               | Complex slope.          |
| Severe: shrink-swell.                       | Slight .....         | Moderate: unstable fill.                 | Poor: shrink-swell.               | Fair: thin layer.          | Not needed .....               | Percs slowly.           |
| Severe: shrink-swell; low strength.         | Slight .....         | Moderate: low strength; compressible.    | Poor: shrink-swell; low strength. | Poor: too clayey.          | Not needed .....               | Percs slowly.           |
| Severe: shrink-swell; low strength.         | Slight .....         | Moderate: low strength; compressible.    | Poor: shrink-swell; low strength. | Poor: too clayey           | Not needed .....               | Slope.                  |
| Severe: shrink-swell; low strength.         | Slight .....         | Moderate: unstable fill.                 | Poor: shrink-swell; low strength. | Fair: thin layer.          | Percs slowly .....             | Percs slowly.           |
| Severe: shrink-swell; floods.               | Slight .....         | Moderate: compressible.                  | Poor: shrink-swell; wetness.      | Poor: wetness; too clayey. | Floods .....                   | Not needed.             |
| Severe: shrink-swell.                       | Slight .....         | Moderate: unstable fill.                 | Poor: shrink-swell.               | Poor: too clayey.          | Not needed .....               | Slope; percs slowly.    |
| Severe: floods                              | Moderate: seepage.   | Moderate: compressible; piping.          | Fair: low strength.               | Fair: too clayey.          | Floods .....                   | Not needed.             |
| Severe: shrink-swell.                       | Slight .....         | Moderate: compressible; shrink-swell.    | Poor: shrink-swell.               | Fair: too clayey.          | Floods .....                   | Not needed.             |
| Severe: low strength.                       | Moderate: seepage.   | Moderate: unstable fill; low strength.   | Poor: shrink-swell.               | Fair: thin layer.          | Not needed .....               | Slope.                  |
| Severe: shrink-swell.                       | Slight .....         | Moderate: unstable fill.                 | Poor: shrink-swell.               | Poor: too clayey.          | Percs slowly .....             | Percs slowly.           |
| Severe: shrink-swell; wetness.              | Slight .....         | Moderate: unstable fill; compressible.   | Poor: shrink-swell.               | Poor: thin layer.          | Favorable .....                | Slope.                  |
| Severe: floods; wetness; low strength.      | Moderate: seepage.   | Moderate: unstable fill.                 | Poor: low strength; wetness.      | Fair: too clayey.          | Floods .....                   | Not needed.             |
| Slight .....                                | Severe: seepage      | Moderate: piping.                        | Good .....                        | Poor: too sandy.           | Not needed .....               | Too sandy.              |
| Moderate: low strength; wetness.            | Slight .....         | Moderate: unstable slopes; compressible. | Fair: low strength; shrink-swell. | Good .....                 | Percs slowly .....             | Slope.                  |

TABLE 7.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for—  |                                |                              |                                     |                                   |
|-----------------------------|-------------------------------------|--------------------------------|------------------------------|-------------------------------------|-----------------------------------|
|                             | Septic tank absorption fields       | Sewage lagoons                 | Shallow excavations          | Dwellings without basements         | Sanitary landfills                |
| Wilson: WcB .....           | Severe: percs slowly.               | Slight .....                   | Severe: too clayey; wetness. | Severe: shrink-swell; low strength. | Severe: too clayey.               |
| Wolfpen: WoC .....          | Moderate: wetness.                  | Moderate: seepage.             | Moderate: wetness.           | Slight .....                        | Severe: wetness.                  |
| Woodtell:<br>WtC .....      | Severe: percs slowly.               | Moderate: slope.               | Severe: too clayey.          | Severe: shrink-swell.               | Severe: too clayey.               |
| WtD .....                   | Severe: percs slowly.               | Severe: slope                  | Severe: too clayey.          | Severe: shrink-swell.               | Severe: too clayey.               |
| WwC .....                   | Severe: percs slowly; large stones. | Moderate: slope; large stones. | Severe: large stones.        | Severe: shrink-swell; large stones. | Severe: too clayey; large stones. |

packed, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 7 apply only to a depth of about 6 feet, and therefore limitations ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 to 15 feet. Nevertheless, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

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

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability

and depth to fractured or permeable bedrock or other permeable material.

Dikes, levees, and other embankments require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among unfavorable factors.

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

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

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

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these

*interpretations—Continued*

| Degree and kind of limitation for—Continued |                                  |  | Suitability as source of—                       |                                 | Soil features affecting—       |                         |
|---|----------------------------------|--|---|---------------------------------|--------------------------------|-------------------------|
| Local roads and streets                     | Pond reservoir areas             | Dikes, levees, and other embankments     | Road fill                                       | Topsoil                         | Drainage for crops and pasture | Terraces and diversions |
| Severe: shrink-swell; low strength.         | Slight .....                     | Moderate: unstable slopes; compressible. | Poor: shrink-swell; low strength.               | Poor: thin layer.               | Percs slowly .....             | Percs slowly.           |
| Slight .....                                | Moderate: seepage.               | Moderate: piping.                        | Good .....                                      | Poor: too sandy.                | Not needed .....               | Too sandy.              |
| Severe: shrink-swell.                       | Slight .....                     | Moderate: unstable slopes.               | Poor: shrink-swell; low strength.               | Poor: thin layer.               | Not needed .....               | Percs slowly.           |
| Severe: shrink-swell.                       | Slight .....                     | Moderate: unstable slopes.               | Poor: shrink-swell; low strength.               | Poor: thin layer.               | Not needed .....               | Slope; percs slowly.    |
| Severe: shrink-swell; large stones.         | Moderate: seepage; large stones. | Moderate: unstable slopes.               | Poor: shrink-swell; large stones; low strength. | Poor: thin layer; large stones. | Not needed .....               | Slope; large stones.    |

structures provides outlets for runoff and is not difficult to vegetate.

**Soil test data**

Table 8 contains engineering test data for some of the major soil series in Hopkins and Rains Counties. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 6.

Shrinkage limit is the percentage of moisture at which shrinkage of the soil material stops.

Linear shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit.

Shrinkage ratio is the relation of change in volume of the soil material to the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when oven-dry.

**Urban Development**

Soil characteristics and properties become increasingly important as soil use intensifies. Urban development is one of the most intensive land uses. Some of the more important soil characteristics and properties affecting soil use for urban development are flood hazard, permeability, wetness, depth to water table, slope, depth to bedrock, shrink-swell potential, corrosion po-

tential, and suitability for growing lawn grasses, trees, and shrubs. Information in tables 3, 5, 6, and 7 can be helpful to urban planners, developers, and industrial users of the land.

Ratings for use of soils for most urban land uses can be developed from the information in this survey. The Hopkins and Rains Soil Conservation District will furnish technical assistance in determining ratings for the desired land uses.

**Formation and Classification of Soils**

This section presents the factors of soil formation and the classification of the soil series.

**Factors of Soil Formation**

The factors that determine the kind of soil that forms at any given point are the climate under which the soil material accumulated and weathered; the living organisms on and in the soil; the composition of the parent materials; the topography, or lay of the land; and the length of time the forces of soil development have acted on the soil material (4). The relative importance of each factor differs from place to place, and each modifies the effect of the other four. In some cases one factor may dominate in soil formation.

Climate and living organisms, chiefly living organisms of vegetation, are the active factors of soil formation. They alter the accumulated soil material and cause the development of soil horizons. Mainly by its influence on erosion and runoff, topography modifies the effect of climate and vegetation. The parent material affects the kind of profile that can be formed. In extreme cases parent material determines profile composition almost entirely. Finally, time is needed to change the parent material into a soil that has distinct horizons. Generally this takes a long time.

TABLE 8.—Soil

[Tests performed by Texas Highway Department Testing Laboratory in accordance with standard

| Soil name and location   | Parent material   | Texas report no. | Depth                | Shrinkage <sup>1</sup> |                       |       |
|--|---|------------------|----------------------|------------------------|-----------------------|-------|
|  |   |                  |                      | Limit                  | Linear                | Ratio |
| Crockett loam:<br>250 feet east of county road; 1 mile north of its intersection with Texas Highway 11; 6.6 miles west of intersection of Texas Highways 19 and 11 in Sulphur Springs, Texas. (Modal)                                      | Shaly clay -----  | 71-29-R          | <i>Inches</i><br>0-9 | <i>Percent</i><br>23   | <i>Percent</i><br>4.7 | 1.61  |
|  |   | 71-30-R          | 9-18                 | 15                     | 16.3                  | 1.92  |
|  |   | 71-31-R          | 45-84                | 17                     | 16.5                  | 1.83  |
| Freestone fine sandy loam:<br>150 feet east of county road; 2.8 miles south of Farm Road 1567; this point is 0.6 mile east of Arbala, Texas. (Modal)   | Shaly clay -----  | 71-41-R          | 0-5                  | 20                     | 1.2                   | 1.67  |
|  |   | 71-42-R          | 22-32                | 18                     | 12.7                  | 1.83  |
|  |   | 71-43-R          | 60-72                | 16                     | 20.5                  | 1.88  |
| Leson clay:<br>225 feet north of Texas Highway 11 from a point 10.8 miles west of the intersection of Texas Highways 11 and 19 in Sulphur Springs, Texas. (Modal)  | Shaly clay -----  | 71-27-R          | 12-42                | 11                     | 24.8                  | 1.99  |
|  |   | 71-28-R          | 64-75                | 15                     | 26.8                  | 1.90  |
| Lufkin loam:<br>0.4 mile southeast of Farm Road 1567; 4 miles west of intersection of Farm Road 1567 and Texas Highway 19, which is 8 miles south of intersection of Texas Highway 19 and Interstate 30 in Sulphur Springs, Texas. (Modal) | Shaly clay -----  | 71-35-R          | 0-8                  | 21                     | 1.6                   | 1.67  |
|  |   | 71-36-R          | 18-37                | 21                     | 17.0                  | 1.99  |
|  |   | 71-37-R          | 47-72                | 14                     | 15.3                  | 1.97  |
| Raino loam:<br>0.3 mile southeast of Farm Road 1567; 4 miles east of intersection of Farm Road 1567 and Texas Highway 19, which is 8 miles south of intersection of Texas Highway 19 and Interstate 30 in Sulphur Springs, Texas. (Modal)  | Loamy shale -----                                       | 71-38-R          | 3-24                 | 19                     | 0.7                   | 1.72  |
|  |   | 71-39-R          | 27-38                | 16                     | 15.8                  | 1.93  |
|  |   | 71-40-R          | 60-90                | 15                     | 12.3                  | 1.88  |
| Wolfpen loamy fine sand:<br>275 feet west of Farm Road 269; 3.2 miles south of intersection of Farm Road 269 and Interstate 30, which is 12 miles east of Sulphur Springs, Texas. (Modal)  | Stratified sandy loam, sandy clay loam, and sandy clay. | 71-44-R          | 6-27                 | 16                     | 0.3                   | 1.84  |
|  |   | 71-45-R          | 38-45                | 19                     | 8.3                   | 1.76  |
| Woodtell loam:<br>200 feet west of county road at a point 1.3 miles south of Texas Highway 11 and 0.5 mile east of intersection of Texas Highways 11 and 154 in Sulphur Springs, Texas. (Modal)  | Loamy shale -----                                       | 71-32-R          | 3-8                  | 25                     | 1.1                   | 1.58  |
|  |   | 71-33-R          | 8-20                 | 16                     | 17.8                  | 1.87  |
|  |   | 71-34-R          | 50-90                | 21                     | 9.5                   | 1.69  |

<sup>1</sup> Laboratory test procedures can cause minor discrepancies in shrinkage limit, liquid limit, and the computed plasticity index.<sup>2</sup> Mechanical analyses according to AASHTO Designation T 88-70 (2). Results by this procedure differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

test data

procedures of the American Association of State Highway and Transportation Officials (AASHTO) (2)]

| Mechanical analysis <sup>2</sup> |                   |                    |                     |                          |         |          |                     | Liquid limit         | Plasticity index | Classification <sup>3</sup> |       |
|----------------------------------|-------------------|--------------------|---------------------|--------------------------|---------|----------|---------------------|----------------------|------------------|-----------------------------|-------|
| Percentage passing sieve—        |                   |                    |                     | Percentage smaller than— |         |          | AASHTO <sup>4</sup> |                      |                  | Unified <sup>5</sup>        |       |
| 3/8-in.                          | No. 4<br>(4.7 mm) | No. 10<br>(2.0 mm) | No. 40<br>(0.42 mm) | No. 200<br>(0.074 mm)    | 0.05 mm | 0.005 mm | 0.002 mm            |                      |                  |                             |       |
| ----                             | ----              | ----               | 100                 | 95                       | 76      | 19       | 13                  | <i>Percent</i><br>33 | 10               | A-4                         | CL    |
| ----                             | ----              | ----               | 100                 | 91                       | 88      | 52       | 48                  | 52                   | 32               | A-7-6                       | CH    |
| ----                             | ----              | ----               | 100                 | 86                       | 83      | 44       | 35                  | 57                   | 36               | A-7-6                       | CH    |
| 100                              | 99                | 99                 | 98                  | 37                       | 28      | 4        | 2                   | 23                   | 3                | A-4                         | SM    |
| 100                              | 98                | 97                 | 96                  | 63                       | 59      | 46       | 42                  | 46                   | 23               | A-7-6                       | CL    |
| ----                             | ----              | ----               | 100                 | 99                       | 96      | 68       | 56                  | 69                   | 44               | A-7-6                       | CH    |
| 100                              | 99                | 96                 | 100                 | 99                       | 95      | 63       | 55                  | 80                   | 54               | A-7-6                       | CH    |
| ----                             | ----              | ----               | 100                 | 95                       | 91      | 67       | 57                  | 96                   | 70               | A-7-6                       | CH    |
| ----                             | ----              | ----               | 100                 | 84                       | 67      | 14       | 9                   | 24                   | 5                | A-4                         | CL-ML |
| ----                             | ----              | ----               | 100                 | 91                       | 83      | 48       | 41                  | 51                   | 34               | A-7-6                       | CH    |
| ----                             | 100               | 99                 | 99                  | 89                       | 80      | 39       | 36                  | 47                   | 33               | A-7-6                       | CL    |
| ----                             | 100               | 99                 | 99                  | 77                       | 60      | 9        | 6                   | 21                   | 3                | A-4                         | ML    |
| ----                             | 100               | 99                 | 100                 | 89                       | 79      | 49       | 44                  | 51                   | 32               | A-7-6                       | CH    |
| ----                             | 100               | 99                 | 99                  | 76                       | 64      | 30       | 26                  | 41                   | 25               | A-7-6                       | CL    |
| ----                             | ----              | ----               | 100                 | 23                       | 19      | 6        | 2                   | 18                   | 2                | A-2-4                       | SM    |
| ----                             | ----              | ----               | 100                 | 40                       | 37      | 30       | 27                  | 35                   | 19               | A-6                         | SC    |
| 100                              | 95                | 93                 | 91                  | 49                       | 35      | 5        | 3                   | 27                   | 5                | A-4                         | CL-ML |
| ----                             | ----              | 100                | 100                 | 86                       | 77      | 63       | 59                  | 58                   | 36               | A-7-6                       | CH    |
| ----                             | ----              | 100                | 98                  | 68                       | 59      | 29       | 24                  | 41                   | 24               | A-7-6                       | CL    |

<sup>3</sup> Classification made by Soil Conservation Service.

<sup>4</sup> Based on AASHTO Designation M 145-49 (2).

<sup>5</sup> Based on Unified Soil Classification System (3).

### ***Climate***

Rainfall, temperature, and humidity have been important in the development of soils in the survey area. The climate is a uniform one, with warm temperatures and high humidity. Adequate rainfall favors plant growth and chemical activity, and it encourages the activity of micro-organisms in spring, summer, and fall. As a result of this, most of the soils are deep.

### ***Living organisms***

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Gains in the content of organic matter and in the supply of nitrogen, gains and losses in the supply of other plant nutrients, and changes in the porosity of soils are among the changes governed by living organisms.

In Hopkins and Rains Counties the formation of soils has been affected more by vegetation than by other living organisms. As vegetation dies, a large amount of organic matter is contributed to the soil, both on and below the surface. The decaying leaves and stems add it to the surface, and the decomposing roots add it throughout the material below. The network of tubes and pores left by decaying roots increases the passage of air and water through the soil and provides food for soil organisms.

Man has influenced soil formation by clearing trees, plowing, and planting crops. Thus, he has increased runoff and erosion and reduced the content of organic matter. Also, since tillage compacts the soil material, he has reduced the amount of air and water that passes through the soil. Consequently, the number of living organisms in the soil material has also been reduced.

### ***Parent material***

"Parent material" is the unconsolidated mass from which a soil is formed. It determines the limits of chemical and mineralogical composition of the soil. Rocks forming the parent material in Hopkins and Rains Counties range from Cretaceous to Recent in age and consist mainly of units of clay, silt, sand, siltstone, and sandstone.

The Navarro group of Cretaceous age, which is undivided, is exposed in the extreme northern part of Hopkins County (1). The calcareous, clayey sediment of the Navarro forms clayey soils such as those of the Heiden, Leson, and Ferris series.

Strata of the Tertiary system are represented by the Midway, Wilcox, and Claiborne groups (5).

The Midway group extends across most of the northern and southwestern parts of Hopkins County and the western third of Rains County. West of Sulphur Springs the Midway group is represented by the Kincaid and Wills Point formations. East of Sulphur Springs, the Kincaid and Wills Point formations are not distinguishable, and the Midway group is undivided. The group consists of clay, silt, glauconitic sand, and thin beds of limestone and sandstone. The Crockett, Wilson, and Bazette series are the dominant soils within this outcrop.

Eocene series strata of the Wilcox group, which is undivided, make up the southeastern part of Hopkins

County and the eastern two-thirds of Rains County. The Wilcox group consists of mostly silty and sandy clay with local beds of silt, quartz sand, and lignite. The silty and sandy, noncalcareous clays formed soils such as Woodtell, Lufkin, and Annona. Wolfpen and Picketon soils formed in lentil sands derived mainly from the Wilcox group.

In southeastern Hopkins County are outcrops of the Carrizo Sand and Reklaw formations of the Claiborne group. Surface exposures are composed of clay, silt, sand, and massive, poorly cemented sandstone. These materials have weathered to form Kirvin soils.

Along the major streams are deposits of Recent age alluvium. Typical soils developed from the alluvium are Kaufman, Gladewater, Hopco, and Nahatche.

### ***Topography***

Topography, or relief, affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature.

The topography of Hopkins and Rains Counties ranges from nearly level to strongly sloping. Soils on flood plains are nearly level and some soils along the sides of drainageways are strongly sloping. Erosion removes soil material at a faster rate on the strong slopes than it does on the more gentle slopes. Thus, soils that are strongly sloping, such as Bazette, Ferris, Woodtell, and Ellis, have a thinner solum than the nearly level to gently sloping soils.

### ***Time***

Soils that have distinct horizons generally take a long time to form. The differences in length of time that parent materials have been in place are commonly reflected by the degree of soil development.

The soils in Hopkins and Rains Counties range from young to old. The young soils have little horizon development. The older ones have well defined soil horizons.

Nahatche soils are an example of young soils in the survey area. Horizon development is not clear in these soils, and the arrangement of the soil material similar to that of the one created by the original water deposits. Bernaldo soils are an example of older soils that have well developed soil horizons.

### ***Classification***

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

TABLE 9.—Classification of soil series

| Series              | Family                                     | Subgroup                 | Order        |
|---------------------|--|--------------------------|--------------|
| Annona              | Fine, montmorillonitic, thermic            | Vertic Paleudalfs        | Alfisols.    |
| Bazette             | Fine, montmorillonitic, thermic            | Udic Haplustalfs         | Alfisols.    |
| Bernaldo            | Fine-loamy, siliceous, thermic             | Glossic Paleudalfs       | Alfisols.    |
| Crockett            | Fine, montmorillonitic, thermic            | Udertic Paleustalfs      | Alfisols.    |
| Ellis               | Fine, montmorillonitic, thermic            | Vertic Ustochrepts       | Inceptisols. |
| Ferris              | Fine, montmorillonitic, thermic            | Udorthentic Chromusterts | Vertisols.   |
| Freestone           | Fine-loamy, siliceous, thermic             | Glossaquic Paleudalfs    | Alfisols.    |
| Gladewater          | Fine, montmorillonitic, nonacid, thermic   | Vertic Haplaquepts       | Inceptisols. |
| Heiden              | Fine, montmorillonitic, thermic            | Udic Chromusterts        | Vertisols.   |
| Hopco               | Fine-silty, mixed, thermic                 | Cumulic Haplaquolls      | Mollisols.   |
| Kaufman             | Very fine, montmorillonitic, thermic       | Typic Pelluderts         | Vertisols.   |
| Kirvin <sup>1</sup> | Clayey, mixed, thermic                     | Typic Hapludults         | Ultisols.    |
| Leson               | Fine, montmorillonitic, thermic            | Udic Pellusterts         | Vertisols.   |
| Lufkin              | Fine, montmorillonitic, thermic            | Vertic Albaqualfs        | Alfisols.    |
| Nahatche            | Fine-loamy, mixed, nonacid, thermic        | Aeric Fluvaquents        | Entisols.    |
| Pickton             | Loamy, siliceous, thermic                  | Grossarenic Paleudalfs   | Alfisols.    |
| Raino               | Fine-loamy over clayey, siliceous, thermic | Aquic Glossudalfs        | Alfisols.    |
| Wilson              | Fine, montmorillonitic, thermic            | Vertic Ochraqualfs       | Alfisols.    |
| Wolfpen             | Loamy, siliceous, thermic                  | Arenic Paleudalfs        | Alfisols.    |
| Woodtell            | Fine, montmorillonitic, thermic            | Vertic Hapludalfs        | Alfisols.    |

<sup>1</sup> These soils are taxadjunct to the Kirvin series because the clay fraction is borderline to kaolinitic mineralogy. This difference does not alter use, management, or behavior of the soils.

broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (7). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (6).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 9, the soil series of Hopkins and Rains Counties are placed in the family, subgroup, and order categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

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

The six orders to which the soils of Hopkins and Rains Counties belong are Alfisols, Entisols, Inceptisols, Mollisols, Ultisols, and Vertisols. Alfisols have a light-colored surface layer low in organic matter, a clay-enriched B horizon, an accumulation of aluminum and iron, and a base saturation of more than 35 percent.

Entisols have little or no evidence of development of pedogenic horizons. Inceptisols have a light-colored surface layer low in content of organic matter, but they lack a clay-enriched B horizon.

Mollisols have a dark-colored surface layer high in content of organic matter, and they have a base saturation of more than 50 percent.

Ultisols have a light-colored surface layer low in organic matter, a clay-enriched B horizon, and a base saturation of less than 35 percent.

Vertisols are clayey soils that have deep, wide cracks during part of each year in most years.

**SUBORDER.** Each order is subdivided 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 water logging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquent* (*Aqu*, meaning water or wet, and *ent*, from Entisol).

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

**SUBGROUP.** Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other

TABLE 10.—*Temperature and precipitation*

[Data from records kept at Sulphur Springs, 1949–71, eleva-

| Month           | Temperature <sup>1</sup> |                                 |                       |                                | Precipitation              |  |                   |                   |                     |
|-----------------|--------------------------|---------------------------------|-----------------------|--------------------------------|----------------------------|--|-------------------|-------------------|---------------------|
|                 | Average daily maximum    | Average monthly highest maximum | Average daily minimum | Average monthly lowest minimum | Average total <sup>1</sup> | Probability of receiving selected amounts during month |                   |                   |                     |
|                 |                          |                                 |                       |                                |                            | 0 or trace   | 0.50 inch or more | 1.00 inch or more | 2.00 inches or more |
|                 | ° F                      | ° F                             | ° F                   | ° F                            | In                         | Pct  | Pct               | Pct               | Pct                 |
| January .....   | 54.5                     | 76.4                            | 31.9                  | 12.7                           | 2.79                       | <1   | 95                | 88                | 63                  |
| February .....  | 58.2                     | 76.7                            | 35.1                  | 19.9                           | 3.49                       | <1   | 97                | 91                | 70                  |
| March .....     | 64.6                     | 81.5                            | 40.3                  | 25.7                           | 3.16                       | <1   | 99                | 94                | 75                  |
| April .....     | 74.7                     | 86.1                            | 50.7                  | 37.0                           | 5.54                       | <1   | >99               | 97                | 88                  |
| May .....       | 81.9                     | 91.4                            | 59.4                  | 45.8                           | 5.27                       | <1   | >99               | 98                | 88                  |
| June .....      | 89.3                     | 97.0                            | 67.0                  | 58.1                           | 3.46                       | 5  | 93                | 85                | 67                  |
| July .....      | 94.3                     | 101.3                           | 70.5                  | 62.4                           | 3.23                       | <1   | 86                | 76                | 55                  |
| August .....    | 94.9                     | 102.4                           | 68.9                  | 59.2                           | 2.41                       | 1  | 84                | 74                | 47                  |
| September ..... | 88.4                     | 98.0                            | 62.3                  | 48.7                           | 4.69                       | 1  | 88                | 79                | 59                  |
| October .....   | 78.9                     | 91.1                            | 51.6                  | 36.2                           | 4.45                       | <1   | 90                | 90                | 59                  |
| November .....  | 66.3                     | 82.4                            | 40.1                  | 24.5                           | 3.09                       | <1   | 91                | 80                | 63                  |
| December .....  | 57.4                     | 76.0                            | 34.3                  | 18.6                           | 3.34                       | <1   | 96                | 91                | 71                  |
| Year .....      | 75.3                     | -----                           | 51.0                  | -----                          | 44.92                      | -----  | ---               | ---               | ---                 |

<sup>1</sup> Average length of record, 23 years.<sup>2</sup> Average length of record, 16 years.

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 Hapludults (a typical Hapludult).

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 (see table 9). An example is the fine, mixed, thermic family of Typic Hapludults.

## Climate <sup>6</sup>

The climate of Hopkins and Rains Counties is humid subtropical with hot summers. Rainfall is abundant, averaging 44.92 inches annually, and is fairly evenly distributed throughout the year. Prevailing winds are southerly March through November, and northerly December through February. The Gulf of Mexico plays a dominant role in the climate of the area during the spring, summer, and fall months, while modified polar and arctic air masses play a major role in the winter climate. Temperature and precipitation data are summarized in table 10.

Winter temperatures are mild. The daily maximum fails to go above freezing on an average of about only four days during each year. Arctic or unusually cold polar air masses plunging rapidly southward out of

<sup>6</sup> By ROBERT B. ORTEN, climatologist for Texas, National Weather Service, U. S. Department of Commerce.

Canada bring sharp drops in temperature. Ordinarily, however, cold spells are of short duration. In a typical sequence the weather turns cold one day, reaches the lowest temperature on the second night, then warms up again on the third day. Although cloudiness is more prevalent in winter, the area continues to receive between 50 and 60 percent of the total possible sunshine during this season. Winds accompanying a vigorous cold front may be strong northerly, but these decrease rapidly after the frontal passage.

Daytime temperatures are quite warm in summer, particularly in August. Summer nights are not unpleasant, however, since the daily minimal average is only 59 to 71° F during the warmest months. Except for occasional thundershowers that dissipate the afternoon heat, there is little variation in the day-to-day weather in summer. Temperatures are neither too hot nor too cold in spring and fall.

Precipitation falls mostly as thunderstorms resulting from the interaction of cold fronts from the north with the warm, moist, tropical air moving northward from the Gulf of Mexico. Consequently, rainfall is heaviest late in spring and again early in fall. Slow, general rains are more common in winter. The predominantly anticyclonic atmospheric circulation over East Texas in summer and the exclusion of cold fronts from the sea result in a decrease in rainfall during this season. Monthly and seasonal rainfall totals vary considerably. The driest year on record since 1892 was 1896 when only 22.83 inches fell. The wettest year was 1957 because of torrential rains in both April and May that boosted the annual total to 71.09 inches.

Snowfall averages 2.3 inches annually. Average values are misleading, because single snowfall of 4 to 5 inches may be followed by several years with no measurable amounts. Generally, snow melts as rapidly

*data for Hopkins and Rains Counties*

tion 495 feet. > equals more than; < equals less than]

| Precipitation—Continued  |                     |                     |                     |   |                   |                   |                            |                              |                             |
|--|---------------------|---------------------|---------------------|---|-------------------|-------------------|----------------------------|------------------------------|-----------------------------|
| Probability of receiving selected amounts during month—Continued |                     |                     |                     | Average number of days with— <sup>2</sup> |                   |                   | Snow, sleet                |                              |                             |
| 3.00 inches or more  | 4.00 inches or more | 5.00 inches or more | 6.00 inches or more | 0.10 inch or more                         | 0.50 inch or more | 1.00 inch or more | Average total <sup>1</sup> | Maximum monthly <sup>1</sup> | Greatest depth <sup>2</sup> |
| <i>Pct</i>   | <i>Pct</i>          | <i>Pct</i>          | <i>Pct</i>          |   |                   |                   | <i>In</i>                  | <i>In</i>                    | <i>In</i>                   |
| 45   | 30                  | 20                  | 14                  | 4   | 2                 | 1                 | 1.3                        | 9.8                          | 9                           |
| 50   | 35                  | 24                  | 15                  | 6   | 3                 | 1                 | .2                         | 1.5                          | 2                           |
| 54   | 35                  | 20                  | 13                  | 5   | 3                 | 1                 | .5                         | 8.8                          | 8                           |
| 71   | 55                  | 42                  | 31                  | 7   | 4                 | 2                 | 0                          | 0                            | 0                           |
| 71   | 61                  | 43                  | 32                  | 6   | 4                 | 2                 | 0                          | 0                            | 0                           |
| 50   | 37                  | 25                  | 19                  | 5   | 3                 | 1                 | 0                          | 0                            | 0                           |
| 42   | 28                  | 20                  | 12                  | 4   | 2                 | 1                 | 0                          | 0                            | 0                           |
| 34   | 22                  | 14                  | 9                   | 4   | 2                 | 1                 | 0                          | 0                            | 0                           |
| 39   | 29                  | 19                  | 11                  | 5   | 3                 | 2                 | 0                          | 0                            | 0                           |
| 42   | 25                  | 20                  | 12                  | 5   | 2                 | 1                 | 0                          | 0                            | 0                           |
| 47   | 36                  | 25                  | 21                  | 5   | 2                 | 1                 | ( <sup>a</sup> )           | ( <sup>a</sup> )             | 0                           |
| 55   | 40                  | 25                  | 18                  | 6   | 3                 | 1                 | .3                         | 3.3                          | 3                           |
| ---  | ---                 | ---                 | ---                 | 62  | 33                | 15                | 2.3                        | 9.8                          | ---                         |

<sup>a</sup> Trace, an amount too small to measure.

as it falls and is an unimportant source of moisture. More troublesome than snowfall are the occasional ice storms which do considerable damage to trees, shrubs, and utility lines, and make travel hazardous. These occur during brief periods in January and February.

The growing season (freeze-free period) in Hopkins and Rains Counties averages 238 days. The average date of the last freeze in the spring is March 23, while the average date of the first freeze in the fall is November 16.

Average annual relative humidity is about 83 percent at 6:00 a.m., Central Standard Time; 56 percent at noon; and 55 percent at 6:00 p.m. Seasonal averages vary only slightly. The area receives about 67 percent of the total possible sunshine annually. Mean annual lake evaporation is estimated to be 52 to 54 inches.

Violent wind or hailstorms may accompany the thunderstorms of late spring and early summer, but these are infrequent. Seven tornadoes are known to have touched ground in Hopkins County during the seven-year period 1959-1966. Four of these occurred in one year, 1961. Only minor property damage resulted from these storms.

**Literature Cited**

(1) Adkins, W. S. 1932. Mesozoic systems in Texas. Sellards, E. H., Adkins, W. S., and Plummer, F. B. The geology of Texas: vol. 1, Univ. Texas Bull. 3232, pp. 239-518.  
 (2) American Association of State Highway [and Transportation] Officials. 1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 vol., pp. 301 and 617, illus.  
 (3) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(4) Baldwin, Mark, Kellogg, Charles E., and Thorp, James. 1938. Soil classification. U.S. Dep. Agric. Yearb., pp. 970-1001 illus.  
 (5) Plummer, F. B. 1932. Genozoic systems in Texas. Sellards, E. H., Adkins, W. S., and Plummer, F. B. The geology of Texas: vol. 1, Stratigraphy. Univ. Texas, Bull. 3232, 1007 pp., illus.  
 (6) Simonson, Roy W. 1962. Soil classification in the United States. Soil Science 137: 1027-1034, illus.  
 (7) United States Department of Agriculture. 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and in September 1968]  
 (8) \_\_\_\_\_ 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

**Glossary**

- AC soil.** A soil that has an A horizon and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.  
**Aeration, soil.** The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but that in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.  
**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.  
**Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.  
**Alluvial fan.** A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where its gradient lessens abruptly.  
**Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.  
**Amendment.** Any material, such as lime, gypsum, sawdust, or synthetic conditioner, that is worked into the soil to make it more productive. A fertilizer is also an amendment, but

- the term "amendment" is used most commonly for material other than fertilizer that is added to soil.
- Aspect** (forestry). The direction toward which a slope faces. Synonym: Exposure.
- Association, soil.** A group of soils geographically associated in a characteristic repeating pattern.
- 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.
- Base saturation.** The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.
- Bunch grass.** A grass that grows in tufts, in contrast to a sod-forming grass.
- Buried soil.** A developed soil, once exposed but now overlain by more recently formed soil.
- Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.
- 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.
- Claypan.** A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.
- Climax vegetation.** The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.
- Coarse fragments.** Mineral or rock particles more than 2 millimeters in diameter.
- Coarse-textured soil.** Sand and loamy sand.
- Cobblestone.** A rounded or partly rounded fragment of rock, 3 to 10 inches in diameter.
- Colluvium.** Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.
- Companion crop.** A crop that is grown with another crop; usually a small grain sown with alfalfa, clover, or some other forage crop for the purpose of protecting the forage crop until it is well established.
- Complex, soil.** A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.
- Complex, slope.** Slopes short and irregular.
- Compressible.** Decrease in soil volume excessive under load.
- Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.
- Conglomerate.** Rock composed of gravel and rounded stones cemented together by hardened clay, lime, iron oxide, or silica.
- Conifer** (botany). Any tree of the pine family bearing true cones and any of the yew family having a berrylike fruit. The wood of conifers is commercially known as "softwood."
- 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.
- Continental climate.** The climate in areas distant from the ocean; characterized by considerable variation in temperature and in other weather conditions.
- Contour.** An imaginary line connecting points of equal elevation on the surface of the soil.
- Contour farming.** Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.
- Cover crop.** A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.
- Creep, soil.** The downward movement of masses of soil and soil material, primarily through the action of gravity. The movement is generally slow and irregular. It occurs most commonly when the lower part of the soil is nearly saturated with water, and it may be facilitated by alternate freezing and thawing.
- Crown** (forestry). The branches and foliage of a tree; the upper part of a tree.
- Crusty soil.** Soil tending to form a thin, massive or platy surface layer under the beating action of raindrops. The opposite of "crusty" is "self-mulching."
- Cull tree.** Live tree of merchantable size but not merchantable because of defect or decay.
- Cultivation.** A mechanical stirring of the soil in place, as for preparation of a seedbed or control of weeds.
- Deciduous.** Refers to plants that lose their leaves at maturity, or at certain seasons. Contrasts with evergreen.
- Decreaser.** Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.
- Deferred grazing.** The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.
- Deflocculate.** To separate, or to break up, soil aggregates into the individual particles; to disperse the particles of a granulated clay to form a clay that runs together, or puddles.
- Delta.** An alluvial deposit, formed largely beneath the water, where a stream or river drops its load of sediment on entering a body of more quiet water. Commonly triangular in shape.
- Dendritic.** Branched like a tree or shrub; used to describe a river of natural drainage system.
- Diversion, or diversion terrace.** A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.
- Diversion dam.** A structure that deflects water from a waterway or stream into a different watercourse, an irrigation canal, or a water-spreading system.
- Dominant trees.** The tallest trees in a stand.
- Drainage, surface.** Runoff, or surface flow, of water from an area.
- Erodible.** Susceptible to erosion.
- Erodes easily.** Water erodes soil easily.
- Erosion.** The wearing away of the land surface by wind (sandblast), running water, and other geological agents.
- Favorable.** Features of soil favorable.
- 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.

- Fine-textured soils.** *Moderately fine textured:* Clay loam, sandy clay loam, silty clay loam; *Fine-textured:* sandy clay, silty clay, and clay. Roughly, soil that contains 35 percent or more of clay.
- First bottom.** The normal flood plain of a stream, subject to frequent or occasional flooding.
- Flood plain.** Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.
- Floods.** Soil temporarily floods by stream overflow, runoff or high tides.
- Forage.** Plant material that can be used as feed by domestic animals; it may be grazed or cut for hay.
- Forb.** Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.
- Friability.** Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.
- Genesis, soil.** The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.
- Gilgai.** Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.
- Gleization.** The reduction, translocation, and segregation of soil compounds, notably of iron, usually in the lower horizons, as a result of waterlogging with poor aeration and drainage; expressed in the soil by mottled colors dominated by gray. The soil-forming processes leading to the development of a gley soil.
- Gleyed soil.** A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.
- Gully.** A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.
- Habitat.** The natural abode of a plant or animal; it refers to the kind of environment in which a plant or animal normally lives as opposed to its range, or geographical distribution.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:
- O horizon.**—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.
- A horizon.**—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).
- B horizon.**—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.
- C horizon.**—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter.
- R layer.**—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.
- Hue.** One of the three variables of color. The dominant spectral (rainbow) color; it is related to the dominant wavelength of the light. See Munsell notation.
- Humid climate.** A climate with enough precipitation to support a forest vegetation, although there are exceptions where the plant cover includes no trees, as in the Arctic or high mountains. The lower limit of precipitation may be as little as 15 inches in cool regions and as much as 60 inches in hot regions. The precipitation-effectiveness index ranges between 64 and 128. A climate that has a high average relative humidity.
- Humidity, relative.** The ratio of the actual amount of water vapor in the air to the quantity that would be there if it were saturated.
- Humus.** The well-decomposed, more or less stable part of the organic matter in mineral soils.
- Hydraulic equilibrium** (of water in soil). The condition for zero flow rate of liquid or film water in soil. This condition is satisfied when the pressure gradient force is just equal and opposite to the gravity force.
- Hydrologic cycle.** The continual circulation of the moisture supply of the earth from the time it is transferred from the atmosphere to the earth in precipitation, distributed along both surface and subterranean courses, and returned to the atmosphere by evaporation from land and water areas and by transpiration from plants.
- Hydrologic soil groups.** Groups of soils having similar rates of infiltration by water, even when wetted, and similar rates of water transmission within the soil. There are four such groups of soils currently recognized by the Soil Conservation Service.
- Group A.** Soils having a high infiltration rate even when thoroughly wetted, consisting chiefly of deep, well-drained to excessively drained sand, gravel or both. These soils have a high rate of water transmission and low runoff potential.
- Group B.** Soils having a moderate infiltration rate when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well drained to well drained soils of moderately fine to moderately coarse texture. These soils have a moderate rate of water transmission and a moderate runoff potential.
- Group C.** Soils having a slow infiltration rate when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water or (2) soils with moderately fine to fine texture and slow infiltration rate. These soils have a slow rate of water transmission and a high runoff potential.
- Group D.** Soils having a very slow infiltration rate when thoroughly wetted consisting chiefly of (1) clay soils with a high swelling potential; (2) soils with a high permanent water table; (3) soils with a claypan or a clay layer at or near the surface; and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission and a very high runoff potential.
- Igneous rock.** Rock that has been formed by the cooling of molten mineral material. Examples: Granite, syenite, diorite, and gabbro.
- Illuviation.** The accumulation of material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial horizon.
- Immature soil.** A soil lacking clearly defined horizons because the soil-forming forces have acted on the parent material only a relatively short time since it was deposited or exposed.
- Impervious soil.** A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.
- Improvement cutting** (forestry). A cutting made for the primary purpose of improving a stand of trees. Undesirable species, trees of poor form, and those that are diseased or a

- source of insect infestation are removed so as to improve the quality and vigor of the stand. Thinning is an improvement cutting made in immature stands.
- Increasers.** Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; increasers commonly are shorter than decreasers, and some are less palatable to livestock.
- Increment (forestry).** The increase in diameter, basal area, height, volume, quality, or value of individual trees or stands during a stated period.
- Indicator plants (ecology).** Plants that give reliable information concerning present condition and past history of an area as to soil, alkalinity, salinity, climate, depth to water table, overgrazing, fire, and the use to which the area is best adapted.
- Inherited soil characteristic.** Any characteristic of a soil that results directly from the nature of the material from which it formed, as contrasted to characteristics that are wholly or partly the result of soil-forming processes acting on parent material. For example, some soils are red because the parent material was red, but the color of most red soils is the result of the soil-forming processes.
- Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.
- Internal soil drainage.** The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none*, *very slow*, *slow*, *medium*, *rapid*, and *very rapid*.
- Invaders.** On range, plants that come in and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface. (Most weeds are "invaders".)
- Land.** The total natural and cultural environment within which production takes place. Land is a broader term than soil. In addition to soil, it applies to mineral deposits and water supply; location in relation to centers of commerce and population; the size of the individual tracts of holdings; and the existing plant cover, works of improvement, and the like.
- Land classification.** The classification of units of land for the purpose of showing their relative suitabilities for some specific use.
- Large stones.** Rock fragments 10 inches or more across.
- Lime.** Chemically, lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived materials applied to neutralize acid soils. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oyster-shells, and marl also contain calcium.
- Lime concretion.** An aggregate cemented by the precipitation of calcium carbonate (CaCO<sub>3</sub>).
- Lime requirement.** The amount of standard ground limestone required to bring a 6.6-inch layer of an acre (about 2 million pounds) of acid soil to some specified lesser degree of acidity, generally to slightly acid or very slightly acid. The requirement is generally given in tons per acre of nearly pure limestone ground finely enough so that all of it passes through a 10-mesh screen and at least half of it passes through a 100-mesh screen.
- Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.
- Loess.** A fine-grained eolian deposit consisting dominantly of silt-sized particles.
- Low strength.** Not enough strength to adequately support the load.
- Marl.** An earthy, unconsolidated deposit formed in fresh-water lakes that consist chiefly of calcium carbonate mixed with various amounts of clay or other impurities.
- Marsh.** Periodically wet or continually flooded areas. Surface not deeply submerged. Covered dominantly with sedges, cat-tails, rushes, or other water-tolerant plants. Includes fresh-water and salt-water marshes.
- Mature soil.** Any soils with well-developed soil horizons having characteristics produced by the natural processes of soil formation and in near equilibrium with its present environment.
- Meadow.** A field in which biennial or perennial crops are grown for hay.
- Mechanical analysis (soils).** The percentage of the various sizes of individual mineral particles, or separates, in the soil. Also, a laboratory method of determining soil texture.
- Mechanical stability (soils).** Resistance of soil to breakdown by mechanical forces, such as tillage or abrasion from wind-borne soil particles; strength of coherence; mechanical strength.
- Medium-textured soil.** Soil of very fine sandy loam, loam, silt loam, or silt texture.
- Mellow soil.** A porous, soft, granular soil that is easily worked without becoming compacted.
- Merchantable forest.** Refers to the trees or part of the stand that can be marketed under given economic conditions. Merchantable length refers to the marketable length of a log in a tree; merchantable volume refers to the marketable volume in trees or logs.
- Micro-organisms.** Forms of life that are either too small to be seen with the unaided eye or are barely discernible.
- Microrelief.** Minor surface configurations of the land.
- Mineral soil.** Soil composed mainly of inorganic (mineral) material and low in content of organic material. Its bulk density is greater than that of organic soil.
- Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.
- Mottled.** 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.
- Muck.** An organic soil consisting of fairly well decomposed organic material that is relatively high in mineral content, finely divided, and dark in color.
- Munsell notation.** A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.
- Natural soil drainage.** Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.
- Excessively drained* soils are commonly very porous and rapidly permeable and have a low available water capacity.
- Somewhat excessively drained* soils are also very permeable and are free from mottling throughout their profile.
- Well-drained* soils are nearly free from mottling and are commonly of intermediate texture.
- Moderately well drained* soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and 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.
- Neutral soil.** In practice, a soil having a pH value between 6.6 and 7.3. Strictly speaking, a soil that has a pH value of 7.0
- Nitrogen fixation** (soils). The taking in of free nitrogen from the air by organisms in the soil so that this nitrogen eventually becomes available to plants.
- Nitrogen-fixing plant.** A plant that can take in and fix the free nitrogen in the atmosphere by the aid of bacteria living in the root nodules. Legumes with the associated rhizobium bacteria in the nodules of roots are the most important nitrogen-fixing plants. Fixation brought about by the aid of bacteria in plant roots is called symbiotic fixation; if done by free-living organisms acting independently, it is referred to as nonsymbiotic fixation.
- Nodule.** A structure developed on the roots of most legumes and a few other plants in response to the stimulus of root-nodule bacteria. Legumes bearing these nodules are nitrogen-fixing plants that use atmospheric nitrogen instead of depending on nitrogen compounds in the soil.
- Normal erosion.** The erosion that takes place on the land surface in its natural environment undisturbed by human activity. Synonym: Geologic erosion.
- Normal soil.** A soil having a profile in near equilibrium with its environment; developed under good but not excessive drainage from parent material of mixed mineral, physical, and chemical composition. Its characteristics show the full effects of the forces of climate and living matter.
- Not needed.** Practice not applicable.
- Nutrient, plant.** Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.
- Organic matter.** A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.
- Organic soil.** A general term applied to a soil or to a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers. In chemistry, organic refers to the compounds of carbon.
- Overgrazing.** Grazing so heavy as to impair future forage production and to deteriorate plants, soil, or both. Contrasts with undergrazing.
- Overmature** (forestry). A tree or forest that is mature, is no longer growing, and has begun to decay and to deteriorate.
- Overstocked: forestry:** Stands containing so many trees that their normal growth is retarded. *Wildlife:* A population of animals in excess of the carrying capacity of their habitats. *Range management:* More animals on a range area than it will support or maintain through the grazing period without overgrazing. Contrasts with understocking.
- Overstory.** The trees in a forest that form the upper crown cover. Contrasts with understory.
- Parent material.** Disintegrated and partly weathered rock from which soil has formed.
- Percs slowly.** Water moves through the soil too slowly.
- Permanent pasture.** Pasture that is on the soil for a long time, in contrast to rotation pasture, which is on the soil only a year or two because it is grown in rotation with other crops.
- 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.*
- Phase, soil.** A division of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.
- pH value.** A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.
- Plantation** (forestry). An area artificially reforested by planting young trees or by seeding.
- Plastic** (soil consistence). Capable of being deformed without being broken.
- Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.
- Plastic limit.** The moisture content at which a soil changes from a semisolid to a plastic state.
- Plinthite.** More or less clayey, red or dark-red material, ordinarily in the form of mottles and high in iron, that hardens irreversibly if exposed to repeated alternate wetting and drying. In a moist soil, plinthite can be cut with a spade, whereas ironstone, the irreversibly hardened equivalent, cannot be cut but may be broken or shattered with a spade.
- Productivity** (of soil). The present capability of a soil for producing a specified plant or sequence of plants under a specified system of management. It is measured in terms of output, or harvest, in relation to input of production for the specific kind of soil under a specified system of management.
- Profile, soil.** A vertical section of the soil through all its horizons and extending into the parent material.
- Proper range use.** Grazing rangeland at such intensity that the quality of the vegetation will improve and the amount of plant residue will be sufficient to conserve soil and water.
- Pulpwood.** Wood used for paper, fiberboard, or similar manufactured products.
- Quartzite.** A compact, granular, metamorphosed sandstone.
- Range** (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land on which there are some forest trees.
- Range condition.** The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.
- Range plant cover.** All the herbaceous and shrubby plants on a range that livestock can reach, regardless of whether these plants constitute forage.
- Range seeding.** Establishing perennial grasses or improved re-seeding grasses or legumes on rangeland to prevent the loss of soil and water and to restore the productivity of native grassland.
- Range site.** An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.
- Range survey.** A systematic, comprehensive inventory and analysis of the range resources and the related problems of management in a range area, and development of plans for its management.
- Range type.** An area of range differentiated from other range areas primarily by its kind of plant cover, such as grass, browse, or conifer.
- 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:
- |                          |            |                              |            |
|--------------------------|------------|------------------------------|------------|
| 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 |

- Reforestation.** The natural or artificial restocking of an area with forest trees. Commonly, the term "reforestation" refers to artificial restocking.
- Regolith.** The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Only the upper part of this, modified by organisms and other soil-building forces, is regarded by soil scientists as soil. Most American engineers speak of the whole regolith, even to great depths, as "soil."
- Relief.** The elevations or inequalities of a land surface, considered collectively.
- Residual material.** 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.
- Retention, moisture.** The difference between the total precipitation and total runoff; the precipitation falling in a drainage area that does not escape as runoff.
- Reticulate mottling.** A type of mottling distinguished by a network of differently colored streaks; most frequently occurs in the deeper parts of latosolic soils.
- Rill.** A steep-sided channel resulting from accelerated erosion. A rill normally is a few inches in depth and width and is not large enough to be an obstacle to farm machinery.
- Root zone.** The part of the soil that is penetrated, or can be penetrated, by plant roots.
- Rotation age (forestry).** The age at which a stand is considered ready for harvesting under the plan of management selected.
- Rotation grazing.** Grazing two or more pastures, or parts of a range, in regular order, with definite recovery periods between grazing periods. Contrasts with continuous grazing.
- Rotation pasture.** A cultivated area used as a pasture one or more years as a part of crop rotation. Contrasts with permanent pasture.
- Roughage.** Feed with a higher fiber content and low total digestible nutrients, as hay and stover.
- Row crop.** A crop planted in rows, generally 2 to 4 feet apart, so as to allow cultivation between rows during the growing season.
- Runoff (hydraulics).** The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.
- 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.
- Sandy soils.** A broad term for soils of the sand and loamy sand classes; soil material with more than 70 percent sand and less than 15 percent clay.
- Second bottom.** The first terrace above the normal flood plain of a stream.
- Second growth (forestry).** Forest that originates naturally after removal of a previous stand by cutting, fire, or other cause. A loosely used term for young stands.
- Section.** A standard subdivision of areas used in the United States Land Office surveys, intended to be 1 mile square and to contain 640 acres.
- Sedimentary rock.** A rock composed of particles deposited from suspension in water. The chief sedimentary rocks are conglomerate, from gravel; sandstone, from sand; shale, from clay; and limestone, from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sands have been consolidated into sandstone.
- Seed tree.** Any tree which bears seed; specifically, a tree left to provide seed for natural reproduction.
- Seepage.** Slow escape of water from a soil along an extensive line of surface.
- Selection cutting.** Removal of mature timber, usually the oldest or largest trees, at short intervals, commonly 5 to 20 years. Single scattered trees or small groups of trees are cut repeatedly to encourage the establishment of natural reproduction and to gain a stand of uneven age. Trees for cutting are generally selected on the basis of age, vigor, and condition.
- 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 layers, are similar in differentiating characteristics and in arrangement in the profile.
- Sesquioxides.** Oxides having trivalent cations, as iron or aluminum oxides.
- Shale.** A sedimentary rock formed by the hardening of clay deposits.
- Sheet erosion.** The removal of a fairly uniform layer of soil or material from the land surface by the action of rainfall and runoff water.
- Shrink-swell potential (engineering).** Amount that a soil will expand when wet or contract when dry. Indicates kinds of clay in soil.
- Shrub.** A woody perennial plant differing from a perennial herb by its persistent and woody stems, and from a tree by its low stature and habit of branching from the base.
- 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.
- Silting.** Settling of waterborne sediments, chiefly silt, in lakes, reservoirs, stream channels, or overflow areas.
- Silviculture.** The art of producing and tending a forest; the theory and practice of controlling forest establishment, composition, and growth.
- Site class (forestry).** A grouping of site indexes, by species, for convenience in management. Groupings may express relative productivity or actual height attained by trees at a specified age.
- Site index.** A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.
- Slash (forestry).** Debris left after logging, pruning, thinning, or brush cutting; or large accumulations of debris after a wind or fire.
- Slickensides.** Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.
- Slick spots.** Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.
- Small stones.** Rock fragments less than 10 inches across.
- Snag (forestry).** A standing dead tree from which the leaves and most of the branches have fallen, or a part of such a dead tree.
- Sod grass.** A grass that reproduces by stolons or rhizomes or that otherwise forms a more or less continuous sod or turf.
- Softwood.** Generally one of the group of trees that in most cases have needles, or scalelike leaves; the conifer; also the wood from such trees.
- 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.
- Soil Map.** A map designed to show the distribution of soil mapping units in relation to the prominent physical and cultural features of the earth's surface.
- Soil separates.** Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).
- 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.
- Stones.** Rock fragments greater than 10 inches in diameter if rounded, and greater than 15 inches along the longer axis if flat.
- Stony.** Used to describe soils that contain stones in numbers that interfere with or prevent tillage.
- Storage capacity.** The amount of water that can be stored in the soil for both evaporation and future use by plants.
- Stratified.** Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.
- Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles) adhering together without any regular cleavage, as in many claypans and hardpans).
- Stubble.** The basal part of plants that remain after the top has been harvested; also the part of grasses that remains after current grazing is completed.
- Stubble mulch.** Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.
- Stumpage** (forestry). The value of standing, uncut timber.
- Subgrade** (engineering). The substratum, consisting of in-place material or fill material, that is prepared for highway construction; does not include stabilized base course or actual paving material.
- Subgrade modulus** (engineering). The resistance of soil material to unit area displacement under load, expressed in pounds per square inch. Hence, if a load of 1,000 pounds, on 100 square inches of surface, penetrates 1 inch, the modulus is 10.
- Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.
- Subsoiling.** Tillage of a soil below normal depth ordinarily to shatter a hardpan or claypan.
- Substratum.** Technically, the part of the soil below the solum.
- Surface layer.** A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.
- Surface soil.** 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."
- Thin layer.** Inadequate thickness of suitable soil.
- Thinning** (forestry). A cutting made in immature stands after the sapling stage for the purpose of increasing the rate of growth of the trees left standing.
- Tilth, soil.** The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.
- Timber.** A term loosely applied to forest stands or their products; often used for wood prepared forms suitable for heavy construction; specifically, sawed lumber 5 by 5 inches or more in breadth and thickness.
- Timber stand improvement** (forestry). All cuttings not a part of a major harvest that are done during the life of a stand for the general purpose of improving the composition, condition, or rate of growth.
- Too clayey.** Soil slippery and sticky when wet and slow to dry.
- Too sandy.** Soil soft and loose; droughty and low in fertility.
- Topsoil.** A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.
- Trace elements.** The chemical elements found in soils in extremely small amounts, yet which are essential to plant growth. Some of the trace elements are zinc, cobalt, manganese, copper, and iron.
- Transitional soil.** A soil somewhat resembling two different kinds of soils and genetically related to them.
- Transpiration.** The discharge of water vapor into the atmosphere from the leaves and stems of living plants.
- Tree.** A woody plant that reaches a height of at least 8 to 10 feet and has a single stem and a definite crown shape. (There is no clear-cut distinction between trees and shrubs. Some plants, as sumac and willow, may grow as either trees or shrubs.)
- Tree planting.** Planting trees, shrubs, vines, or cuttings of these, to prevent soil loss and excessive runoff and to produce wood products.
- Understory.** The part of a forest that is below the upper crown canopy. Contrasts with overstory.
- Unpalatable.** A term applied to feed, forage, or individual plant species that are not well liked and, therefore, are not eaten readily by domestic animals.
- Unsuitable fill.** Banks of fills likely to cave or slough.
- Upland** (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.
- Value** (color). One of three variables of color. Value increases as the relative intensity of reflected light increases. See Munsell notation.
- Water table.** The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.
- Water table, perched.** The upper surface of a body of free ground water that is separated from an underlying body of ground water by unsaturated material.
- W-ditches.** Two parallel drainage ditches, each having a V cross section, and the excavated material from the ditches placed between them.
- Weathering.** All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.
- Weed tree.** A tree that is of relatively little or no value.
- Well-graded soil.** A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.
- Wetness.** Soil wet during period of use.
- Wilting point** (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit or other land use interpretative group, read the introduction to the section it is in for general information about its management. Blank spaces signify that the soil was not placed in a particular grouping.

| Map symbol | Mapping unit   | De-<br>scribed<br>on<br>page | Capability<br>unit | Pasture and<br>hayland group | Range site<br>Name |
|------------|--|------------------------------|--------------------|------------------------------|--------------------|
| Ar         | Annona-Raino complex-----                                      | 6                            | IIIw-2             | 8A                           | Claypan Savannah   |
| BaC        | Bazette clay loam, 3 to 5 percent slopes-----                  | 8                            | IVe-1              | 8B                           | Claypan Prairie    |
| BaD        | Bazette clay loam, 5 to 12 percent slopes-----                 | 8                            | VIe-1              | 8B                           | Claypan Prairie    |
| BeB        | Bernaldo fine sandy loam, 1 to 3 percent<br>slopes-----        | 9                            | IIe-1              | 8C                           | Sandy Loam         |
| CrA        | Crockett loam, 0 to 1 percent slopes-----                      | 9                            | IIIs-1             | 8A                           | Claypan Prairie    |
| CrB        | Crockett loam, 1 to 3 percent slopes-----                      | 9                            | IIIe-1             | 8A                           | Claypan Prairie    |
| CrC        | Crockett loam, 3 to 5 percent slopes-----                      | 10                           | IVe-1              | 8A                           | Claypan Prairie    |
| CrC2       | Crockett loam, 2 to 5 percent slopes, eroded---                | 10                           | IVe-1              | 8A                           | Claypan Prairie    |
| EsD        | Ellis clay, 5 to 12 percent slopes-----                        | 11                           | VIe-2              | 7B                           | Eroded Blackland   |
| Fed2       | Ferris clay, 5 to 12 percent slopes, eroded---                 | 11                           | VIe-2              | 7B                           | Eroded Blackland   |
| FrB        | Freestone fine sandy loam, 1 to 3 percent<br>slopes-----       | 12                           | IIe-2              | 8C                           | Sandy Loam         |
| Gw         | Gladewater clay-----   | 13                           | Vw-2               | 1B                           | Clayey Bottomland  |
| HeC2       | Heiden clay, 3 to 5 percent slopes, eroded----                 | 15                           | IIIe-3             | 7A                           | Blackland          |
| Ho         | Hopco silty clay loam-----                                     | 15                           | Vw-1               | 2A                           | Loamy Bottomland   |
| Ka         | Kaufman clay-----  | 16                           | Vw-2               | 1A                           | Clayey Bottomland  |
| KnD        | Kirvin gravelly fine sandy loam, 3 to 8<br>percent slopes----- | 16                           | IVe-2              | 8C                           | Sandy Loam         |
| KvD        | Kirvin soils, 3 to 8 percent slopes-----                       | 17                           | VIe-3              | 8C                           | Sandy Loam         |
| LeB        | Leson clay, 1 to 3 percent slopes-----                         | 17                           | IIe-3              | 7A                           | Blackland          |
| LeC        | Leson clay, 3 to 5 percent slopes-----                         | 18                           | IIIe-3             | 7A                           | Blackland          |
| Lr         | Lufkin-Raino complex-----                                      | 18                           | IIIw-2             | 8E                           | Claypan Savannah   |
| Na         | Nahatche soils-----  | 19                           | Vw-1               | --                           | Loamy Bottomland   |
| PkC        | Pickton loamy fine sand, 1 to 5 percent<br>slopes-----         | 20                           | IIIs-3             | 9B                           | Deep Sand          |
| WcB        | Wilson clay loam, 0 to 2 percent slopes-----                   | 21                           | IIIw-1             | 7H                           | Claypan Prairie    |
| WoC        | Wolfpen loamy fine sand, 1 to 5 percent<br>slopes-----         | 22                           | IIIs-2             | 9A                           | Sandy              |
| WtC        | Woodtell loam, 2 to 5 percent slopes-----                      | 24                           | IIIe-2             | 8A                           | Claypan Savannah   |
| WtD        | Woodtell loam, 5 to 12 percent slopes-----                     | 24                           | VIe-1              | 8B                           | Claypan Savannah   |
| WwC        | Woodtell stony loam, 1 to 5 percent slopes-----                | 25                           | VIIIs-1            | --                           | Claypan Savannah   |

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