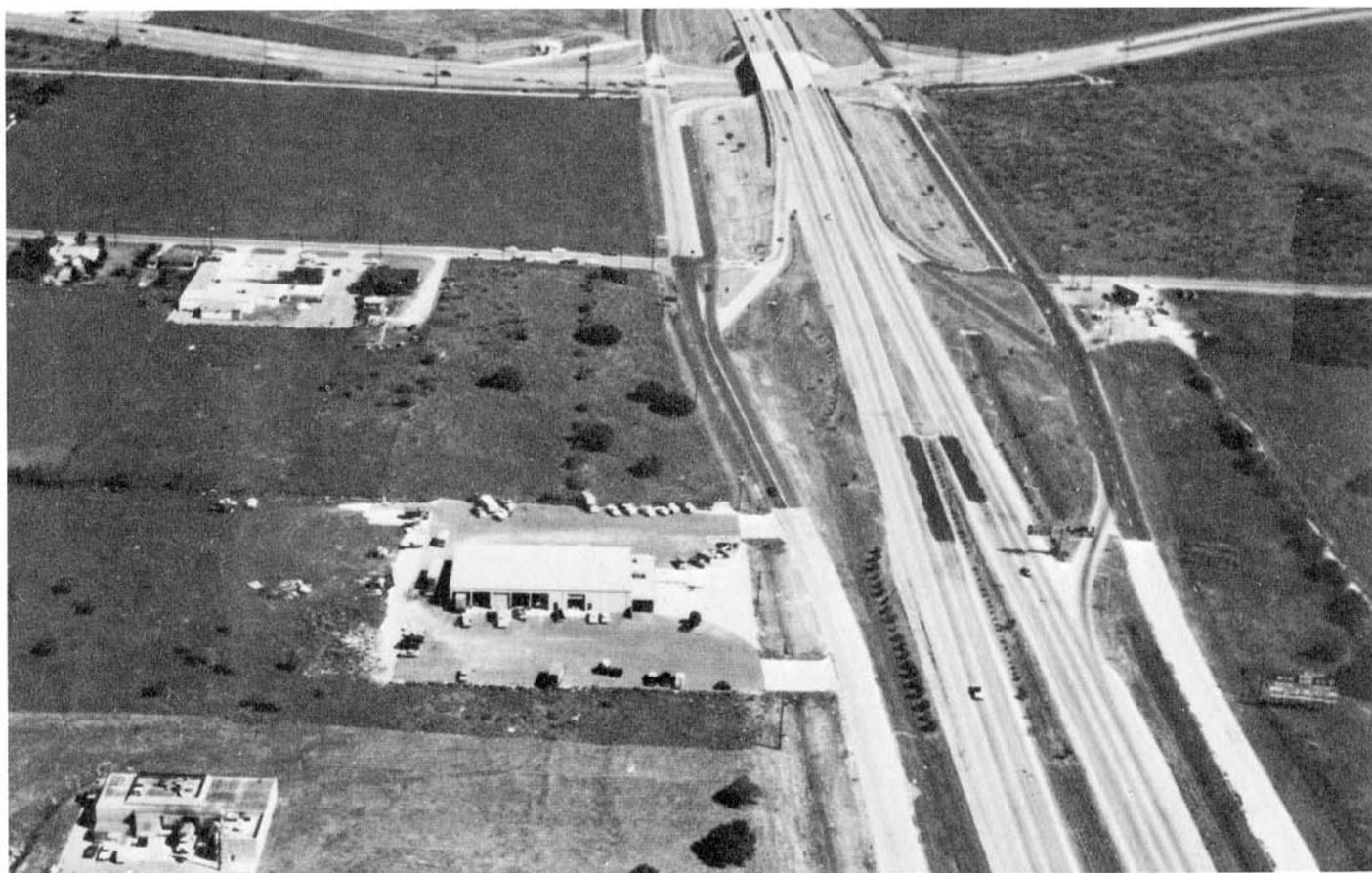


SOIL SURVEY OF

# Travis County, Texas



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

Issued June 1974

Major fieldwork for this soil survey was done in the period 1960-1968. Soil names and descriptions were approved in 1969. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1969. 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 Taylor and Hays-Caldwell-Travis Soil and Water Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

## HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; 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 Travis County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

### Finding and Using Information

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

Ranchers and others can find, under "Use of the Soils for 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.

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Use of the Soils for Community Development" and "Use of the Soils for Recreation Facilities."

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

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

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

Cover: Farmland being converted to urban use. Urban land and soils of the Austin and Houston Black series are represented.
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# CONTENTS

	Page
HOW THIS SURVEY WAS MADE-----	2
GENERAL SOIL MAP-----	3
Mainly shallow, rolling, and steep soils of the Edwards Plateau-----	3
1. Brackett association-----	3
2. Tarrant association-----	4
3. Speck-Tarrant association-----	5
Mainly deep, gently sloping soils of the Blackland Prairies-----	5
4. Houston Black-Heiden association-----	5
5. Austin-Eddy association-----	6
6. Burleson-Wilson association-----	7
7. Ferris-Heiden association-----	8
Mainly deep, nearly level and gently sloping soils of terraces and flood plains adjacent to the Colorado River-----	8
8. Bergstrom-Norwood association-----	9
9. Travis-Chaney association-----	9
10. Lewisville-Patrick association-----	9
DESCRIPTIONS OF THE SOILS-----	10
Altoga series-----	11
Austin series-----	12
Bergstrom series-----	15
Brackett series-----	17
Burleson series-----	19
Chaney series-----	20
Crawford series-----	22
Crockett series-----	23
Denton series-----	24
Dougherty series-----	25
Eddy series-----	26
Ferris series-----	28
Frio series-----	29
Hardeman series-----	30
Heiden series-----	31
Heiden series, neutral subsoil variant-----	33
Hornsby series-----	34
Hornsby gravelly soils, clayey variant-----	36
Houston Black series-----	37
Lewisville series-----	39
Lincoln series-----	41
Miller series-----	42
Mixed alluvial land-----	43
Norwood series-----	44
Patrick series-----	45
Pedemales series-----	46
Purves series-----	48
Riverwash-----	48
San Saba series-----	49

Speck series-----	50
Stephen series-----	51
Tarrant series-----	52
Travis series-----	55
Trinity series-----	57
Urban land-----	58
Volente series-----	60
Wilson series-----	62
Yahola series-----	63
<b>USE AND MANAGEMENT OF THE SOILS-----</b>	<b>70</b>
Management of cultivated soils-----	70
Capability grouping-----	72
Management by capability units-----	73
Predicted yields-----	82
Use of the soils for range-----	82
Range sites and condition classes-----	83
Descriptions of range sites-----	84
Use of the soils for pasture and hay-----	90
Management of the soils for pasture and hay-----	90
Pasture and hayland suitability groups-----	91
Engineering uses of the soils-----	95
Engineering classification systems-----	95
Estimated engineering properties-----	96
Engineering interpretations-----	97
Engineering test data-----	98
Use of the soils for community development-----	98
Foundations-----	98
Sewage disposal systems-----	98
Areas subject to flooding and erosion-----	99
Underground utility lines-----	99
Landscaping and gardening-----	99
Use of the soils for recreation facilities-----	100
Use of the soils for wildlife-----	101
<b>FORMATION, CLASSIFICATION, AND MORPHOLOGY</b>	
<b>OF THE SOILS-----</b>	<b>102</b>
Factors of soil formation-----	102
Parent material-----	102
Plants and animals-----	102
Climate-----	102
Relief-----	102
Time-----	103
Processes of horizon differentiation-----	103
Classification of the soils-----	103
<b>ADDITIONAL FACTS ABOUT THE COUNTY-----</b>	<b>106</b>
History-----	106
Climate-----	107
<b>LITERATURE CITED-----</b>	<b>108</b>
<b>GLOSSARY-----</b>	<b>109</b>
<b>GUIDE TO MAPPING UNITS-----</b>	<b>Removed</b>

## SOIL SURVEY OF TRAVIS COUNTY, TEXAS

FIELDWORK BY LEROY E. WERCHAN, A. C. LOWTHER, AND ROBERT N. RAMSEY, SOIL CONSERVATION SERVICE

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

TRAVIS COUNTY is in the south-central part of Texas. It is pentagonal in shape and has an area of 670,080 acres. The irregular northern boundary is on a watershed divide between the Colorado and Brazos Rivers (fig. 1). Annual rainfall in the county averages 32.5 inches, and the mean temperature is 68 degrees. Elevations range from 400 to 1,400 feet above sea level.

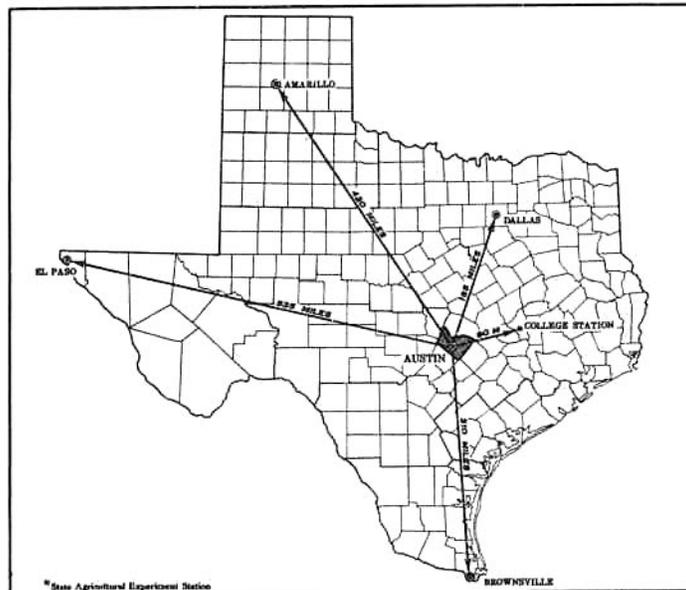


Figure 1.—Location of Travis County in Texas.

The county seat, Austin, is also the capital of Texas. Population of the county is about 264,000 of which 250,000 is urban.

Travis is an urbanized county, dominated by Austin's governmental, Education, and associated scientific and research facilities. Dairying and the raising of cattle, sheep, and poultry provide 60 percent of farm income. Grain sorghum, small grains, hay, corn, and cotton are the principal crops. The chain of lakes and the abundance of wild game in the hills provide popular means of recreation.

In the western part of Travis County, on the Edwards Plateau, ranching is the chief enterprise. In the eastern part, on the Blackland Prairie, row crops and cattle farming are dominant. The bottom-lands are low terraces along the Colorado River are used for row crops, hay, and cattle farming.

There are approximately 157,000 acres in crops, 342,000 acres in range, 56,000 acres in pasture and meadows, and 60,000 acres in urban development. More than 22,000 acres is large lakes. The rest of the acreage is mostly used for roads, military bases, individual rural dwellings and grounds, gravel and stone pits, small ponds, and numerous rural villages and other settlements along the lakes.

## HOW THIS SURVEY WAS MADE<sup>1/</sup>

<sup>1/</sup> Underscored numbers in parentheses refer to Literature Cited.

Soil scientists made this survey to learn what kinds of soil are in Travis County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots. The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey (6)

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Travis and Houston Black, 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, Houston Black clay, 1 to 3 percent slopes, is one of several phases within the Houston Black series.

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

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

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

A soil complex consists of areas of two or more soils so intermingled or so small in size that they not 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. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Austin-Brackett complex, 3 to 5 percent slopes, eroded, 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. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Tarrant soils and Rock outcrop, steep or Tarrant soils and Urban land, 0 to 2 percent slopes, are two examples of undifferentiated groups.

In some areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Mixed alluvial land is a land type in Travis County.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they 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 Travis County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

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

The ten soil associations in this county are described in the following pages. The terms for texture used in the descriptive headings for several of the associations apply to the surface layer. For example, in the heading for association 1, the word "loamy" refers to the texture of the surface layer.

### Mainly Shallow, Rolling and Steep Soils of the Edwards Plateau

Most of the soils in this group are too shallow, stony, or steep for cultivation. Ranching is the chief enterprise, and most of the soils are well suited to this use. Wildlife habitat and recreation are other important uses for areas of these soils.

#### 1. Brackett Association

##### Shallow, gravelly, calcareous, loamy soils overlying interbedded limestone and marl

This association consists of gently undulating to steep soils capped in places by soils on narrow ridges (fig. 2). These soils occur in a large area that includes Lake Travis, Lake Austin, and the Pedernales River. These water areas are excluded from the acreage figures for the association.

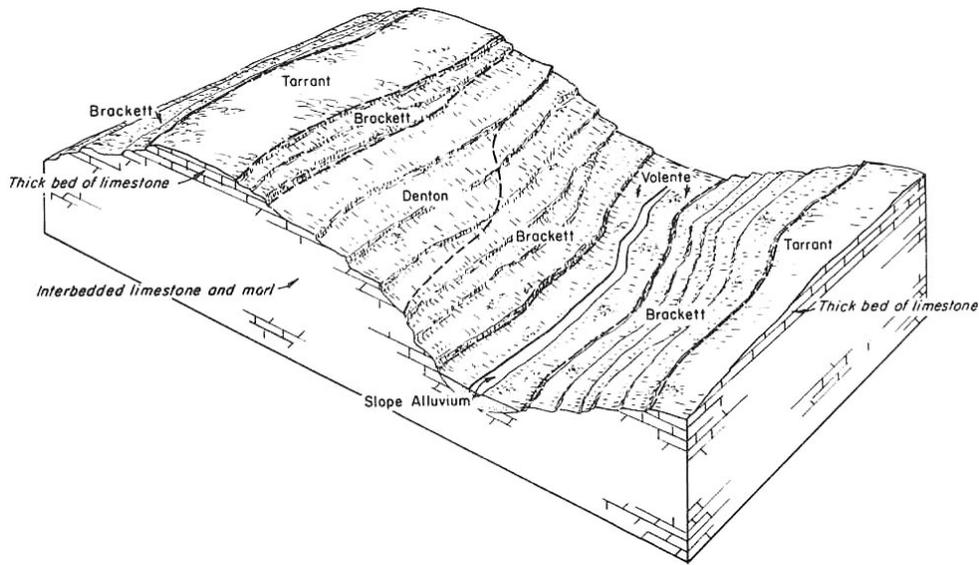


Figure 2.—Representative pattern of soils in association 1.

Brackett soils are gently undulating to steep. Tarrant soils are on narrow ridges. The total land area of this association makes up about 38 percent of the county.

Brackett soils make up about 63 percent of this association, and Tarrant soils, about 11 percent. The remaining 26 percent of the association consists of Volente, Denton, San Saba, Pedernales, and Altoga soils.

Brackett soils have a surface layer of light brownish-gray gravelly clay loam about 6 inches thick. The percentage of coarse fragments ranges from a few to about 75 percent. The next layer, about 12 inches thick, is very pale brown clay loam that contains scattered soft limestone in places. The underlying material is interbedded limestone and marl.

This association is mainly too shallow, stony, gravelly, or steep for farming, but it is well suited to range. Wildlife, particularly deer and turkey, are plentiful in this association. Many ranchers not only raise livestock but also sell hunting rights as part of their ranching operations.

Urban expansion is rapidly encroaching on range near cities and along the lakes. This association is very scenic.

## 2. Tarrant Association

### Very shallow, stony, calcareous, clayey soils intermingled with shallow soils overlying limestone

This association consists of nearly level to steep soils on high ridges. It makes up about 5 percent of the county.

Tarrant soils make up about 63 percent of this association; other soils, about 37 percent. Other soils are of the Speck, Crawford, Denton, and San Saba series and Rock outcrop.

Tarrant soils are about 8 inches thick over lime-Stone. The surface layer is dark grayish-brown clay that is about 60 percent flaggy limestone in the lower part. In most places large flaggy limestone fragments cover about 50 percent of the surface.

This association is not suitable for farming, but it is well suited to native grasses. Nearly all of this association, with the exception of a few patches of the deeper Denton and San Saba soils, is used as range. An important associated use is for wildlife. Many deer and wild turkey roam over this association, and ranch operations often include leasing for hunting rights in addition to raising livestock.

Land uses are changing rapidly in many areas of this association. Native trees and shrubs make these areas desirable for home building. The main limitations to use of this association for urban development are breaking and moving the massive limestone for site leveling, or for grading streets, or for installing septic systems.

### 3. Speck-Tarrant Association

#### Shallow, stony, loamy soils and very shallow, stony, clayey soils overlying limestone

This association consists of nearly level to gently sloping and gently undulating soils. It makes up about 4 percent of the county.

Speck soils make up about 52 percent of the association, and Tarrant soils make up about 45 percent. The remaining 3 percent is San Saba and Crawford soils and Mixed alluvial land.

Speck soils are about 18 inches thick over limestone. The surface layer is reddish-brown clay loam. It is underlain by dark reddish-brown gravelly clay. This soil is noncalcareous, but mildly alkaline.

Tarrant soils are about 8 inches thick over limestone. The surface layer is dark grayish-brown clay that has about a 50 percent cover of large gray limestone fragments. The lower part of the soil is about 60 percent flaggy limestone. Most Tarrant soils are calcareous.

This association is mainly gravelly or stony and not suitable for farming. Most of it is in grasses and scattered trees. Except for a few areas of San Saba and Crawford soils, this association is used for range. Soils of this association are well suited as wildlife habitat. Leasing for hunting rights is often part of the ranching enterprise.

Land uses are changing in many areas of this association. Native trees and shrubs make these areas desirable for home building. The use of this association for urban development is limited mainly by thick beds of limestone beneath the soils. These beds make it difficult to level sites, cut streets to grade, or dig septic systems.

#### Mainly Deep, Gently Sloping Soils of the Blackland Prairies

The soils in this group are mainly used for crops and pasture, but urban areas are expanding in many places. Mainly, the soils are clays that have a high shrink-swell potential, are highly corrosive to pipes, and are poorly suited to septic systems.

### 4. Houston Black-Heiden Association

#### Deep, nearly level and gently sloping, calcareous, clayey soils overlying marl

This association consists of an irregular series of nearly level to gently sloping soils (fig. 3) on broad ridges above gently rolling, narrow side Mopes. The valleys are narrow to broad, and in most areas alluvial soils occur along well-defined drainageways.

Houston Black soils are on the ridges and in the valleys. Heiden soils occupy the side slopes. The association makes up about 21 percent of the county.

Houston Black soils make up about 70 percent of this association, and Heiden soils, about 20 percent. The remaining 10 percent of the association consists mainly of Ferris and Trinity soils.

Houston Black soils have a surface layer of very dark gray clay about 24 inches thick. The underlying material, to a depth of BQ inches, is darkgray to grayish-brown clay. These soils are calcareous.

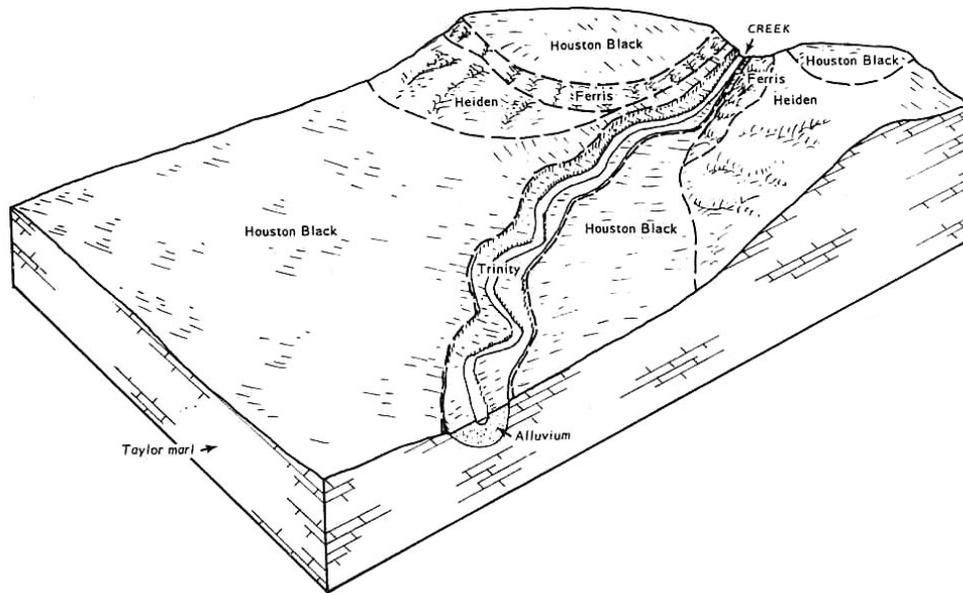


Figure 3.—Representative pattern of soils in association 4.

Heiden soils have a surface layer of dark grayish-brown clay about 16 inches thick. The underlying material is grayish-brown, mottled clay. Most areas of Heiden soils are calcareous.

This association is used mainly for farming. Most crops suited to the county are grown. Many pastures of improved grasses have been established, especially on the steeper slopes and in flooded bottoms.

Land uses are changing in areas of this association. Farming areas are decreasing, and urban areas are expanding. The main limitations in use of the soils of this association in urbanization are the shrink-swell characteristics, as they affect foundations and streets; corrosivity, as it affects pipelines and cables; and the poor suitability of the soils for septic systems.

## 5. Austin-Eddy Association

### Moderately deep and shallow, calcareous, clayey and gamy soils overlying chalk

This association consists of nearly level to sloping soils on narrow ridges and adjoining side slopes and gently sloping to sloping soils on broad ridges and side slopes (fig. 4). These soils formed over chalk.

Austin soils are on broad ridges and side slopes, and Eddy soils are on narrow ridges and side slopes. This association makes up about 12 percent of the county.

Austin soils make up about 29 percent of the association, and Eddy soils, about 15 percent. The winning 56 percent of the association consists mainly of Stephen, Brackett, Houston Black, and Frio soils, channeled, and Urban land.

Austin soils are about 34 inches thick over chalky marl and chalk rock. The surface layer is very dark grayish-brown silty clay about 14 inches thick. The next layer is brown silty clay that extends to a depth of about 34 inches. The underlying material is a light-brown mixture of weathered chalk 1 and silty clay loam. Austin soils are calcareous.

Eddy soils are about 14 inches thick over chalk. The surface layer is grayish-brown clay loam. Broken pieces of chalk cover about 25 percent of the surface.

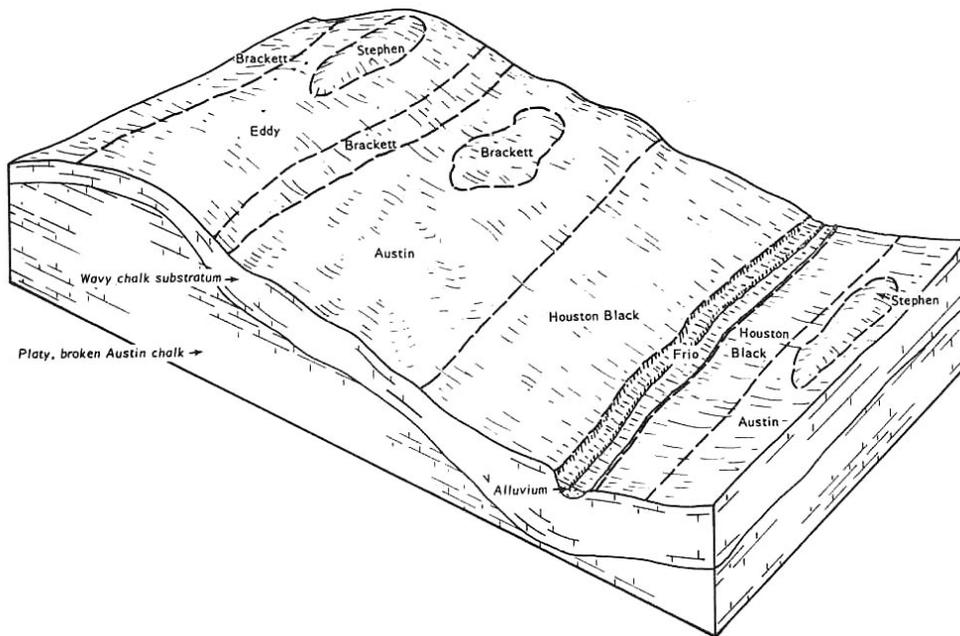


Figure 4.—Representative pattern of soils in association 5.

Austin soils are mainly cultivated, and Eddy, soils are mainly in pasture. Erosion is the main limitation to use of the soils for crops.

This association is in the path of urban expansion, and much of it, is already used for urban and suburban development. Limitations to building on these soils are the high shrink-swell potential and unsuitability for septic systems.

## 6. Burleson-Wilson Association

### Deep, clayey and loamy soils overlying marl

This association consists of nearly level and gently undulating Burleson soils and nearly level to gently sloping Wilson soils. Where they occur together, the Wilson soils are generally on ridges (fig. 5). This association makes up about 4 percent of the county.

Burleson soils make up about 53 percent of the association, and Wilson soils, about 30 percent. The remaining 17 percent of the association consists mainly of Crockett, Heiden, and Trinity soils.

Burleson soils have a surface layer of crusty, dark gray to very dark gray clay about 42 inches thick. The next layer extends to a depth of about 55 inches. It is gray clay that has mottles or streaks of darker material in filled cracks. The underlying material is very pale brown silty clay.

Wilson soils have a surface layer of crusty, gray clay loam about 6 inches thick. The next layer, rich extends to a depth of 60 inches or more, is very dark gray clay that shades to browner in the lower part.

Permeability is very slow. Burleson soils crack to the surface, and infiltration is mainly through this route. Wilson soils do not crack to the surface, and most of the rainfall runs off.

This association is used for crops. The trend, however, is toward developing improved grass pasture or native grass range.

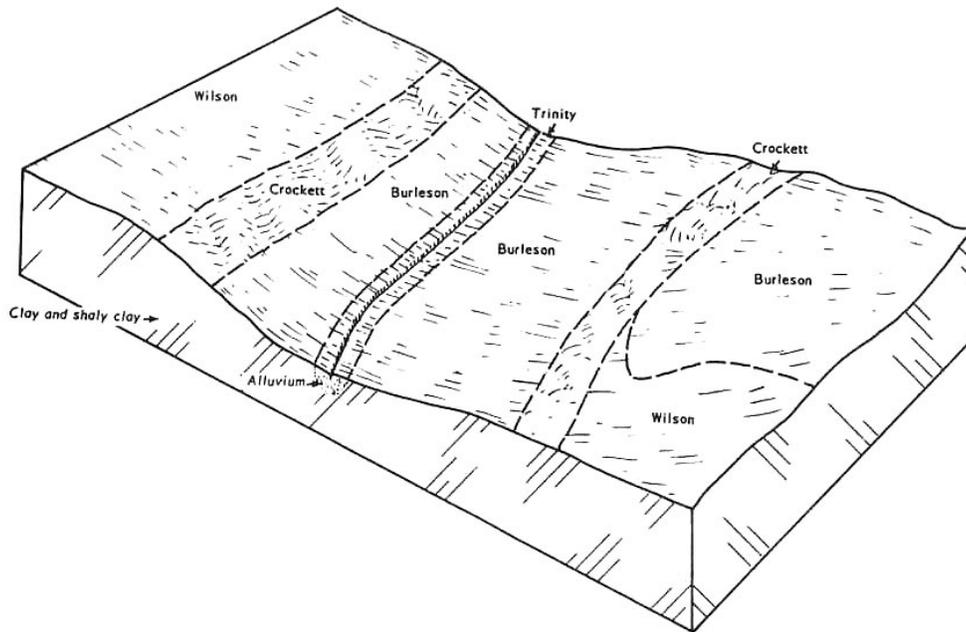


Figure 5.—Representative pattern of soils in association 6.

## 7. Ferris-Heiden Association

### Deep, rolling and moderately steep, calcareous, clayey soils overlying marl

This association consists of irregular-shaped, rolling and moderately steep soils on side slopes and ridges and in valleys. Deep gullies are in most areas. Decker Lake is in this association. Exclusive of the 1,269 acres of Decker Lake, this association makes up about 3 percent of the county.

Ferris soils occupy rolling and moderately steep side slopes, and Heiden soils are on ridges and in valleys. Minor soils are Houston Black soils on ridges and in valleys and Trinity soils on flood plains.

Ferris soils make up about 47 percent of the association, and Heiden soils, about 24 percent. The remaining 29 percent of the association consists mainly of Houston Black and Trinity soils.

Ferris soils have a surface layer of light olive-gray clay about 36 inches thick. It is mottled with yellow in the lower part. The underlying material is pale-yellow, mottled silty clay.

Heiden soils have a surface layer of dark grayish-brown clay about 16 inches thick. The next layer is mottled, grayish-brown clay.

Both Ferris and Heiden soils are calcareous throughout the profile. Wide and deep cracks form when they are dry. When they are wet, the cracks close and water infiltration is very slow.

This association is mainly used for range. It is too steep and erodible for farming. Use of the soils for tame pasture, however, is increasing.

### Mainly Deep, Nearly Level and Gently Sloping Soils of Terraces and Flood Plains Adjacent to the Colorado River

The soils in this group are used mainly for crops and pasture, and they are well suited to this use. Flooding is a hazard in places. Sand and gravel are mined in many places. Land uses are changing in many areas; farms are being replaced by urban developments.

## 8. Bergstrom-Norwood Association

### Deep, calcareous, loamy soils overlying recent and old alluvium

This association consists of bottom-land and low terrace soils on long, narrow flood plains. It is a smooth, nearly level plain, broken only by a few short escarpments and gently sloping, shallow drainageways. The association includes Town Lake and the Colorado River.

Bergstrom soils are on low terrace benches, and Norwood soils are on bottom lands. The land area of this association makes up about 4 percent of the county.

Bergstrom soils make up about 59 percent of the association, and Norwood soils, about 12 percent. The remaining 29 percent of the association consists of mainly Yahola, Lincoln, and Miller soils, and Riverwash.

Bergstrom soils have a surface layer of dark grayish-brown silt loam about 26 inches thick. The underlying material is reddish-brown silt loam.

Norwood soils have a surface layer of grayish-brown silty clay loam about 18 inches thick. The underlying material is stratified loams and sands.

Most of this association is used for crops and pasture. Some of this association is used for urban development.

## 9. Travis-Chaney Association

### Deep, acid, loamy soils overlying old alluvium

This association consists of smooth, gently sloping and gently rolling soils that occupy high terraces along rivers. These soils formed in alluvium. The Chaney soils are generally less sloping than the Travis soils, and they occupy the ridges and valleys. This association makes up about 3 percent of the county.

Travis soils make up about 28 percent of this association, and Chaney soils, about 14 percent. The remaining 58 percent of the association consists mainly of Dougherty, Altoga, Lewisville, Wilson, Burleson, Houston Black, and Hornsby soils.

Travis soils have a surface layer of brown to light-brown fine sandy loam. The underlying layer is red sandy clay.

Chaney soils have a surface layer of pale-brown to very pale brown fine sandy loam. The next layer is mottled, dark-red clay.

This association is used mainly for pasture or wooded range. Some of the soils are gravelly, and they are stripped to a depth of 8 to 10 feet for this gravel. The main limitation to use of this association for urban development is the corrosion of buried utilities.

## 10. Lewisville-Patrick Association

### Deep and moderately deep, calcareous, clayey soils overlying old gravelly alluvium

This association consists of nearly level to gently sloping soils and gently sloping to rolling soils on terraces along creeks and rivers. The nearly level to gently sloping Lewisville soils occupy ridges, and the gently sloping and rolling Patrick soils are on the slopes. This association makes up about 3 percent of the county.

Lewisville soils make up about 56 percent of the association, and Patrick soils, about 10 percent. The remaining 34 percent of the association consists mainly of Altoga, Houston Black, Trinity, and Frio soils (fig. 6).

Lewisville soils have a surface layer of dark grayish-brown silty clay about 13 inches thick. The next layer, which extends to a depth of about 29 inches, is brown silty clay. The underlying material is very pale brown silt loam to a depth of 72 inches.

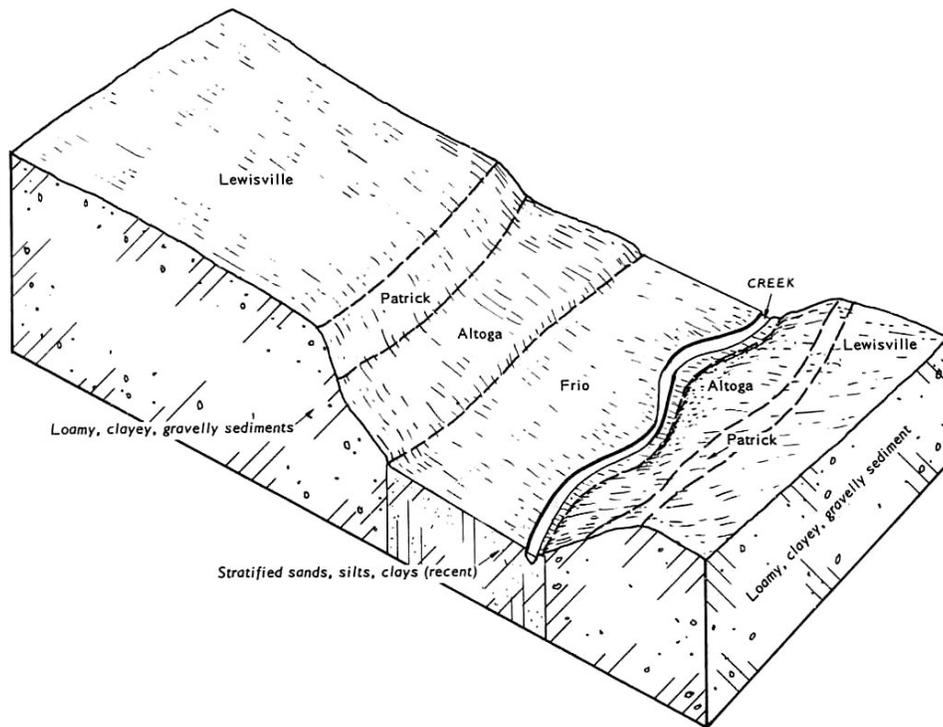


Figure 6.—Representative pattern of soils in association 10.

Patrick soils have a surface layer of dark grayish-brown clay about 10 inches thick. The next layer is brown clay loam that extends to a depth of about 22 inches. The underlying material is very gravelly loamy sand.

Lewisville soils are mainly farmed, and Patrick soils are used for pasture. Patrick soils are also an important source of sand and gravel; gravel pits have been dug in many areas.

Urban development is important in this association. The main limitations to urban expansion are the corrosivity of the soils, the high shrink-swell potential, and the hazard of flooding.

## DESCRIPTIONS OF THE SOILS

In this section the soil series and mapping units represented in Travis County are described. The approximate acreage and proportionate extent of each mapping unit are given in table 1.

The soils of each series are first described as a group. Important features common to all the soils of the series are listed, and the position of the soils on the landscape is given. For each series there is a short narrative description of a representative profile and a much more detailed description of the same profile, from which highly technical interpretations can be made. Following the profile is a brief statement of the range of characteristics of the soils in the series as mapped in this county. Comparisons are made with other soils that are nearby or are generally similar to the soils of the series being described.

Each mapping unit in the series is next described. These are the areas delineated on the map and identified by soil symbols. Generally these descriptions tell how the profile of the soil differs from that described as representative of the series. They also tell about the use and suitability of the soil described and something about management needs. Some of the mapping units also discuss use of the soil for urban construction.

For full information about any one mapping unit, it is necessary to read the description of the soil series as well as the description of the mapping unit. General information about the broad patterns of soils in the county is given in the section "General Soil Map." The color names and color symbols given are for a dry soil, unless otherwise indicated.

### **Altoga Series**

The Altoga series consists of deep, well-drained, silty clay soils. These soils occur high on the landscape, mostly on long narrow side slopes, but also on ridges paralleling the major streams. The slope ranges from about 1.5 to 2.5 percent on ridges and from 3 to 8 percent on side slopes. Altoga soils developed in friable, calcareous alluvium under a cover of mid and tall grasses.

In a representative profile, the surface layer is light brownish-gray silty clay about 5 inches thick. The next layer, which extends to a depth of about 24 inches, is very pale brown silty clay loam. The next lower layer is pale-yellow silty clay loam to a depth of about 60 inches.

Permeability is moderate, and the available water capacity is high.

Representative profile of Altoga silty clay, 3 to 6 percent slopes, eroded, in a pasture 150 feet north of Farm to Market Road 969, from a point 500 feet east of junction with Bluestein Blvd.

A1—0 to 5 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) when moist; moderate, fine, subangular blocky and granular structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

B21—5 to 24 inches, very pale brown (10YR 7/4) silty clay loam, light yellowish brown (10YR 6/4) when moist; weak, fine, granular structure; hard, friable; splotches of light brownish gray and pale yellow; earthworm casts; scattered calcium carbonate concretions make up an estimated 50 percent of content; calcareous; moderately alkaline; clear, smooth boundary.

B22—24 to 60 inches, pale-yellow (2.5Y 7/4) silty clay loam, light yellowish brown (2.5Y 6/4) when moist; weak, fine, granular structure; hard, friable; soft masses of segregated calcium carbonate make up an estimated 70 percent of content; calcareous; moderately alkaline.

The A horizon ranges from 5 to 15 inches in thickness. It is light brownish gray, brown, pale brown, or grayish brown. The texture ranges from silty clay through clay loam.

The B21 horizon ranges from 12 to 30 inches in thickness. It is very pale brown, brown, or yellowish brown. The estimated calcium carbonate content is 50 to 60 percent.

The B22 horizon is pale yellow, light yellowish brown, very pale brown, or pale brown. This horizon has soft masses of calcium carbonate and some hard concretions of calcium carbonate. The estimated carbonate content is 60 to 80 percent.

Altoga silty clay, 1 to 3 Percent slopes (AgB).—This soil mainly occupies long, narrow ridges above other, more sloping units of Altoga silty clay. A few gently sloping areas are on irregular, broad ridges. The slope is dominantly 1.5 to 2.5 percent. Areas range from 20 to 75 acres in size.

The surface layer is brown and about 10 inches thick. The next layer is very pale brown silty clay loam about 24 inches thick. The next layer, extending to a depth of about 60 inches, is pale-yellow silty clay loam.

Runoff is medium, and the erosion hazard is moderate. This soil is easy to work.

Much of this soil is used for crops. All crops commonly grown in the county are grown on this soil. It is well suited to improved pasture, hay, or range. (Capability unit IIIe-7, pasture and hayland group 7C, Rolling Blackland range site)

Altoga silty clay, 3 to 6 percent slopes, eroded (AgC2).—This soil occurs as long, narrow areas paralleling the major streams. It has the profile described as representative of the series. Areas range from 50 to 150 acres in size.

Included in mapping were a few areas of a loamy soil that is similar in color and slope. Also included were areas of Altoga silty clay that have slopes of 8 percent.

This soil is easy to cultivate. Tillage is generally good, but the erosion hazard is moderately severe. Bare surfaces are compacted during hard rain showers. Most areas have gullies several hundred feet apart, and in some cultivated areas rills occur in each plowed furrow. This soil is droughty during the summer months.

This soil is suited to crops, improved pasture, and native grass range. (Capability unit IIIe-2, pasture and hayland group 7D, Rolling Blackland range site)

Altoga soils and Urban land, 2 to 8 percent slopes (AID).—This unit is mainly on single side slopes but is partly on gently sloping ridges. Altoga soils make up about 65 percent of this unit, Urban land, about 30 percent, and other soils, about 5 percent.

In undisturbed areas of Altoga soils the surface layer is brownish-gray silty clay about 6 inches thick. The next layer is very pale brown silty clay loam about 18 inches thick. The underlying material is pale-yellow silty clay loam. A few areas of clay loam were included in mapping.

The more sloping parts of this unit are cut and shaped for building sites and lots. Cuts and fills are mostly in the silty clay, and they range from a few inches to a foot or two, depending on the slope. Although the thickness of the soil horizons varies widely from thickness of horizons described as representative of the series, the basic characteristics remain much the same. A few areas have a thin layer of imported loamy or other materials on the surface.

Works and structures on Urban land are mostly single-unit dwellings and streets, driveways, sidewalks, and patios. This includes a few small shopping centers and service stations with paved parking areas.

The soil characteristics that affect urbanization are mainly shrink-swell potential, corrosivity, percolation rate, and alkalinity.

Information on urban planning for this mapping soil is in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Austin Series**

The Austin series consists of moderately deep, well-drained, silty clay soils underlain by fractured chalk. These soils occur high on the landscape on broad ridges and adjoining side slopes. Most of these soils are gently sloping to gently undulating and gently rolling. The slope ranges from 1 to about 8 percent and is dominantly 2 to 6 percent. The Austin soils developed under a prairie vegetation of mid and tall grasses.

In a representative profile, the surface layer is very dark grayish-brown silty clay about 14 inches thick. The next layer, which extends to a depth of about 34 inches, is brown silty clay. The underlying material is light-brown, weathered chalk and silty clay loam materials, which rest on a bed of soft chalk at a depth of about 48 inches.

Permeability is moderately slow, and the available water capacity is high. Root development is restricted, except in the underlying chalk.

Representative profile of Austin silty clay, 1 to 3 percent slopes, in a cultivated field 1,000 feet north of Parmer Lane from a point 1.3 miles southeast of its intersection with Farm to Market Road 1325.

- Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2 silty clay, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure and fine subangular blocky structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.
- A1—8 to 14 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) when moist; strong, fine, granular structure and fine subangular blocky; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.
- B—14 to 34 inches, brown (7.5YR 5/2) silty clay, dark brown (7.5YR 4/2) when moist; moderate, fine, subangular blocky and granular structure; hard, friable; scattered, soft and hard calcium carbonate concretions and splotches make up an estimated 45 percent of content; calcareous; moderately alkaline; clear, smooth boundary.
- C—34 to 48 inches, light-brown (7.5YR 6/4) weathered chalk and silty clay loam, brown (7.5YR 5/4) when moist; chalk has yellow facings; structureless, but breaks to weak, granular structure; hard, friable; estimated calcium carbonate content 60 percent; calcareous; moderately alkaline; abrupt, wavy boundary.
- R—48 to 52 inches, soft white chalk that has yellow stains on interfaces; becomes harder at increased depth.

Thickness of the solum ranges from 20 to 40 inches. Depth to chalk ranges from 24 to about 54 inches. Chalk is easily spaded in the upper part but is harder with increase in depth.

The A horizon is 8 to 20 inches thick. Colors are dark grayish brown, very dark grayish brown, and dark brown.

The B horizon is 8 to 32 inches thick. Colors are grayish brown, pale brown, brown, light yellowish brown, or light brownish gray. Scattered calcium carbonate concretions occur in most places. The calcium carbonate content is estimated to be 45 to 60 percent.

The C horizon is finely divided, weathered, soft crumbly chalk that has interstices filled with loamy materials. Colors are reddish yellow, very pale brown, light brown, yellow, or light gray. The estimated calcium carbonate content is 60 to 80 percent.

Austin silty clay, 1 to 3 percent slopes (AsB).—This soil occupies high ridges in areas that range from 50 to 100 acres in size. Most areas are broad and irregular, but some are long and narrow. Surfaces are mostly smooth. This soil has the profile described as representative of the series.

Included in mapping were a few areas that have slopes of less than 1 percent and some areas where the surface layer is more than 20 inches thick. Also included were small spots of Stephen soils and narrow areas of Houston Black soils along drainageways.

The hazard of erosion is only moderate. There is a slight hazard of surface crusting and the formation of plowpans.

Most of this soil is used for crops, and it is well suited to the crops commonly grown in the county. It is also well suited to improved pasture, hay, and range. (Capability unit 1Ie-2, pasture and hayland group 7C, Rolling Blackland range site)

Austin silty clay, 3 to 6 percent slopes, eroded (AsC2).—This soil occupies single and complex side slopes mostly below areas of Austin silty clay, 1 to 3 percent slopes. Most areas of this soil are long and narrow, and the slope is dominantly 3 to 4.5 percent. Areas range from 50 to 150 acres in size. Parts of most areas are rifled, and a few are gullied.

The surface layer is very dark grayish-brown silty clay about 10 inches thick. The next layer, to a depth of about 25 inches, is brown silty clay. The underlying material is light-brown weathered chalk.

Small areas of Stephen, Brackett, or Eddy soils were included in mapping. Narrow areas of Houston Black soils were included along some drainageways. In a few areas of this Austin silty clay, slopes are about 3 percent.

Some areas of this soil are used for crops, and others are used for improved pasture or hay. Although the soil is suited to either use, the erosion hazard is moderately severe in plowed areas that are left idle. This soil is also suitable for growing native range grasses. (Capability unit IIIe-2, pasture and hayland group 7D, Rolling Blackland range site).

Austin-Brackett complex, 3 to 5 percent slopes, eroded (AtC2).—The soils of this complex occur on side slopes in areas that range from 20 to about 80 acres in size. The soil pattern is variable. Brackett soils dominate in gullied areas and occupy the crest of the slope in noneroded areas. Individual areas of Austin or Brackett soils are generally smaller than 10 acres and are irregular in shape.

This complex consists of about 47 percent Austin silty clay and 39 percent Brackett clay loam. Eddy and Stephen soils make up the remaining 14 percent. Each delineated area includes both Austin and Brackett soils in varying percentages. The content of Austin silty clay ranges from 25 to 72 percent, and the content of Brackett clay loam ranges from 7 to 75 percent, but is generally 28 to 75 percent. Stephen and Eddy soils do not occur in every delineation, but Stephen soils make up as much as 21 percent of some areas, and Eddy soils make up as much as 9 percent.

In this complex the Austin soil has a surface layer of very dark grayish-brown silty clay about 9 inches thick. The next layer is brown silty clay about 12 inches thick. The Brackett soil has a surface layer of light brownish-gray clay loam about 6 inches thick, and the next lower layer is light yellowish-brown clay loam about 8 inches thick. The underlying material is soft limestone.

Both major soils in this complex are moderately slowly permeable, well drained, and calcareous. Parts of most delineations are eroded and contain rills or shallow and deep gullies. Erosion is a severe problem on unprotected soils.

This complex is suitable for crops. It is also suited to improved pasture, hay, or range. (Capability unit IVe-2, pasture and hayland group 7C, Rolling Blackland range site)

Austin-Brackett complex, 5 to 8 percent slopes, eroded (AtD2).—This complex of soils occupies long, single and complex side slopes. Areas of this soil range in size from 20 to about 70 acres. The soil pattern is variable. The Brackett soils occupy the crest of the slope in most areas. Individual bodies of Austin or Brackett soils are mostly less than 10 acres in size and irregular in shape.

This complex consists of about 55 percent Austin silty clay and about 35 percent Brackett clay loam. Eddy and Stephen soils make up the remaining 10 percent. Each delineated area includes Austin and Brackett soils in varying amounts. The percentage of Austin silty clay ranges from 40 to about 58 percent, and the percentage of Brackett clay loam ranges from 33 to about 40 percent. Stephen soils do not occur in every delineation, but make up as much as 20 percent of some areas. Eddy soils make up as touch as 9 percent of some delineations.

In this complex, the Austin soil has a surface layer of dark-brown silty clay about 9 inches thick. The next layer, to a depth of about 28 inches, is brown silty clay. The underlying material is soft chalk. The Brackett soil has a surface layer of light brownish-gray clay loam about 6 inches thick, over a layer of light yellowish-brown clay loam about 8 inches thick.

Parts of most areas of this complex are eroded and contain rills or shallow gullies. Erosion is severe on unprotected areas.

This soil is not suitable for cultivation. It is suited to improved pasture or hay or range. (Capability unit VIe-1, pasture and hayland group 7D, Rolling Blackland range site)

## **Bergstrom Series**

The Bergstrom series consists of deep, well-drained, nearly level to gently sloping soils. These soils occupy large areas on low terraces above flood plains. The slope ranges from 0.25 to 3.0 percent. These soils developed in calcareous alluvium under a cover of mid and tall grasses.

In a representative profile, the surface layer is dark grayish-brown silt loam about 26 inches thick. The next layer, to a depth of about 60 inches, is reddish-brown silt loam. The underlying material is reddish-yellow calcareous silt loam to a depth of 80 inches.

Permeability is moderate, and the available water capacity is high.

Representative profile of Bergstrom silt loam, 0 to 1 percent slopes, in a cultivated field 500 feet northeast of Farm to Market Road 969 from a point 0.25 mile northwest of Webberville.

- Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard, very friable; calcareous; moderately alkaline; abrupt, smooth boundary.
- A11—6 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard, friable; calcareous; moderately alkaline; gradual, smooth boundary.
- A12—9 to 26 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, subangular blocky and granular structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.
- B—26 to 60 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) when moist; weak, fine, subangular blocky and granular structure; hard, friable; few fine pores; few films and threads of calcium carbonate throughout; few powdery lime masses in lower part; calcareous; moderately alkaline; clear, smooth boundary.
- C—60 to 80 inches, reddish-yellow (5YR 6/6) silt loam, yellowish red (5YR 5/6) when moist; structureless; hard, friable; a few thin strata and lenses that are more clayey and more sandy; a few strongly cemented calcium carbonate concretions; calcareous; moderately alkaline.

The A horizon ranges from 20 to 48 inches in thickness. Colors are dark brown, dark grayish brown or very dark grayish brown. Texture ranges from silt loam to silty clay loam.

The B horizon ranges from 10 to about 40 inches in thickness. Colors are reddish brown, light reddish brown, reddish yellow, brown, light brown, pale brown or brownish yellow.

Thickness of the solum over the C horizon of unaltered alluvial materials ranges from 50 to about 80 inches. The C horizon ranges from clay loam to silt loam in texture. Colors are reddish brown, light reddish brown or reddish yellow. This horizon has calcium carbonate threads and concretions and is weakly stratified.

Bergstrom silt loam, 0 to 1 percent slopes (BeA).—This soil occupies smooth, nearly level benches on flood plains. It occurs in irregularly shaped areas that are 20 to 60 acres or more in size. The slope is dominantly about 0.25 percent. This soil has the profile described as typical for the series.

Included in mapping were areas of a similar soil that has a surface layer less than 20 inches thick. In a few transitional areas, silty clay loams or very fine sandy loams were also included.

Most of this soil is used for crops, improved pasture, or hay. It is also used for native grass range. (Capability unit I-2, pasture and hayland group 2A, Loamy Bottomland range site)

Bergstrom silt loam, 1 to 3 percent slopes (BeB).—This gently sloping soil occupies long, narrow areas around intermittent drainageways and on bench slopes. Areas range in size from about 20 to 40 acres. The slope is dominantly about 2 percent.

This soil has a surface layer of dark grayish-brown silt loam about 23 inches thick. The next layer is reddish-brown silt loam that extends to a depth of about 60 inches.

Included in mapping were soils that have a silty clay loam surface layer.

Most of this soil is used for crops or improved pasture and hay. It is easily worked. The erosion hazard is moderate in cultivated areas. This soil is also used for native grass range. (Capability unit 11e-3, pasture and hayland group 2A, Loamy Bottomland range site)

Bergstrom silty clay loam, 0 to 1 percent slopes (BgA).—This soil occupies broad, smooth, nearly level benches on flood plains. Areas are irregularly shaped and range from about 40 to 250 acres in size. Most areas slope about 0.25 percent.

This soil has a surface layer of dark-brown silty clay loam about 25 inches thick. The next layer is reddish-brown silt loam to a depth of about 60 inches.

Included in mapping were a few areas dissected by drainageways. Also included were areas where the surface layer is less than 20 inches thick.

Most of this soil is used for row crops and improved pasture and hay. It is also used for native grass range. (Capability unit 1-1, pasture and hayland group 2A, Loamy Bottomland range site)

Bergstrom silty clay loam, 1 to 3 percent slopes (BgB).—This gently sloping soil occupies the head and sides of shallow intermittent drainageways. It is also at the foot of low escarpments separating terrace benches, and in long, narrow areas immediately above the river bluffs. Areas range from 20 to 50 acres in size.

This soil has a surface layer of dark-brown silty clay loam about 22 inches thick. The next layer is reddish-brown silt loam to a depth of about 60 inches.

Included in mapping were soils that have a brownish surface layer less than 20 inches thick.

Most of this soil is used for crops. It is easily worked, and the erosion hazard is moderate. This soil is also well suited to improved past hay, or range, (Capability unit 11e-2, pasture hayland group 2A, Loamy Bottomland range site)

Bergstrom soils and Urban land (Bh).—This mapping unit occupies the nonflooding bottom lands a low terraces of the Colorado River. It consists of about 58 percent Bergstrom soils and about 35 percent Urban land. Norwood and Yahola soils make up about 7 percent. The slope ranges from 0 to 2 percent, but it is 0.5 percent or less over about 90 percent of the area.

Bergstrom soils have a surface layer of grayish-brown silty clay loam or silt loam about 20 inches thick. The next layer is reddish-brown silt loam that extends to a depth of about 60 inches.

Works and structures on Urban land are mostly single-unit dwellings and adjacent streets, driveways, and sidewalks. In a few places paved areas, such as parking lots around manufacturing buildings, warehouses, and small shopping centers, make up about 75 percent of the unit.

In some places adjacent to Town Lake, surfaces are covered with several feet of imported rock in preparation for commercial building. In most places, however, the soils are as described in the several series.

The main soil characteristics that affect construction are shrink-swell potential, corrosivity, percolation rate, and alkalinity. Information about this mapping unit needed for use in urban planning can be found in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Brackett Series**

The Brackett series consists of shallow, well-drained soils that developed under a prairie vegetation of mid and tall grasses and some trees. Brackett soils mostly have a gravelly surface layer and are underlain by interbedded limestone and marl (plate 1), but some Brackett soils are underlain by fractured chalk. Because of outcropping of the underlying material, most of these soils are benched. They occupy large areas of gently undulating to steep topography.

In a representative profile, about 75 percent of the surface is covered with coarse fragments of limestone or chalk. The surface layer is light brownish-gray gravelly clay loam about 6 inches thick. The next layer is very pale brown clay loam about 12 inches thick. It contains scattered pieces of soft limestone or chalk. The underlying material is interbedded limestone and marl.

Permeability is moderately slow, and the available water capacity is low.

Representative profile of Brackett gravelly clay loam in an area of Brackett soils rolling, in a pasture 500 feet east of Hudson Bend Road from a point 0.4 mile northeast of the intersection with Ranch Road 620.

- A1—0 to 6 inches, light brownish-gray (10YR 6/2) gravelly clay loam, grayish brown (10YR 5/2) moist; hard, friable; strong, fine, granular structure; 0.5- to 3-inch limestone fragments cover about 75 percent of the surface and make up 15 percent of this horizon; calcareous; moderately alkaline; clear, smooth boundary.
- B—6 to 18 inches, very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) when moist; weak, granular structure; hard, friable; about percent content of limestone fragments up 3 inches in diameter; calcareous; moderately alkaline; clear, smooth boundary.
- C—18 to 48 inches, interbedded soft limestone and marl.

Thickness of the solum ranges from 10 to 20 inches. The surface cover of coarse fragments ranges from a few to 75 percent. The amount of coarse fragments within the solum ranges from a few to less 35 percent and is about 10 to 20 percent in most places. The calcium carbonate equivalent ranges from about 50 to 80 percent in the solum. Clay content ranges from 18 to 35 percent.

The A horizon is light brownish gray, brown, grayish-brown, pale brown, or very pale brown. Texture is clay loam, loam, gravelly clay loam, or gravelly loam.

The B horizon is very pale brown, pale brown, brown, pale yellow, light brownish gray, light yellowish brown, or grayish brown. Texture is clay loam, loam, gravelly clay loam, or gravelly loam.

The C horizon ranges from interbedded weakly cemented limestone and marl to pink silt loam to a strongly weathered white chalk of about silt loam texture.

Brackett clay loam, 2 to 4 percent slopes (BkC).—is soil occupies smooth, irregularly shaped areas high ridges and adjoining side slopes. Individual areas range from 10 to 25 acres in size.

The surface layer is light brownish-gray clay loam about 6 inches thick. The surface is about 35 percent covered with fragments. The next layer, to a depth of about 16 inches, is brown clay loam.

Included in mapping were small areas of a similar soil that is less than 10 inches deep, and other small areas of a soil as much as 24 inches deep over chalk. In a few areas the surface layer is dark grayish brown. These inclusions make up about 25 percent of most areas mapped as this soil.

This soil is used mostly for crops and pasture. It is droughty during the summer months, and the erosion hazard is moderate where slopes are left bare. This soil is only marginally suited to crops; it is better suited to improved pasture or range. (Capability unit IVE-3, pasture and hayland group 13A Adobe range site)

Brackett soils, rolling (BID) .—These soils occupy gently undulating to rolling topography, generally on benches 100 to 500 feet wide that are separated by outcrops of the underlying limestone and marl. Slope is dominantly 5 to 12 percent, but it ranges from 1 to 12 percent. These soils developed over interbedded limestone and marl. Individual areas are more than 1,000 acres in size.

These soils have the profile described as representative of the series. About 20 percent of the mapping unit consists of rock outcrop. Broken limestone fragments cover up to 75 percent of the surface. The texture of the surface layer is gravelly clay loam, gravelly loam, loam, or clay loam.

Included in mapping were soils less than 10 inches thick on the outer edges of the benches and some soils resting directly on indurated limestone. Also included, in narrow valleys, were deeper soils, such as those of the Volente, Altoga, and San Saba series. These included soils make up 10 to 15 percent of the mapping unit.

A large part of the annual rainfall is lost through runoff and seepage from the limestone outcrops. These soils are not suited to crops. They are better suited to range or wildlife habitat. (Capability unit VIIIs-2, Adobe range site, pasture and hayland group not assigned)

Brackett soils and Rock outcrop, steep (BoF).—This mapping unit is on steep breaks along creeks and rivers. Individual areas are long and narrow or irregular in shape and up to 1,000 acres in size. In most areas about 75 percent of the surface is covered by 2- to 4-inch limestone fragments. The slope ranges from 15 to 30 percent.

The composition of this mapping unit is variable, but it consists of about 35 percent Brackett soils, 21 percent Rock outcrop, and 40 percent soils similar to the Brackett soils.

The Brackett soils are on benches 15 to 50 feet wide that are separated by outcrops. The surface layer is light brownish-gray gravelly clay loam or gravelly loam about 4 inches thick. About 60 percent of its surface is covered with coarse fragments. The next layer is pale-brown clay loam that extends to a depth of about 15 inches. The underlying material is interbedded limestone and marl.

The soils similar to the Brackett soils are less than 10 inches deep; they contain more than 35 percent limestone fragments or they rest directly on hard limestone. The percentage of Rock outcrop and very shallow soils increases as the slope increases.

Included in mapping were deeper soils, such as those of the Volente, Lewisville, or Altoga series, in long, narrow valleys. These included soils make up about 4 percent of the acreage.

These soils are not suited to crops. They are better suited to range or wildlife habitat. (Capability unit VIIIs-3, Steep Adobe range site, pasture and hayland group not assigned)

Brackett soils and Urban land, 12 to 30 percent slopes (BrF).—This mapping unit occupies steep breaks. Areas range from long and narrow to irregular in shape. Brackett soils make up about 48 percent, Urban land about 20 percent, and rock outcrop and other soils about 32 percent.

The Brackett soils have a surface layer of light brownish-gray gravelly clay loam or gravelly loam about 4 inches thick. The next layer, about 10 inches thick, is pale-brown clay loam. The underlying layer is interbedded limestone and marl.

In urbanization, soils and landforms are altered to prepare building sites, create trafficways, or create a better environment for growing lawn grasses and for growing landscaping plants. In leveling some areas, cuts as much as 6 or 8 feet deep are made and the removed soil is spread on the slopes. In other places, split-level construction is used to offset the effect of steep slopes on foundations. The larger stones are usually removed and most yards are topdressed with 2 to 4 inches or more of imported loamy or clayey materials. About a fourth of the soils not covered with structures are modified in these ways. Most trafficways are constructed on the contour.

Urban land is occupied mostly by single-unit dwellings and adjacent streets, driveways, sidewalk and patios. A few areas are used for small shopping centers and service stations with paved parking lots. Most structures are on the less sloping narrow ridges.

The main problems in urbanization involve shaping the underlying interbedded limestone and marl for constructing streets or building sites or trenching for utilities. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Burleson Series**

The Burleson series consists of deep, moderately well drained, clay soils. These are nearly level to gently undulating soils on uplands and nearly level and gently sloping soils on stream terraces. These soils developed under a prairie vegetation of mid and tall grasses.

In a representative profile, the surface layer consists of about 42 inches of dark-gray or very dark gray clay. The next layer, which extends to a depth of about 55 inches, is gray clay mottled and splotched with grayish brown. The underlying material, to a depth of 60 inches, is very pale brown, calcareous silty clay that has yellow splotches or mottles.

The available water capacity is high. These soils crack when dry and are very slowly permeable when wet.

Representative profile of Burleson clay, 1 to 2 percent slopes, in a cultivated field, 200 feet south of a county road from a point 2.5 miles southwest of Littig.

- Ap—0 to 6 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; 1/4-inch thick surface crust is gray (10YR 5/1) when dry; moderate, fine, angular blocky and granular structure; extremely hard, very firm; neutral; abrupt, smooth boundary.
- A12—6 to 42 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, medium, angular blocky structure; intersecting slickensides in the lower part; extremely hard, very firm; scattered iron-manganese concretions; neutral; gradual, wavy boundary.
- AC—42 to 55 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; streaks of materials from Ap and A12 horizons in old filled cracks, other streaks and splotches of grayish brown; weak, medium, blocky structure; shiny ped surfaces; intersecting slickensides; extremely hard, very firm; scattered iron manganese concretions; a few strongly indurated calcium carbonate concretions in the lower part; calcareous; mildly alkaline in the lower part; gradual, wavy boundary.
- C—55 to 60 inches, very pale brown (10YR 7/3) silty clay, pale brown (10YR 6/3) when moist; faintly splotched with yellow; massive, breaking to weak, coarse, blocky structure; shiny ped faces and some intersecting slickensides; extremely hard, very firm; scattered calcium carbonate and iron-manganese concretions; calcareous; moderately alkaline.

Thickness of the solum ranges from 36 to 55 inches.

The A horizon is 12 to 50 inches thick. Colors are very dark gray and dark gray. Reaction is slightly acid to neutral. The surface is covered by hard, reddish-brown chert, 1 to 6 inches in diameter, which ranges from a few scattered pebbles to less than 25 percent cover on clay and from 30 to 60 percent cover on gravelly clay.

The AC horizon is 12 to 46 inches thick. Colors range from dark gray through gray. Reaction ranges from neutral to mildly alkaline.

The C horizon is clay or silty clay. Colors are grayish brown, light brownish gray, brown, yellowish brown, very pale brown, olive yellow, or yellow. Marine clays are mottled in shades of olive, yellow, and gray. Reaction ranges from mildly alkaline to moderately alkaline.

The colors in the C horizon are more brown and less gray than is within the defined range for the series, but this does not alter the usefulness and behavior of these soils.

Burleson clay, 0 to 1 percent slopes (BsA).—This soil occupies valleys and smooth, irregularly shaped, broad high ridges. Areas range from 50 to 150 acres in size. The slope is mostly complex on ridges and concave in the valleys, and it is dominantly about 0.5 percent.

This soil has a surface layer of dark-gray clay about 40 inches thick. The next layer, to a depth of about 52 inches, is gray clay. The underlying material is very pale brown silty clay.

Some delineations of this soil contain small depressed areas that range from a quarter acre to about 4 acres in size. Water stands in these shallow depressions for several days to several weeks, depending on the season of the year. Plant growth is generally retarded.

This soil is used mostly for crops and pasture. A few areas are used for range. (Capability unit IIw-2, pasture and hayland group 7A, Grayland range site)

Burleson clay, 1 to 2 percent slopes (BsB).—This soil occupies foot slopes and high, broad, irregularly shaped ridges. On foot slopes, it lies below other, more sloping Burleson soils. Areas range from 20 to 50 acres in size. This soil has the profile described as typical for the series.

Slopes are low and surfaces are smooth, but sheet and rill erosion are hazards in cultivating this soil. The erosion hazard is moderate on bare surfaces.

This soil is used mostly for crops and pasture, but some areas are used for range. It is well suited to improved pasture, hay, or native range grasses. (Capability unit IIe-4, pasture and hayland group 7A, Grayland range site)

Burleson gravelly clay, 1 to 3 percent slopes (BtB).—This soil occupies irregularly shaped areas ranging from 10 to 20 acres in size. It is mostly on ridges or in smooth, broad valleys. Slopes are complex.

The surface layer is dark-gray gravelly clay 34 inches thick. About 40 percent is covered with reddish-brown Chert rocks and gravel. This surface layer contains about 10 percent gravel. The next layer, to a depth of about 50 inches, is gray clay.

A few small areas of Burleson clay were included in mapping.

Most of this soil is used for range. It is well suited to range, and it is suited to improved pasture or hay. (Capability unit IIe-4, pasture and hayland group 7A, Gravelly Loam range site)

Burleson gravelly clay, 3 to 5 percent slopes (BtC).—This soil occupies long and narrow areas below ridges or above valleys of less sloping Burleson gravelly clay. Areas range from 30 to 60 acres in size. Slopes are complex.

About 50 percent of the soil surface is covered with reddish-brown chert rock and gravel. The surface layer, about 40 inches thick, is dark-gray clay that contains about 10 percent gravel. The underlying material, to a depth of 60 inches, is brown silty clay.

Mapped areas of this soil include more than 10 percent of Burleson soils that have less than 25 percent surface gravel. A few small gullied areas are also included.

Most areas are used for range. This soil is well suited to range, and it is suited to improved pasture or hay. (Capability unit IIIe-1, pasture and hayland group 7A, Gravelly Loam range site)

### **Chaney Series**

The Chaney series consists of deep, acid, moderately well drained, gently sloping to gently undulating soils. These soils developed over old alluvium, under a cover of trees and tall grasses. They occupy high terraces.

In a representative profile, the surface layer is about 6 inches of slightly acid, pale-brown to very pale-brown fine sandy loam. The next layer, about 18 inches thick, is dark-red clay that is mottled. The next lower layer, which extends to a depth of about 54 inches, is dark-red sandy clay mottled with strong brown and gray. The underlying material, to a depth of 60 inches, is sandy clay loam mottled with light gray and brown.

Permeability is slow, and the available water capacity is high.

Representative profile of Chaney fine sandy loam, 2 to 5 percent slopes, eroded, in a pasture 500 feet west of Caldwell Lane from a point 0.25 mile east and 0.5 mile north of Garfield.

- A1—0 to 4 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; hard, friable; slightly acid; abrupt, smooth boundary.
- A2—4 to 6 inches, very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) when moist; weak, fine, granular structure; hard, friable; slightly acid; abrupt, smooth boundary.
- B21t—6 to 24 inches, prominently mottled clay, dark-red (2.5YR 3/6), yellowish brown (10YR 5/4), and dark brown (10YR 3/2) when moist; moderate, mediums and coarse, blocky structure; extremely hard, very firm; distinct clay films; strongly acid; gradual, smooth boundary.
- B22t—24 to 54 inches, prominently mottled sandy clay, dark red (2.5YR 3/6), strong brown (7.5YR 4/6), and gray (10YR 6/1) when moist; gray colors increase as depth increases; weak, coarse, blocky structure; extremely hard, very firm; a few clay films; strongly acid; gradual, smooth boundary.
- B3—54 to 60 inches, sandy clay loam; mixed light gray (10YR 7/1) and brown (7.5YR 5/4) when moist; weak, coarse, blocky structure; extremely hard, very firm; patchy coatings and bridgings of clay; a few scattered gypsum crystals; neutral.

The A horizon ranges from 4 to 14 inches in thickness. Color of the A horizon is dark brown, brown, pale brown, very pale brown, grayish brown, or light yellowish brown.

The B21t and B22t horizons are highly mottled, and colors are mixed shades of red, yellow, brown, and gray. Reaction ranges from strongly acid to medium acid in the B21t horizon and from very strongly acid to slightly acid in the B22t horizon. The B3 horizon ranges from mottled light-gray or yellowish-red clay to reddish-yellow sandy clay loam. Reaction ranges from medium acid to moderately alkaline.

The Chaney soils of Travis County are outside the range of the series in that the solum is more than 50 inches thick and the reaction of the B21t and B22t horizons is strongly acid, but this does not alter the usefulness or behavior of the soils.

Chaney fine sand loam, 1 to 2 percent slopes (ChB).—This soil occupies high, broad ridges that said both single and complex slopes. Areas range from 20 to 60 acres in size.

This soil has a surface layer of brown fine sandy loam about 10 inches thick. The next layer, to a depth of about 50 inches, is clay mottled with shades of red, gray, and brown. The underlying material is brown sandy clay loam.

About 10 to 15 percent of each mapped area can be Crockett or Hornsby soils. Also included were a few small areas that slope less than 1 percent.

Most of this soil is used for pasture or range. It is suitable for crops, but the choice of crops is limited. It is better suited to range. (Capability unit IIIe-3, pasture and hayland group 8A, Tight Sandy Loam range site)

Chaney fine sandy loam, 2 to 5 percent slopes, eroded (ChC2).—Most of this soil has slopes of 4 percent and occurs on sides of ridges, but some of it has slopes of about 2 percent and is on eroded ridges. Most areas are long and narrow. They range from 20 to 50 acres in size. This soil has the profile described as representative of the series.

Included in mapping were similar soils that have a sandy clay surface layer and some small areas of Crockett soils. These inclusions make up about 25 percent of the acreage.

The erosion hazard is moderately severe. A few widely spaced gullies are in most areas.

This soil is used mainly for improved pasture or range. It is marginally suitable for crops, and the choice of crops is limited. This soil is better suited to improved pasture, hay, or range than to tilled crops. (Capability unit IVe-4, pasture and hay land group 8A, Tight Sandy Loam range site)

### **Crawford Series**

The Crawford series consists of well-drained, moderately deep, noncalcareous, clay soils that developed over hard limestone. These soils are in valleys and on side slopes and ridges. Uncultivated areas have a weak gilgai microrelief. These soils developed under bunch and short grasses and scattered clumps of trees.

In a representative profile, the surface layer is about 14 inches of dark-brown neutral clay. The next layer, about 12 inches thick, is reddish-brown neutral clay. The next lower layer, which extends to a depth of about 32 inches, is reddish-brown neutral clay. The underlying material is hard limestone.

Crawford soils crack when dry. They are very slowly permeable when wet. The available water capacity is high.

Representative profile of Crawford clay, 1 to 2 percent slopes, in a pasture 100 feet north of McCarty Lane, from a point 0.6 mile east of the intersection with Brodie Lane and 2 miles southwest of the intersection with Texas Highway 71.

A11—0 to 14 inches, dark-brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate, fine and medium, subangular blocky and granular structure; extremely hard, very firm; neutral; clear, smooth boundary.

A12—14 to 26 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist; streaks of materials from A11 horizon in old filled cracks; parallelepiped structure; extremely hard, very firm; shiny ped faces and intersecting slickensides; neutral; clear, smooth boundary.

AC—26 to 32 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, blocky structure; extremely hard, very firm; many, fine, broken fragments of hard limestone; neutral; abrupt, smooth boundary.

R—32 to 34 inches, limestone that has a hardness greater than 3 on Mohs scale.

Thickness of the solum ranges from 24 to 32 inches.

The A11 horizon is 4 to 14 inches thick. Color of the A11 horizon is dark reddish brown, reddish brown, dark brown, dark grayish brown and very dark grayish brown.

The A12 horizon is 7 to 20 inches thick. Colors are dark reddish brown or reddish brown.

The AC horizon is 4 to 30 inches thick. Colors are dark reddish brown and reddish brown.

Crawford clay, 0 to 1 percent slopes (CrA).—This soil occupies valleys and ridges, mostly in association with more sloping Crawford soils. Areas range from 20 to 40 acres in size.

This soil has a surface layer of dark-brown clay about 12 inches thick. The next layer, to a depth of about 32 inches, is reddish-brown clay. The underlying material is hard limestone.

Included in mapping are areas of a similar soil that is only 20 inches deep over limestone.

This soil is used mostly for range. It is also suitable for crops, improved pasture, or hay. (Capability unit IIs-1, pasture and hayland group 7A, Redland range site)

Crawford clay, 1 to 2 percent slopes (CrB).—This soil is irregular in shape, and it ranges from 20 to 30 acres in size. It has the profile described as representative for the series. From a few scattered pebbles to a cover of less than 25 percent of reddish-brown chert gravel is on the surface.

Included in mapping were small spots of a soil similar to Crawford clay that is only 20 inches deep over limestone and that contains up to 15 percent chert gravel. Also included were a few areas of Crawford clay that slope as much as 5 percent.

Slopes are smooth and this soil seldom gullies, but sheet and rill erosion are a limitation to farming. This soil is well suited to range. It is also well suited to crops, improved pasture, or hay. (Capability unit IIe-1, pasture and hayland group 7A, Redland range site)

### **Crockett Series**

The Crockett series consists of deep, noncalcareous, moderately well drained soils that developed over calcareous clays. These soils occupy gently sloping and gently undulating topography. They developed under a cover of tall grasses,

In a representative profile, the surface layer consists of about 4 inches of brown fine sandy loam that is neutral in reaction. This layer rests abruptly on mottled clay that extends to a depth of about 42 inches. The colors are in shades of red, brown, gray, yellow, and olive. The underlying material is a light yellowish-brown clay to a depth of 60 inches.

Permeability is very slow, and the available water capacity is high.

Representative profile of Crockett fine sandy loam in an area of Crockett soils, 1 to 5 percent slopes, eroded, in a pasture 200 feet south of a point on a public road, 0.5 mile east of Littig.

A1—0 to 4 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; hard, friable; neutral; abrupt, wavy boundary.

B21t—4 to 18 inches, mixed and mottled reddish-brown (5YR 4/4) and light brownish-gray (10YR 6/2) clay, when moist includes some dark grayish brown (10YR 4/2); weak, medium, blocky structure; extremely hard, very firm; common clay films; neutral; clear, smooth boundary.

B22t—18 to 42 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; common, fine and medium, olive-yellow and reddish-brown mottles; weak, medium, blocky structure; extremely hard, very firm; common clay films; mildly alkaline; a few hard calcium carbonate concretions in lower part; gradual, smooth boundary.

C—42 to 60 inches, light yellowish-brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) when moist; common olive-yellow mottles; massive breaking to weak, coarse, blocky structure; extremely hard, very firm; common calcium carbonate concretions and some gypsum crystals; calcareous; moderately alkaline.

The thickness of the solum ranges from 40 to 70 inches. The thickness of the A horizon ranges from 4 to 12 inches. The textures are fine sandy loam, clay loam, or sandy clay loam. The colors are light brown, dark brown, brown, light brownish gray, grayish brown, dark grayish brown, yellowish brown or dark yellowish brown. The A horizon ranges from slightly acid to neutral in reaction.

The B22t horizon ranges from neutral to mildly alkaline.

The colors of the C horizon are light gray, light brownish gray, light yellowish brown, brownish yellow, olive yellow, or yellow. Mottles range from medium to coarse. The colors are shades of red, brown, yellow, or gray. Reaction ranges from neutral to moderately alkaline.

Crockett soils, 1 to 5 percent slopes, eroded (CsC2).—These soils occupy ridges and adjoining side slopes. They are gently sloping and gently undulating. Most areas range from 10 to 30 acres in size, and are irregular in shape. The surface layer is fine sandy loam, clay loam, or sandy clay loam. About 48 percent of the acreage has a surface layer that is dominantly clay loam. Included in mapping were small spots of Wilson soils in depressions in valleys and on ridges.

The erosion hazard is moderate to severe. V-shaped gullies, 6 to 8 feet wide, extend into the lower layers in many areas of these soils.

These soils are marginally suited to crops. The soils are suitable for improved pasture, but are better suited to range. (Capability unit IVe-4, pasture and hayland group 7H, Grayland range site)

### **Denton Series**

The Denton series consists of moderately deep, well-drained, calcareous, clayey soils that developed over interbedded limestone and marly clays. These soils occupy ridges and side slopes. They are gently sloping and gently undulating. Denton soils developed under a cover of mid and tall grasses.

In a representative profile, the surface layer is dark grayish-brown, firm but crumbly silty clay about 22 inches thick. The next layer, which extends to a depth of about 32 inches, is brown silty clay. The next lower layer, to a depth of about 38 inches, is also brown silty clay, but it contains a large number of limestone fragments. The underlying material, to a depth of 40 inches, is hard fractured limestone.

The available water capacity is high, and permeability is slow. Surfaces dry quickly.

Representative profile of Denton silty clay, 1 to 3 percent slopes, in a pasture 400 feet south of a ranch road from a point 1 mile northwest of its junction with Nameless Road and 5 miles northwest of junction with Ranch Road 1431.

- A1—0 to 22 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular and subangular blocky structure; shiny pressure faces in the lower part; hard, firm, but crumbly; calcareous; moderately alkaline; clear, smooth boundary.
- B—22 to 32 inches, brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) when moist; moderate, fine and medium, subangular blocky and granular structure; streaks of dark grayish brown in old filled cracks; some shiny pressure faces; hard, friable; a few scattered limestone fragments and calcium carbonate concretions; calcareous, moderately alkaline; clear, smooth boundary.
- C—32 to 38 inches, brown (7.5YR 5/4) silty clay, ark brown (7.5YR 4/4) when moist; massive; about 40 percent of mass is limestone fragments; hard, friable; scattered calcium carbonate concretions; calcareous, moderately alkaline; abrupt boundary.
- R—38 to 40 inches, hard, fractured limestone.

Thickness of the solum over limestone bedrock or interbedded limestone and marl ranges from 24 to 40 inches.

The A horizon ranges from 20 to 30 inches in thickness. Colors are dark brown, very dark brown, dark grayish brown or very dark grayish brown.

The B horizon is brown, yellowish brown or dark yellowish brown.

The C horizon ranges from 6 to 10 inches in thickness and has a content of 15 to 40 percent limestone fragments. Colors are reddish yellow, yellowish red, brown, or light brown.

Denton silty clay, 1 to 3 percent slopes (DeB).—This soil occurs on smooth ridges. Areas are irregular in shape and ordinarily are about 10 to 25 acres in size. This soil has the profile described # representative for the series.

Included in mapping were small areas of Purves silty clay on low knolls. Also included were some areas that have a surface layer as thin as 14 inches and areas that are more than 40 inches deep to limestone rock. A few areas have slopes of less than 1 percent. All inclusions make up about 30 percent of the acreage.

Although the erosion hazard is moderate, this soil is mostly cultivated. It is well suited to crops. This soil is also well suited to native grass range, improved pasture, and hay. (Capability unit IIe-2, pasture and hayland group 7C, Deep Upland range site)

Denton silty clay, 3 to 5 percent slopes (DeC).—This gently sloping, undulating soil occupies side slopes below the less sloping Denton soils on ridges. Areas of this soil are irregular in shape and range from about 20 to 50 acres in size.

This soil has a surface layer of dark grayish-brown silty clay about 20 inches thick. The next layer, to a depth of about 35 inches, is brown silty clay. It is up to 40 percent limestone fragments in the lower part. The underlying material is hard limestone.

Included in mapping were small areas of Purves silty clay, which occur as outcrops on low knolls. Some mapped areas contain a few gullies, and a few others have slopes ranging up to 8 percent. In some areas the surface layer is as thin as 14 inches, and in others the depth to bedrock is more than 40 inches. Included soils are about 40 percent of some mapped areas.

The erosion hazard is moderately severe. This soil is suitable for the commonly grown field crops of the county, but it is better suited to range, improved pasture, or hay. (Capability unit IIIe-2, pasture and hay land group 7C, Deep Upland range site)

### **Dougherty Series**

The Dougherty series consists of nearly level to gently sloping, well-drained, acid, sandy soils that developed in old alluvium. These soils occupy broad ridges. They developed under tall grasses and an open canopy of trees.

In a representative profile, the surface layer is pale-brown loamy sand about 9 inches thick. The next layer is light-brown loamy sand about 15 inches thick. The next layer extends to a depth of 60 inches and consists of slightly acid sandy clay loam that is red in the upper part and light red in the lower part. Most of this soil is used for pasture, but some is used for crops.

Permeability is moderate, and the available water capacity is moderate.

Representative profile of Dougherty loamy sand, 0 to 2 percent slopes, in a pasture 50 feet south of Farm to Market Road 969 from a point 0.25 mile west of Hornsby-Dunlap.

A1—0 to 9 inches, pale-brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) when moist; weak, fine, granular structure; soft, friable; slightly acid; abrupt boundary.

A2—9 to 24 inches, light-brown (7.5YR 6/4) loamy sand, brown (7.5YR 5/4) when moist; weak, fine, granular structure; soft, friable; slightly acid; clear, smooth boundary.

B21t—24 to 46 inches, red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) when moist; weak, fine, subangular blocky structure; slightly hard, friable; patchy clay films coated and bridged on peds; slightly acid; clear, smooth boundary.

B22t—46 to 60 inches, light-red (2.5YR 6/6) sandy clay loam, red (2.5YR 5/6) when moist; weak, fine, subangular blocky structure; hard, friable; patchy clay films and sand grains bridged and coated with clay; slightly acid.

The A horizon ranges from loamy fine sand to fine sand and is 20 to 34 inches thick. The color is pale brown, light brown, light brownish gray, grayish brown, or yellowish brown.

The color of the B horizon is red, light reddish brown, reddish brown, reddish yellow, yellowish red, or light red.

Dougherty loamy sand, 0 to 2 percent slopes (DoA).—This soil is on broad ridges that are irregular in shape and range from 50 to 500 acres in size. Slopes are long and smooth, and they are dissected by shallow drainageways. This soil has the profile described as representative of the series.

Included in mapping were spots of a soil that has a fine sand surface layer that is more than 40 inches thick. In depressed areas included soils have lower layers mottled with red, gray, and brownish yellow. Included soils make up about 30 to 40 percent of the acreage.

This soil is used mainly for improved pasture, but a few small areas are used for crops. It is better suited to pasture, hay, or range than to crops. (Capability unit Ills-3, pasture and hayland group 9A, Sandy range site)

Dougherty soils and Urban land, 0 to 2 percent slopes (DuA).—This mapping unit occupies river terraces and urban built-up areas. The topography is smooth. Dougherty soils make up about 52 percent of the acreage; urban land, about 25 percent; and other soils, about 23 percent.

Dougherty soils have a surface layer of pale brown fine sand or loamy fine sand about 25 inches thick. Red sandy clay loam is below the surface layer.

The Urban land is used for foundations for single unit dwellings and supporting streets, sidewalks, and driveways. Construction also includes churches, an auction barn, and schools with their large paved or graveled parking areas.

Except for a few trees, little of the natural flora exists on this mapping unit.

Information on use of this mapping unit in urban planning can be found in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Eddy Series**

The Eddy series consists of shallow to very shallow, well-drained, gravelly loams that developed over chalk. From 20 to 50 percent of most areas is covered by broken chalk fragments. These are the highest soils on the landscape in which they occur.

Mostly, they occupy convex ridges and adjoining side slopes in a nearly level to gently undulating landscape. They also occur as outcrops in areas of deeper soils. They developed under a cover of mid and tall grasses and a scattering of trees.

The surface layer consists of about 4 inches of grayish-brown gravelly loam that has about a 25 percent cover of broken chalk fragments. The next layer is a mixture of grayish-brown gravelly loam and broken chalk fragments. It extends to a depth of about 14 inches. The underlying material is weakly cemented, white, broken, platy chalk rock.

These soils are poorly suited to farming. Many chalk fragments are brought to the surface by plowing. Because of the shallow depth to limestone, the available water capacity is low. Permeability is moderately slow.

Representative profile of Eddy gravelly loam, 3 to 6 percent slopes, in a pasture 200 feet south of Howard Lane from a point 1 mile northwest of its junction with Interstate Highway 35.

- A1—0 to 4 inches, grayish-brown (10YR 5/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; strong, fine, granular structure; slightly hard, friable; 1- to 2-inch platy, broken chalk fragments cover about 25 percent of the surface and make up about 5 percent of the soil material; calcareous; moderately alkaline; clear, smooth boundary.
- C—4 to 14 inches, grayish-brown (10YR 5/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; about 75 percent, by volume, is partly weathered, broken chalk fragments; calcareous; moderately alkaline; clear, wavy boundary.

R—14 to 20 inches, weakly cemented, white, broken, platy chalk that has cleavage faces of yellow and pale brown; strongly cemented in the lower part.

Thickness of the soil over soft chalk ranges from 6 to 15 inches. Texture is gravelly loam or gravelly clay loam. Color is light brownish gray, grayish brown, dark grayish brown, pale brown, brown, or dark brown.

The C horizon is about 35 to 80 percent, by volume, broken, platy, 1- to 2-inch chalk fragments, and the amount increases as depth increases. The chalky R horizon becomes harder as depth increases.

Eddy gravelly loam, 0 to 3 percent slopes (EdB).—This soil occupies narrow convex ridges high on the landscape. Areas of this soil range from 15 to 30 acres in size.

These soils have a surface layer of grayish-brown gravelly loam about 6 inches thick. It contains about 25 percent chalk fragments. The next layer is grayish-brown gravelly loam that extends to a depth of about 15 inches. The underlying material is weakly cemented chalk.

Included in mapping were small areas of Stephen and Brackett soils. All inclusions are less than 15 percent of any mapped area.

In addition to the hazards discussed under the series, there is a slight to moderate erosion hazard. The use of this soil for crops is limited to broadcast or drilled crops. It is better suited to range, and it can be used for improved pasture. Its use for hay is marginal. (Capability unit IVs-1, pasture and hayland group 14A, Chalky Ridge range site)

Eddy gravelly loam, 3 to 6 percent slopes (EdC).—This soil has the profile described as typical for the series. Areas range from 10 to 50 acres in size.

Small areas of Stephen or Brackett soils were included in mapping. A few included soils have gray surface colors. A few eroded spots, where the chalk is at the surface, were also included.

The hazard of erosion is severe. This soil is not suited to crops. It is better suited to range, but it can be used for improved pasture. It is not suited to hay. (Capability unit VIe-2, pasture and hayland group 14A, Chalky Ridge range site)

Eddy soils and Urban land, 0 to 6 percent slopes (EuC).—This mapping unit occupies urban built-up areas and convex ridges and side slopes. It is on broad ridges where its slopes are dominantly 0.5 to 2.5 percent and on sides of ridges where its slopes are dominantly 3 to 6 percent. Eddy soils make up about 55 percent of the acreage, Urban land, about 35 percent, and other soils, about 10 percent.

Eddy soils have a surface layer that is about 3 inches of grayish-brown gravelly loam or gravelly clay loam. This layer is about 30 percent gravel. The next layer, to a depth of about 14 inches, is grayish-brown gravelly loam that is about 70 percent chalk fragments. The underlying material is weakly cemented chalk.

Cut and fill operations are limited by the usual good stand of trees. Some steeper areas have been leveled to a depth of 2 feet, but the trees have been carefully preserved by building retaining walls. The underlying chalk is easily ripped up for foundations and roadways, or easily trenched for utilities.

Urban land is occupied mostly by single-unit dwellings, streets, driveways, sidewalks, and patios. In places are multiple-unit dwellings, shopping centers, service stations, schools, and churches and their paved parking lots.

Information on use of this mapping unit in urban planning is given in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Ferris Series**

The Ferris series consists of deep, clay soils that developed in calcareous marls. These soils have complex slopes of 8 to 20 percent. Most areas contain many deep gullies. These soils formed under a cover of tall grasses.

In a representative profile the surface layer is light olive-gray clay about 6 inches thick. The next layer, to a depth of about 36 inches, is also light olive-gray clay mottled with yellow. The underlying material, to a depth of 50 inches, is mottled, pale-yellow silty clay. The soil is calcareous and moderately alkaline.

These soils shrink when dry. The cracks that form are 2 to 4 inches wide and extend into the underlying material. When the cracks are closed, the soils are very slowly permeable. These soils are somewhat excessively drained, and their available water capacity is high.

Representative profile of Ferris clay in an area of Ferris-Heiden complex, 8 to 20 percent slopes, severely eroded, in a pasture 200 feet east of a public graveled road from a point 0.75 mile northwest of its junction with U.S. Highway 290 and 0.5 mile west of Manor.

- A1—0 to 6 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) when moist; moderate, fine and medium, angular blocky structure; extremely hard, very firm; calcareous; moderately alkaline; clear, wavy boundary.
- AC—6 to 36 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) when moist; streaks of slightly darker materials in old filled cracks; common, fine and medium, yellow mottles; moderate, medium, angular blocky structure; shiny ped faces and intersecting slickensides; extremely hard, very firm; scattered concretions of calcium carbonate and iron-manganese; calcareous; moderately alkaline; gradual, wavy boundary.
- C—36 to 50 inches, pale-yellow (2.5Y 7/4) silty clay, light yellowish brown (2.5Y 6/4) when moist; common, fine and medium, yellow and light brownish-gray mottles; massive, breaking to weak, coarse, blocky structure; shiny ped faces and slickensides; extremely hard, very firm; scattered concretions of calcium carbonate and iron-manganese; calcareous; moderately alkaline.

Thickness of the solum ranges from 30 to about 50 inches.

The A horizon is 2 to 16 inches thick. Color is light brownish gray, grayish brown, light yellowish brown, light olive brown, light olive gray, olive gray, pale olive, or olive.

The AC horizon is 18 to 33 inches thick. Color is light brownish gray, grayish brown, light yellowish brown, light olive brown, olive gray, pale yellow, pale olive, olive, light olive gray, or yellowish brown.

The C horizon is light yellowish brown, light olive brown, yellow, olive yellow, pale olive, or pale yellow. This horizon usually has common, fine and medium mottles in shades of yellow, olive, or gray, or it is a mixture of gray, yellow, and olive clays, silty clays, or shaly clays. Scattered to many concretions of calcium carbonate and iron-manganese are in this horizon.

Ferris-Heiden complex, 8 to 20 percent slopes, severely eroded (FhF3).—This complex occupies rolling to hilly topography and has slopes dominantly in the range of 10 to 15 percent. Areas are long and narrow and about 20 to 200 acres in size. Ferris soil makes up about 60 percent of this unit, and Heiden soil, about 40 percent. The Heiden soils are in smoother areas between gullies and on foot slopes. A few areas have scattered, brownish colored, calcareous sandstone on the surface.

The Heiden soils have a surface layer of dark grayish-brown clay about 15 inches thick. The next layer, which extends to a depth of about 50 inches, is grayish-brown clay mottled with olive yellow. The underlying material is yellow silty clay. Areas are severely eroded. Gullies and rills are about 200 feet apart, 3 to 8 feet deep, and 10 to 20 feet wide.

Because of a severe erosion hazard, these soils are not suitable for cultivation. They are, however, suitable for improved pasture, hay, or range. (Capability unit Vle-1, pasture and hayland group 7B, Gullied Blackland range site)

### **Frio Series**

The Frio series consists of deep, friable, nearly level soils on bottom lands along the major streams. These soils are smooth and well drained. They developed in alluvium under tall grasses and a scattering of trees.

In a representative profile, the surface layer is dark grayish-brown silty clay loam about 50 inches thick. It overlies pale-brown clay loam. The soil is calcareous and moderately alkaline throughout.

These soils are moderately slowly permeable, and the available water capacity is high.

Representative profile of Frio silty clay loam, in a pasture 100 feet south of a private farm road from a point 0.5 mile east of its junction with Bluestein Boulevard and 2 miles southeast of U.S. Highway 290.

A11—0 to 30 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; thin, weak surface crust of grayish brown (10YR 5/2); moderate, fine and medium, subangular blocky and granular structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

A12—30 to 50 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular and subangular blocky structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

C—50 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; structureless breaking to weak granular structure; hard, friable; calcareous, moderately alkaline.

Colors of the A horizon are dark grayish brown, dark brown, or very dark grayish brown.

Some areas have a B horizon. The B horizon is light brownish gray, grayish brown, pale brown, brown, or yellowish brown and it is 18 to 28 inches thick.

The C horizon ranges from silty clay loam to clay loam. Colors are light brownish gray, very pale brown, pale brown, or light yellowish brown.

**Frio silty clay loam (Fo)**.—This soil occupies long and narrow areas on a smooth, nearly level landscape. It is subject to flooding. It is inundated about once in a 4- to 10-year period. Most areas range from 50 to 200 acres in size. This soil has the profile described as typical of the series.

Included in mapping were a few soils in narrow drainageways that carry floodwaters when the main stream overflows its banks. These 30- to 50-foot wide sloughs are more clayey than the rest of this soil and stay wet for as much as a week longer. Side slopes on some sloughs are as much as 2 percent. Also included, near the stream, were small areas of Trinity soils and small spots of sand or gravel bars or mixtures of chalk fragments and clayey materials.

This soil is mostly cultivated. It is also used for pasture, or for a combination of pasture and pecan orchards (plate I). It is well suited to these uses, and to native grass range. (Capability unit I-1, pasture and hayland group 1C, Loamy Bottomland range site)

**Frio silty clay loam, frequently flooded (Fr)**.—This soil occupies long, narrow areas along the stream channels. In most years it is flooded several times. Slopes are mostly concave and have gradients of 0.25 or less across the flood plains. Mapped areas are several hundred acres in size.

This soil has a surface layer of dark grayish-brown silty clay loam about 50 inches thick. The underlying material is pale-brown clay loam.

A few areas of Frio soils that have 2 percent slopes were included in mapping. This soil is not suited to crops. Most of it is forested with trees that are common in the county. Cleared areas are used for improved pasture or hay, to which this soil is well suited. This soil is also well suited to range. (Capability unit Vw-1, pasture and hayland group 1C, Loamy Bottomland range site)

Frio soils, channeled (Fs).—These soils are frequently flooded. They occupy long and narrow areas along the major streams that drain soils developed over chalk. Slopes are concave and have a gradient of about 0.5 percent. Areas range from 25 to 100 acres in size.

This soil has a surface layer of dark grayish-brown silty clay loam about 45 inches thick. The underlying material is pale-brown clay loam. A few small broken bits of chalk are in both layers.

About 35 percent of the acreage is exposed chalk beds or chalk beds partly covered with patches of brownish sandy clay loam 2 to 4 inches thick. This also includes pockets of soil up to 2 feet thick along the streambanks and between the channels. Some small areas are grayish colored clays. Most of these soils terminate downstream adjoining areas of Frio silty clay loam, frequently flooded.

These soils are suitable only for grasses. Little vegetation grows in the stream channels, but improved pasture or native range grasses grow well over the rest of these soils. (Capability unit Vw-1, pasture and hayland group 1C, Loamy Bottomland

### **Hardeman Series**

This series consists of deep, well-drained is that developed over old alluvium. These soils occupy long and narrow benches above the flood wins. Slopes are mostly single, and they range about 2 percent on top of the benches or on slopes to 12 percent on the sides of ridges.

In a representative profile, the surface layer is about 16 inches of brown fine sandy loam. The next layer is light-brown fine sandy loam about 22 inches thick. It is underlain to a depth of 60 inches by reddish-yellow silt loam. The soil is calcareous and friable throughout.

Permeability is moderately rapid, and the available water capacity is high.

Representative profile of Hardeman fine sandy loam, 2 to 5 percent slopes, in the Quinlan County Park, 6 miles southwest of Mansfield Dam on a paved ranch road.

- A1—0 to 16 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; hard, friable; few pebbles; calcareous; mildly alkaline; clear, smooth boundary.
- B—16 to 38 inches, light-brown (7.5YR 6/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; weak, fine, granular structure; few fine pebbles and a few lime threads; hard, friable; calcareous; mildly alkaline; clear, smooth boundary.
- C—38 to 60 inches, reddish-yellow (5YR 7/6) silt loam, reddish yellow (5YR 6/6) when moist; massive, breaking to weak, fine, granular structure; few lime threads; scattered soft calcium carbonate lumps; few fine pebbles; hard, friable; calcareous; mildly alkaline.

Thickness of the solum ranges from 30 to about 50 inches. Reaction is mildly alkaline to moderately alkaline throughout the solum and underlying material.

The A horizon ranges from 8 to 33 inches in thickness. Colors are grayish brown, dark grayish brown, pale brown, brown, light yellowish brown, yellowish brown, dark yellowish brown, or dark brown.

The B horizon ranges from 12 to 34 inches in thickness. Colors are brown, pale brown, light yellowish brown, yellowish brown, light brown, or grayish brown.

The C horizon colors are light reddish brown, reddish yellow, brown, pink, pale brown or light brown.

Hardeman fine sandy loam, 2 to 5 percent slopes (HaC).—This soil is in long and narrow areas on benches and side slopes. These areas are 10 to 30 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were soils that have slopes of less than 1 percent. Some areas adjacent to flood plains have a lower layer of silty clay loam that has weak stratification of silts and fine sands. A few small areas of Altoga silty clay were also included. These inclusions make up less than 10 percent of the acreage.

This soil is mainly used for pasture or range. Some areas are used for urban development. This soil is well suited to improved pasture, hay, or native grass range. It is easily tilled. (Capability unit IIIe-4, pasture and hayland group 8C, Sandy Loam range site)

Hardeman fine sandy loam, 5 to 12 percent slopes (HaE).—This soil occupies single slopes in long and narrow areas. These areas are mostly 20 to 40 acres in size.

This soil has a surface layer of brown fine sandy loam about 10 inches thick. The next layer, to a depth of about 36 inches, is light-brown fine sandy loam. The underlying material is reddish-yellow silt loam to a depth of about 60 inches.

A few eroding drainageways dissect some areas of this soil. Included in mapping these areas were soils that have a layer of sandy loam to silty clay loam at a depth of less than 20 inches. A few small areas of Altoga soils were included. All inclusions make up less than 10 percent of the acreage of this soil.

This soil is used mostly for improved pasture or range. Some areas are used for urban development. The less sloping areas are suitable for the commonly grown field crops. This soil is better suited to pasture, hay, or range than to tilled crops. (Capability unit IVe-5, pasture and hayland group 8C, Sandy Loam range site)

Hardeman soils and Urban land, 3 to 12 percent slopes (HdE).—This mapping unit occupies terraces on flood plains and urban built-up areas. It consists of about 72 percent Hardeman soils, about 20 percent Urban land, and about 8 percent other soils.

Undisturbed areas of Hardeman soils have a surface layer of brown fine sandy loam about 36 inches thick. This layer overlies reddish-yellow silt loam.

Most cuts and fills are made in and with the fine sandy loam materials; the essential physical properties of the soil remain the same.

Urban land is mainly occupied by a few large buildings and paved parking areas. Single-unit dwellings and the adjacent streets, sidewalks, and driveways are in places.

This is one of the most desirable units for urbanization. In places, this unit extends to the water's edge of Lake Austin and Town Lake.

Information on use of soils in urban planning is given in sections on engineering, community development, and recreation facilities. (Not placed in a Capability unit, pasture and hayland group, or range site)

## **Heiden Series**

The Heiden series consists of well-drained, deep, clay soils that developed in calcareous marl. In most places the topography is gently undulating and is characterized by gently sloping ridges and hilly side slopes. The slope ranges from 1 to 20 percent.

These soils developed under a cover of tall grasses.

In a representative profile, the surface layer is dark grayish-brown clay about 16 inches thick. The next layer extends to a depth of 50 inches; it is mottled grayish-brown clay. Below this, to a depth 60 inches, is mottled yellow silty clay.

The available water capacity is high. These boils crack when dry. When they are wet, the cracks close and permeability is very slow.

Representative profile of Heiden clay, 3 to 5 percent slopes, eroded, in a cultivated field 500 met east of a point on the Gregg Manor Road. From this point, it is 0.25 mile southeast on the Gregg Manor Road to Manor.

- Ap—0 to 6 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; strong, fine, subangular blocky and granular structure; very hard, very firm; calcareous; moderately alkaline; abrupt, smooth boundary.
- A12—6 to 16 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine and medium, subangular blocky structure; extremely hard, very firm; calcareous; moderately alkaline; gradual, wavy boundary.
- AC1—16 to 50 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; common, fine and medium, yellow (2.5Y 7/6) mottles olive yellow (2.5Y 6/6) moist; moderate, medium, angular blocky (parallelepiped) structure; shiny ped surfaces and intersecting slickensides; darker streaks in filled cracks; extremely hard, very firm; scattered calcium carbonate and iron-manganese concretions; calcareous, moderately alkaline; gradual, wavy boundary.
- AC2—50 to 60 inches, yellow (5Y 7/8) silty clay, olive yellow (5Y 6/8) when moist; massive, breaking to weak, coarse, blocky structure; shiny ped surfaces and slickensides; extremely hard, very firm; scattered calcium carbonate and iron-manganese concretions; calcareous, moderately alkaline.

The A horizon is 12 to 30 inches thick. The colors are very dark grayish brown or dark grayish brown.

The upper part of the AC horizon is light brownish gray, grayish brown, dark grayish brown, light yellowish brown, light olive brown, olive yellow, light olive gray, olive gray, pale olive, olive, or olive yellow. Mottling in shades of yellow and w olive is common. The lower part of the horizon is generally more yellowish or olive colored, and some colors are so highly mixed and mottled that no one 1 color is dominant.

Heiden clay, 1 to 3 percent slopes (HeB).—This soil occupies narrow ridges or foot slopes. Most areas are long and narrow, but some areas are broad and irregular in shape. The slope is dominantly 2 percent. The areas range from 30 to 100 acres in size.

The surface layer is dark grayish-brown clay about 18 inches thick. The next layer, to a depth of about 48 inches, is grayish-brown clay mottled with olive yellow.

Included in mapping were some areas of Wilson soils.

This soil is used mostly for crops and pasture.

The erosion hazard is moderate. This soil is well suited to crops, or to improved pasture or hay- M land. It is also suitable for native grasses in rangeland. (Capability unit Ile-1, pasture and hayland group 7A, Rolling Blackland range site)

Heiden clay, 3 to 5 percent slopes, eroded (HeC2).—This soil has the profile described as representative for the series. It occupies complex a side slopes on a gently undulating topography. Most areas range from 20 to 50 acres in size.

Included in mapping were several areas of Wilson soils. In gullied areas the surface layer is less than 12 inches thick in places. In noneroded areas the surface layer is gray and slightly thicker than 12 inches in places.

The erosion hazard is severe. There are deep and shallow gullies and rills in most places. This soil is used mostly for crops and improved pasture. It is well suited to improved pasture, hay, or range. (Capability unit IIIe-1, pasture and hayland group 7A, Rolling Blackland range site)

Heiden clay, 5 to 8 percent slopes, eroded (HeD2).—This soil is gently rolling and has complex slopes with a dominant gradient of 6 percent. The areas are long and narrow, and they range mostly from 20 to 40 acres in size.

The surface layer is dark grayish-brown clay about 14 inches thick. The next layer, to a depth of about 48 inches, is grayish-brown clay. The underlying material, to a depth of 60 inches, is yellow silty clay.

Most areas are rilled, and there are shallow to deep gullies 300 to 500 feet apart. These gullies stabilize into parabolic shapes in grassland.

This soil is only marginally suitable for crops because of the erosion hazard. Most areas are used for improved pasture or hay, to which they are suited. The soil is also well suited to native grass range. (Capability unit IVe-1, pasture and hayland group 7B, Rolling Blackland range site)

Heiden gravelly clay, 8 to 20 percent slopes, eroded (HgF2).—This soil occupies rolling to hilly topography. Gullies dissect the landscape. The areas are irregular in shape, and they range from 50 to 150 acres in size.

The surface layer is dark grayish-brown gravelly clay about 12 inches thick. About 60 percent of the surface layer is covered with chert gravel. The next layer is grayish-brown clay to a depth of about 48 inches. This layer contains pockets of chert gravel.

Included in mapping were areas where chert gravel covers less than 25 percent of the surface. Also included were small areas of Houston Black gravelly clay on foot slopes. In some places igneous stones, 2 to 6 inches in diameter, occur throughout the profile.

This soil is not suitable for crops. It can be used for improved pasture, but it is better suited to range. Its suitability for hayland is marginal. Capability unit VIe-1, pasture and hayland group 7B, Rolling Blackland range site)

### **Heiden Series, Neutral Subsoil Variant**

Heiden clay, neutral subsoil variant, is a deep and well-drained soil that developed in material weathered from marl. It is gently undulating. The areas are irregular in shape and range from about 15 to 130 acres in size. This soil developed under a cover of tall grasses.

In a representative profile, the surface layer is dark grayish-brown, noncalcareous clay about 18 inches thick. The next layer, about 24 inches thick, is dark grayish-brown, mottled clay. Below this, to a depth of 60 inches, is yellow, mottled, noncalcareous clay.

Most of this soil is used for crops. Cultivation is difficult. When wet, the soil is sticky and plastic, and when it is dry, large cracks extend deep into the lower layers. If plowed when dry, the soil breaks out in large, hard clods that are slow to pulverize. The available water capacity is high, but permeability is very slow when the soil is wet.

Representative profile of Heiden clay, neutral subsoil variant, 3 to 5 percent slopes, in a cultivated field, 100 feet east of County Line Road. From this point it is 800 feet northeast on County Line Road to its junction with Lund Road.

Ap—0 to 6 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when a-moist; compound, moderate, fine, granular and e angular blocky structure; extremely hard, very firm; scattered calcium carbonate concretions on the surface, but matrix is noncalcareous; mildly alkaline; abrupt, smooth boundary.

A1—6 to 18 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, angular blocky structure; shiny ped faces; extremely hard, very firm; scattered iron-manganese concretions in the lower part; noncalcareous; mildly alkaline; gradual, wavy boundary.

AC1—18 to 42 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; common, fine and medium, olive-yellow (2.5Y 6/6) mottles; moderate, medium and coarse, blocky structure; shiny ped faces and intersecting slickensides; extremely hard, very firm; scattered iron-manganese concretions; noncalcareous; mildly alkaline; gradual, wavy boundary.

AC2—42 to 60 inches, yellow (2.5Y 7/6) clay, olive yellow (2.5Y 6/6) when moist; coarsely splotched with light olive gray (5Y 6/2, dry), and commonly mottled with medium, faint, yellow (2.5Y 7/8) streaks of material from the AC1 horizon in old filled cracks; weak, blocky structure; shiny ped faces and intersecting slickensides; extremely hard, very firm; scattered iron-manganese concretions; noncalcareous; mildly alkaline.

The A horizon ranges from 12 to 36 inches in thickness. The colors are very dark grayish brown or dark grayish brown. Scattered calcium carbonate concretions are on the surface in many places, and some profiles have calcium carbonate concretions within the soil, but the matrix is noncalcareous.

The upper part of the AC horizon is dark grayish brown, brown, brownish yellow, olive yellow or light olive brown. The lower part is light yellowish brown, light olive brown, olive yellow, or yellow. Iron-manganese concretions are common, and gypsum crystals occur in some profiles.

Heiden clay, neutral subsoil variant, 1 to 3 percent slopes (HfB).—This soil is gently undulating. The slopes are complex, and the dominant gradient is 1 to 2.5 percent. Areas of this soil are irregular in shape, and they range from 20 to 130 acres in size.

The surface layer is dark grayish-brown, noncalcareous clay about 20 inches thick. The next layer, which extends to a depth of 45 inches, is dark grayish-brown, mottled, noncalcareous clay. Below this, to a depth of 65 inches, is mottled yellow clay.

Included in mapping were a few small areas where the surface layer is calcareous. Also included on lower slopes and along drainageways were noncalcareous soils where the surface layer is gray. These inclusions make up less than 15 percent of the acreage. A few igneous stones are on the surface in some places.

The erosion hazard is moderate. This soil is used mostly for crops, to which it is well suited. It is also well suited to improved pasture, hay, or range. (Capability unit IIe-1, pasture and hayland group 7A, Rolling Blackland range site)

Heiden clay, neutral subsoil variant, 3 to 5 percent slopes (HfC).—This soil has the profile described as typical for the series. Most areas are long and narrow, and they range from 15 to 50 acres in size.

Included in mapping were a few small areas where the surface layer is calcareous, and other areas where the surface layer is gray and noncalcareous. These inclusions make up less than 15 percent of the acreage. In some places a few igneous stones are on the surface.

The erosion hazard is moderately severe. This soil is well suited to crops. It is also well suited to pasture, hay, or range. (Capability unit IIIe-1, pasture and hayland group 7A, Rolling Blackland range site).

### **Hornsby Series**

The Hornsby series consists of deep, moderately well drained, gravelly soils that developed in old alluvium on high terraces. This series occupies the tops and sides of small, elongated knolls, and also broader, irregularly shaped ridges. Slopes are mostly complex. These soils developed under mid and tall grasses and a cover of trees of varying density.

In a representative profile, the surface layer is gravelly loamy sand about 18 inches thick. It is grayish brown in the upper part and very pale brown in the lower part. The next layer is gravelly sandy clay loam to a depth of about 70 inches. It is mottled red, grayish brown, and gray in the upper part and reddish yellow, yellowish red and medium gray in the lower part. The underlying material, to a depth of 82 inches, is light-gray gravelly clay.

Permeability is moderately slow, and the available water capacity is high.

Representative profile of Hornsby gravelly loamy sand, 1 to 5 percent slopes, in a pasture 200 feet east of Blake-Manor Road from a point 2.5 miles north of intersection with Farm to Market Road 969.

- A1—0 to 8 inches, grayish-brown (10YR 5/2) gravelly loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard, very friable; about 30 percent, by volume, quartz and chert pebbles 0.1 to 1 inch in diameter; slightly acid; clear, smooth boundary.
- A2—8 to 18 inches, very pale brown (10YR 7/3) gravelly loamy sand, brown (10YR 5/3) when moist; single grain; hard, very friable; about 60 percent quartz and chert pebbles 0.1 to 1 inch in diameter; slightly acid; abrupt, wavy boundary.
- B21t—18 to 37 inches, gravelly sandy clay loam, mottled red (2.5YR 4/6), grayish brown, (10YR 5/2) and gray (10YR 6/1) when moist; moderate, medium and coarse, blocky structure; very hard, very firm; few clay films on ped surfaces; few cracks, few pores; about 45 percent, by volume, quartz, chert, and partly weathered feldspar pebbles 0.1 to 0.5 inch in diameter; strongly acid; clear, wavy boundary.
- B22t—37 to 70 inches, reddish-yellow (5YR 6/6) gravelly sandy clay loam, yellowish red (5YR 5/6) when moist; few, distinct mottles of medium gray (10YR 6/1) when moist; weak, coarse, blocky structure; very hard, very firm; few clay films on ped surfaces; about 50 percent, by volume, fine quartz and feldspar pebbles; medium acid; gradual, wavy boundary.
- IIC—70 to 82 inches, light-gray gravelly clay (2.5Y 7/2), light brownish gray (2.5Y 6/2) when moist; a few olive-yellow mottles; massive; very hard, very firm; about 15 percent, by volume, fine quartz and feldspar pebbles; a few iron-manganese concretions; slightly acid.

Thickness of the solum ranges from about 60 to 80 inches.

The A horizon ranges in thickness from 15 to 20 inches. Colors of the A1 horizon are brown, light brownish gray, grayish brown, pale brown, light yellowish brown, or yellowish brown. The A2 horizon is slightly lighter in color. Gravel content ranges from 20 to 60 percent. Reaction ranges from medium to slightly acid.

The B horizon ranges from clay loam to sandy clay loam, and gravel content ranges from about 35 to 55 percent. Color is highly variable in shades of red, grayish brown, gray, reddish yellow, brownish yellow and yellowish brown.

The IIC horizon is light gray, yellow, or pale-olive clay, and it has a few mottles of red or olive yellow. Reaction ranges from slightly acid to moderately alkaline. The IIC horizon is calcareous.

Hornsby gravelly loamy sand, 1 to 5 percent slopes (HhC).—This soil occupies old high terraces and the tops and sides of small knolls or broad, irregularly shaped ridges. It has the profile described as typical for the series. Individual areas range from 50 to 100 acres in size.

In a few small areas Travis gravelly soils were included in mapping. A few areas that contain less than 35 percent gravel were also included.

This soil is mostly used for pasture. It is poorly suited to crops and better suited to improved pasture or range. (Capability unit IVs-2, pasture and hayland group 8A, Gravelly range site)

### **Hornsby Gravelly Soils, Clayey Variant**

These soils occupy high broad ridges. Slopes are smooth and dominantly about 1 to 3.5 percent. Areas of these soils range from 25 to 100 acres in size.

In a representative profile, the surface layer is grayish-brown, noncalcareous gravelly loam about 14 inches thick. This rests abruptly on noncalcareous, dark-gray gravelly clay mottled in shades of red, brown, yellow, and gray. It extends to a depth of about 44 inches. The underlying material is gravelly silty clay that is calcareous and mottled in shades of olive, yellow, brown, and gray.

These soils are moderately well drained and slowly permeable. The available water capacity is low.

Representative profile of Hornsby gravelly loam in an area of Hornsby gravelly soils, clayey variant, 1 to 4 percent slopes, in a pasture 100 feet south of a public road from a point 1.5 miles east of junction with U.S. Highway 183 and 1 mile north of the Caldwell County line.

- A1—0 to 14 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard, friable; approximately 75 percent by volume is irregular, reddish chert  $\frac{1}{4}$  to 1 inch in diameter; noncalcareous; mildly alkaline; abrupt, wavy boundary.
- B21t—14 to 26 inches, dark-gray (10YR 4/1) gravelly clay, very dark gray (10YR 3/1) when moist; common, fine mottles of red (10R 4/6) and yellowish brown (2.5Y5/2) when moist; weak, medium, blocky structure; extremely hard, very firm; gravel content slightly less than percent; noncalcareous; mildly alkaline; abrupt, smooth boundary.
- B22t—26 to 44 inches, highly mottled gravelly clay, dark red (2.5YR 3/6), yellowish brown (10YR 5/4), and light brownish gray (2.5Y 5/2) when moist; weak, medium, blocky structure; extremely hard, very firm; clay films; gravel content about 80 percent; noncalcareous; medium acid; abrupt, smooth boundary.
- IIC—44 to 50 inches, light yellowish-brown (2.5Y 6/4) gravelly silty clay, light olive brown (2.5Y 5/4) when moist; common, fine mottles of yellow and gray; structureless, breaking to weak, coarse, blocky structure; extremely hard, very firm; about 30 percent gravel; scattered hard calcium carbonate concretion calcareous; moderately alkaline.

The A horizon ranges from 10 to 16 inches in thickness. Gravel content is 40 to 80 percent by volume. The texture is gravelly loam, gravelly fine sandy loam, or gravelly clay loam. Color is dark yellowish brown or grayish brown, and reaction ranges from medium acid to mildly alkaline.

The B horizon has a gravel content of about 35 to 80 percent. Colors are shades of brown, gray, yellow, or red. The B horizon is usually mottled or highly mixed in color.

The IIC horizon is light olive brown, pale yellow, light yellowish brown, generally mottled or mixed in shades of yellow and olive. Gravel content ranges up to 30 percent.

Hornsby gravelly soils, clayey variant, 1 to 4 percent slopes (HIC).—These soils occur in areas 25 to 100 acres in size. The slope is smooth and dominantly 1 to about 3.5 percent. The surface layer is gravelly loam, gravelly fine sandy loam, or gravelly clay loam.

Most of these soils are used for pasture. The large amount of gravel in these soils severely limits their use for crops. Their suitability for improved pasture or hay is also limited. They are better suited to range. (Capability unit IVs-2, pasture and hayland group 8A, Gravelly range site)

## **Houston Black Series**

The Houston Black series consists of deep, moderately well drained clay soils. These soils have developed in calcareous marls, alluvial clays, and chalk, under a prairie of tall grasses. Slopes are smooth and single or complex; the range is from 0 to 8 percent.

In a representative profile, the surface layer is very dark gray clay about 24 inches thick. The next layer is dark-gray clay that reaches to a depth of about 38 inches. The next lower layer, to a depth of about 80 inches, is grayish-brown clay. The underlying material, to a depth of 104 inches, is mottled clay.

These soils crack when dry and are very slowly permeable when wet. The available water capacity is high.

Representative profile of Houston Black clay, 1 to 3 percent slopes, in a cultivated field 105 feet east of a field road from a point 900 feet south of intersection with Lund Road and about 2 miles northwest of Manda.

- A11—0 to 8 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, fine, subangular blocky structure and moderate, medium, granular structure; extremely hard, very firm; many fine roots; common worm casts; few snail shell fragments; shiny ped faces; few, fine, black concretions of weakly cemented iron-manganese; few, fine, strongly cemented, calcium carbonate concretions; calcareous; moderately alkaline; clear, wavy boundary.
- A12—8 to 24 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, fine, very fine, angular blocky structure; extremely hard, very firm; many fine roots, on worm casts; few snail shell fragments; shiny ped faces; few, fine, black concretions of weakly cemented iron-manganese; few, fine, strongly cemented, calcium carbonate concretions; calcareous; moderately alkaline; gradually, wavy boundary.
- A13—24 to 38 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; coarse, grooved, intersecting slickensides form parallelepipeds; extremely hard, very firm; common fine roots; common worm casts; few snail shell fragments; shiny ped faces; few, fine, black concretions of weakly cemented iron-manganese; few fine, strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.
- AC1—38 to 80 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; few, medium, distinct mottles of olive brown (2.5Y 4/4) and many, coarse, faint mottles of gray (10YR 5/1); coarse, grooved, intersecting slickensides form parallelepipeds; extremely hard, very firm; few fine roots; few worm casts; shiny ped faces; few streaks of dark gray from A13 horizon; few, fine, black, weakly cemented concretions and fine brown masses of iron-manganese; few, fine and medium, strongly and weakly cemented, calcium carbonate concretions, few, medium, powdery masses of calcium carbonate in matrix; moderately alkaline; gradual, wavy boundary.
- AC2—80 to 104 inches, distinctly and coarsely mottled, light olive-brown (2.5Y 5/4) and gray (10YR 6/1) clay; common, fine mottles of olive and brown; weak, medium and coarse, angular blocky structure; few intersecting slickers\_ sides form parallelepipeds; very hard, very firm; few fine roots; few, fine, brown masses of iron-manganese; few powdery masses of calcium carbonate; calcareous in matrix; moderately alkaline.

Thickness of the solum ranges from 60 to more 100 inches. The A horizon is 12 to 60 inches thick. Texture is clay or gravelly clay. Color is very dark gray or dark gray. The AC horizon is 10 to 66 inches thick. Color is gray, dark gray, light brownish gray, grayish brown, dark grayish brown, light yellowish brown, light olive brown, olive gray or pale olive. Where color is gray, this horizon is usually mottled in shades of olive and yellow.

Mottles in shades of olive, yellow, or gray are common.

Houston Black clay, 0 to 1 percent slopes (HnA).— This nearly level soil occupies smooth ridges (plate 1). Areas range from long and narrow to broad and irregular in shape, and from 20 to 200 acres in size.

This soil has a surface layer of very dark gray clay about 40 inches thick. The next layer, to a depth of about 80 inches, is dark-gray clay. The lower part has mottles of olive yellow.

Most of this soil is cultivated, and some of it is used for improved pasture. Although care must be taken to maintain good tilth, this soil is well suited to crops. It is also well suited to improved pasture, hay, or range. (Capability unit IIw-2, pasture and hayland group 7A, Rolling Blackland range site)

Houston Black clay, 1 to 3 percent slopes (HnB).—This gently sloping and gently undulating soil occupies smooth ridges or foot slopes. Slopes are both single and complex. Areas range from long and narrow to broad and irregular in shape and from 20 to 150 acres in size. This soil has the profile described as representative of the series.

The hazard of erosion is moderate. In a few areas erosion is caused by runoff from higher lying adjacent soils.

This soil is well suited to cultivation. It is also well suited to growing native range grasses. (Capability unit IIe-1, pasture and hayland group 7A, Rolling Blackland range site)

Houston Black clay, 3 to 5 percent slopes, eroded (HnC2).—This gently undulating soil occupies areas that are mostly long and narrow. Areas of this soil range from 25 to 100 acres in size.

This soil has a surface layer of dark-gray clay about 30 inches thick. The next layer, to a depth of 70 inches, is gray clay that has yellowish mottles in the lower part.

The hazard of erosion is moderately severe. Most areas are gullied and rilled. Gullies, stabilized into parabolic shapes, are 10 to 20 feet wide.

This soil is suitable for crops, but requires careful management to control erosion. It is well suited to improved pasture, hay, or native grass range. (Capability unit IIIe-1, pasture and hayland group 7A, Rolling Blackland range site)

Houston Black gravelly clay, 2 to 8 percent slopes, eroded (HoD2).—This soil occupies ridges and side slopes. Slopes are single and complex. Areas of this soil are long and narrow and range from 20 to 50 acres in size.

Chert rock, mostly 1 to 3 inches in diameter, covers 30 to 75 percent of the surface in most areas (plate II). The surface layer is dark-gray gravelly clay about 24 inches thick. The next layer, which extends to a depth of 70 inches, is gray clay that contains pockets of chert gravel.

Most of this soil has gullies 200 to 1,000 feet apart. The bottoms of the gullies—usually are covered with gravel that has sloughed off the surface. Included in mapping were some areas that are less than 25 percent covered by gravel.

This soil is difficult to work because of the gravelly surface, and only a few areas are cultivated. It is well suited to improved pasture, hay, or range. (Capability unit IIIe-1, pasture and hayland group 7B, Rolling Blackland range site)

Houston Black soils and Urban land, 0 to 8 percent slopes (HsD).—This unit occupies ridges and foot slopes and urban areas. It consists of about 56 percent Houston Black clay, 30 percent Urban land, and about 14 percent other soils, including Heiden clay and Bureson clay.

The Houston Black soils have a surface layer of very dark gray clay or gravelly clay about 30 inches thick. The next layer, to a depth of 75 inches, is dark-gray clay. The underlying material is mottled clay.

Most of the slopes of less than 4 percent are not cut and shaped for urban development. The steeper slopes are cut to a depth of about 2 feet, and the removed soil is spread over the adjoining natural surface. In mapping these steeper areas, soils were included that have a slightly thicker or thinner surface layer than that described in the representative profile. Also included were soils that have a 2- to 4-inch thick surface layer of imported loamy materials. About 40 percent of the soils not used for urban construction have been altered by cutting or by filling with local or imported soil materials.

Urban land is mainly occupied by single-unit dwellings and streets, driveways, sidewalks, and patios. There are also a few service stations, schools, churches, and small shopping centers and their paved parking lots.

The soils of this unit present problems when used urbanization. These are special problems in designing and maintaining foundations, trafficways, other works of concrete and asphalt caused by a shrink-swell potential; the corrosion of steel pipe; erosion hazard in cutting banks; and a percolation rate that presents hazards for septic systems.

This mapping unit lacks natural flora, except for a few trees. It is difficult to prepare the soils for planting trees or shrubs or to cultivate flower beds with hand tools. Information on use of the soils for urban planning is in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Lewisville Series**

The Lewisville series consists of deep, nearly level to gently sloping, well-drained silty clays. These soils occupy terraces along the major streams. Areas range from broad to long and narrow in shape. Slopes are smooth and up to 2 percent. These soils developed under a cover of mid and tall grasses.

In a representative profile the surface layer, about 13 inches thick, is dark grayish-brown silty clay. The next layer, which extends to a depth of about 29 inches, is brown silty clay. The underlying material, to a depth of 72 inches, is very pale brown silt loam. The soil is calcareous and moderately alkaline throughout.

These soils are moderately permeable, and the available water capacity is high. These soils are easily tilled.

Representative profile of Lewisville silty clay, 1 to 2 percent slopes, in a cultivated field 50 feet south of a paved county road from a point 1 mile northwest of its junction with U.S. Highway 290 and 3 miles east of junction with Interstate 35.

- Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; strong, fine, granular structure; be very hard, firm; calcareous; moderately alkaline; abrupt, smooth boundary.
- A12—4 to 13 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, subangular blocky and granular structure; very hard, firm; calcareous; moderately alkaline; clear, smooth boundary.
- B—13 to 29 inches, brown (10YR 5/3) silty clay, dark brown (10YR 4/3) when moist; common splotches of very pale brown (10YR 7/4); moderate, fine, granular and subangular blocky structure; hard, friable; scattered hard calcium carbonate concretions; calcareous; moderately alkaline; clear, smooth boundary.
- C—29 to 72 inches, very pale brown (10YR 8/3) silt loam, very pale brown (10YR 7/3) when moist; massive, breaking to weak, fine, granular structure; many fine vesicles; hard, friable; splotches of soft calcium carbonate; calcareous; moderately alkaline.

Thickness of the solum ranges from 25 to 46 inches.

The A horizon is 10 to 19 inches thick. Texture is clay loam or silty clay. Color is very dark grayish brown, dark grayish brown, or grayish brown.

The B horizon ranges from 10 to 32 inches in thickness. Color is brown, light brown, reddish yellow, very pale brown, pale brown, light yellowish brown, brownish yellow, or yellowish brown.

The C horizon is light brown, reddish yellow, pale brown, very pale brown or light yellowish brown. In many areas it rests on a bed of gravel at a depth of 10 to 20 feet.

Lewisville silty clay, 0 to 1 percent slopes (LcA).—This nearly level soil occupies broad smooth areas ranging from 20 to 100 acres in size. Slope is dominantly 0.5 percent or less.

This soil has a surface layer of dark grayish-brown silty clay about 15 inches thick. The next layer is brown silty clay that extends to a depth of about 30 inches. The underlying material is pale-brown silt loam.

Included in mapping were areas of a similar soil that has a surface layer about 25 inches thick.

This soil is well suited to crops. It is also well suited to improved pasture, hay, or range. (Capability unit I-1, pasture and hayland group 7C, Rolling Blackland range site)

Lewisville silty clay, 1 to 2 percent slopes (LcB).—This soil occupies complex slopes below Lewisville silty clay, 0 to 1 percent slopes. Most areas are broad, but some are long and narrow. They range from 20 to 80 acres in size. This soil has the profile described as representative of the series.

In about 38 percent of the acreage of soils included in mapping, the surface layer is 23 to 28 inches thick. Also included, in a few eroded areas, is a soil that has a thinner surface layer than that described in the representative profile.

Although the erosion hazard is moderate, this soil is well suited to crops. It is also well suited to improved pasture, hay, or range. (Capability unit IIe-2, pasture and hayland group 7C, Rolling Blackland range site)

Lewisville soils and Urban land, 0 to 2 percent slopes (LeB).—This undifferentiated group occupies nearly level to gently sloping areas along stream terraces. It consists of about 68 percent Lewisville soils, about 25 percent Urban land, and about 7 percent other soils.

Undisturbed areas of Lewisville soils have a surface layer of grayish-brown silty clay about 12 inches thick. In places the surface layer is clay loam. The next layer is brown silty clay to a depth of about 30 inches. The underlying material is pale-brown silt loam.

Where these soils are used for construction, slopes are so gentle that little or no cutting or filling is necessary. About 10 percent of the yard surfaces in the newer additions have a layer of about 2 to 4 inches of imported loamy materials. These thin foreign surface covers do not appreciably alter the basic characteristics of the Lewisville soils as they are used in urbanization.

Urban land is mostly occupied by foundations for single-unit dwellings and the adjacent streets, driveways, sidewalks, and patios. It is also occupied by municipal airports, shopping centers, churches, schools, and service stations and their paved parking lots.

There are limitations to the use of this unit in urbanization. Some of the hazards are a shrink-swell potential that affects foundations and pavements, corrosivity that affects steel pipe, and a percolation rate that affects septic systems.

Except for widely scattered trees, this mapping unit lacks natural flora. Information for use of soils in urban planning is given in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Lincoln Series**

The Lincoln series consists of somewhat excessively drained, deep, calcareous sands stratified with loamy materials (plate II). These soils occupy flood plains of rivers and streams. Areas are long and narrow, and, in most places, extend to the river's edge. In many areas numerous deeply entrenched drainageways are a result of past flooding. In these drainageways the side slopes are up to 5 percent and the ridges and bottoms are nearly level.

In a representative profile, the surface layer is very pale brown loamy fine sand about 18 inches thick. The next layer, about 3 inches thick, is pale-brown, stratified fine sand and sandy loam. The next lower layer, about 4 inches thick, is very pale brown loamy sand. The next lower layer, about 10 inches thick, is brown sandy loam. The underlying material, to a depth of 144 inches, is very pale brown fine sand. This soil is calcareous and mildly alkaline.

Lincoln soils are rapidly permeable. The available water capacity is low.

Representative profile of Lincoln loamy fine sand in a pasture 50 feet west of Farm to Market Road 973 from a point 0.3 mile north of junction with the Colorado River.

- A1—0 to 18 inches, very pale brown (10YR 7/4) loamy fine sand, yellowish brown (10YR 5/4) when moist; massive; soft, very friable; calcareous; mildly alkaline; abrupt, smooth boundary.
- C1—18 to 26 inches, pale-brown (10YR 6/3) stratified fine sand and sandy loam, dark brown (10YR 4/3) when moist; massive, breaking to weak, fine, granular structure; soft, very friable calcareous; mildly alkaline; abrupt, smooth
- C2—26 to 30 inches, very pale brown (10YR 7/4) loamy sand, yellowish brown (10YR 5/4) when moist; massive; soft, very friable; calcareous; mildly alkaline; abrupt, smooth boundary.
- C3—30 to 40 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; massive, breaking to weak, fine, granular structure; slightly hard, friable; calcareous; mildly alkaline; abrupt, smooth boundary.
- C4—40 to 144 inches, very pale brown (10YR 8/4) fine sand, light yellowish brown (10YR 6/4) when moist; massive; thin (¼-inch) strata of fine sandy loam and silt loam at a depth below 60 inches; soft, very friable; calcareous; mildly alkaline.

The A horizon has strata of loamy materials at a depth of less than 40 inches in most places. Where unstratified, the A horizon ranges from 14 inches to more than 60 inches in thickness. Color is pink, light brown, brown, very pale brown, light yellowish brown, grayish brown, light brownish gray, or pale brown.

The C horizon is fine sand, sandy loam, or loamy fine sand, stratified at irregular intervals with layers of silt loam and fine sandy loam 2 to 10 inches thick. Colors of the sandy strata are pink, light reddish brown, reddish yellow, light brown, pale brown, or very pale brown. Colors of the loamy materials are brown, light brown, pale brown, or light yellowish brown.

Lincoln loamy fine sand (Ln).—This soil is on flood plains. It occupies areas that are mostly long and narrow but widen in the bends of the flood plains. These areas range from 20 to 120 acres in size. In some areas numerous entrenched drainageways have resulted from past flooding. This soil has the profile described as representative of the series.

Included in mapping were soils that have a surface layer of fine sand and, in the bottoms of drainageways, soils that have a surface layer of sandy loam or silty clay loam. In areas adjoining Riverwash, this soil has some gravel on the surface.

This soil is mostly used for pasture or as a source of building sand. It is marginally suited to crops. (Capability unit I1s-1, pasture and hayland group 3A, Loamy Bottomland range site)

Lincoln soils and Urban land (Lu).—This undifferentiated group occupies long and narrow areas that are nearly level to gently sloping. It consists of about 85 percent Lincoln soils, about 10 percent Urban land, and about 5 percent other soils.

Undisturbed areas of Lincoln soils have a surface layer of brown loamy fine sand about 17 inches thick. The underlying material is stratified very pale brown and brown loamy sand or sandy loam.

About half the Lincoln soils have been reshaped to eliminate the series of alternate ridges and deeply entrenched drainageways that they commonly contain. Because these soils are mostly loamy fine sand and thin strata of finer materials, restructuring the profile has had little or no effect on basic soil characteristics.

Most of this mapping unit is used for park development, including the construction of grounds, ball parks, and parking areas. Except for graveled and hard-surfaced roads, these developments are on the Lincoln soils.

The Urban land is occupied by foundations of single-unit dwellings and by access roads, driveways, sidewalks, and patios.

Limitations to the use of this unit for urbanization are flooding and a percolation rate that affects septic systems.

Additional information for use of the soils in urban planning is given in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Miller Series**

Miller series consists of deep, well-drained, 141 soils on bottom lands. These soils have developed in clayey alluvium, under a cover of mid and tall grasses and a scattered overstory of trees. Tile slope is smooth and has a gradient of less than 1 percent.

In a representative profile, the surface layer is dark-brown clay about 19 inches thick. The next layer, which extends to a depth of about 70 inches, is reddish-brown clay. The underlying material, to a depth of 120 inches, is reddish-brown silty clay thinly stratified with silt loam. The profile is calcareous and mildly alkaline throughout.

These soils form cracks when dry. When the soils are wet, the cracks close and permeability is very slow. The available water capacity is high.

Representative profile of Miller clay in a cultivated field 50 feet east of a field road from a point 0.6 mile southwest of junction with Farm to Market Road 969 and 0.3 mile west of the Bastrop County line.

- Ap—0 to 6 inches, dark-brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; strong, fine, granular and subangular blocky structure; extremely hard, very firm; calcareous; mildly alkaline; abrupt, smooth boundary.
- A1—6 to 19 inches, dark-brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate, medium, angular blocky structure; extremely hard, very firm; calcareous; mildly alkaline; a clear, wavy boundary.
- B—19 to 70 inches, reddish-brown (5YR 5/3) clay, reddish brown (5YR 4/3) when moist; moderate, fine, blocky structure; extremely hard, very firm; streaks of dark brown in filled cracks; nonintersecting slickensides; carbonate coats on shiny ped faces; calcareous; mildly alkaline; clear, wavy boundary.
- C—76 to 120 inches, reddish-brown (2.5YR 4/4) silty clay, dark reddish brown (2.5YR 3/4) when moist; a few streaks of darker materials from overlying layers; massive, breaking to weak, coarse, blocky structure; extremely hard, very firm; slickensides and shiny ped faces; thin, erratic lenses of light reddish-brown (5YR 6/4) silt loam, reddish brown (5YR 5/4) when moist; calcareous; mildly alkaline.

Thickness of the solum ranges from 44 to 70 inches. Reaction ranges from mildly alkaline to moderately alkaline. The A horizon is 19 to 50 inches thick. It is dark reddish brown, dark brown, very dark grayish brown, or dark grayish brown.

The B horizon is 24 to 51 inches thick. It is reddish brown, brown, or dark brown.

The C horizon is clay or silty clay that has thin strata of silt loam and silty clay loam. Color is reddish brown, dark brown, or brown.

Miller clay (Mc).—This nearly level soil is on smooth, single slopes and large fans. Most areas are long and narrow. Areas range from 60 to 160 acres in size. About 8 percent of the acreage has 1 to 2 percent slopes and occupies long, narrow areas that terminate in drainageways.

This soil is well suited to crops. Most of it is row cropped. In a few sloping areas around drainageways, the erosion hazard is moderate. This soil is also well suited to improved pasture or hay, as well as to range. (Capability unit IIs-1, pasture and hayland group 1A, Clayey Bottomland range site)

### **Mixed Alluvial Land**

Mixed alluvial land (Md) is a miscellaneous land type that occurs on flood plains of creeks and rivers. It consists of gravelly alluvium, beds of gravel, and exposed limestone beds and boulders randomly interspersed with moderately deep to deep, calcareous alluvial materials (plate II). The flood plains range from 150 to 325 feet in width and extend in a winding, irregular fashion for 25 to 50 miles. This long and narrow unit is nearly level overall, but areas at the outer limits of the flood plains have slopes of up to 7 percent.

The materials that make up this miscellaneous land type vary from place to place within any one area and from one area to another. Most areas have three or four principal components, depending on the width of the flood plain.

All areas have a streambed of waterworn limestone that is covered with patchy light-gray silt loam alluvium 1 to 6 inches thick. Limestone boulders occur on the streambed in most places.

Areas of Mixed alluvial land also have a soil of dark grayish-brown, calcareous gravelly clay loam that rests abruptly on the limestone. This soil is typically about 44 inches thick, but it ranges from 2 to 4 feet, and in some places has a 1- to 3-inch overburden of yellowish-brown sandy clay loam. The gravel content is about 30 to 50 percent by volume.

About half the areas have a layer of dark grayish-brown, calcareous silty clay loam about 18 inches thick over a lighter colored substratum. This soil rests abruptly on limestone at a depth of 44 inches. Thickness of this soil ranges from about 16 to 48 inches. The surface layer ranges from silty clay loam to sandy clay loam in texture, and from dark grayish brown to light yellowish brown in color. The lower part of the substratum contains gravel.

Areas of Mixed alluvial land as much as 250 to 325 feet wide usually have an additional component. This consists of a gravel bar or a deposit of gravel mixed with a very small amount of fines. These flood-plain areas widen as they meet soils that developed over marl.

Mixed alluvial land is not suitable for crops or pasture. It is better suited to range or wildlife. (Capability unit Vw-1, Bottomland range site, pasture or hayland group not assigned)

## **Norwood Series**

The Norwood series consists of deep, well-drained, loamy soils on bottom lands. Some areas are smooth, nearly level single slopes, and other areas, also nearly level, are dissected by numerous intermittent drainageways. Norwood soils developed under a mixed vegetation of hardwoods and grasses.

In a representative profile, the surface layer is grayish-brown silty clay loam about 18 inches thick. It overlies a layer of dark-brown silty clay loam stratified with fine sandy loam and silt loam. The soil is calcareous and moderately alkaline.

Norwood soils are moderately permeable, and the available water capacity is high.

Representative profile of Norwood silty clay loam in a pasture 50 feet south of a private road from a point 0.2 mile northeast of junction with Houston lane, and 0.7 mile northeast of junction with Hergotz Lane.

A1—0 to 18 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; hard, very friable; calcareous; moderately alkaline; clear, smooth boundary.

C—18 to 60 inches, stratified dark-brown (7.5YR 4/2) silty clay loam and light-brown (7.5YR 6/4) fine sandy loam; layer of each is about 6 inches thick, and mixed texture is about a silty loam; massive, breaking to weak, fine, granular structure; hard, friable; calcareous; moderately alkaline.

The A horizon ranges from 12 to 20 inches in thickness. Texture ranges from silt loam to silty clay loam. Color is brown, dark brown, grayish brown, light yellowish brown, or yellowish brown.

The C horizon is stratified fine sandy loam, silt loam, very fine sandy loam, sandy clay loam, silty clay loam, loamy fine sand, and fine sand. The strata are reddish yellow, brown, dark brown, light brown, pale brown, and yellowish brown. They vary in thickness and textural components.

Norwood silty clay loam (No).—This nearly level soil occupies smooth bottoms in very shallow drainageways. The slope ranges from 0.25 to 0.75 percent. Areas range from long and narrow to irregular in shape and from 30 to 180 acres in size. This soil has the profile described as typical of the series.

About 30 percent of this soil has a surface layer of silt loam. The silt loam is mostly in large separate bodies, but some small spots occur with areas dominated by silty clay loam. Small areas of Yahola very fine sandy loam transitional to silt loam were included in mapping. In the bottoms of drainageways, some profiles have a higher clay content than that described as representative of the series.

This soil is mainly used for crops and pasture or for hay. Some areas are irrigated. It is well suited to these uses. This soil is also well suited to growing native grasses managed as range. (Capability unit I-1, pasture and hayland group 1C, Loamy Bottomland range site)

Norwood soils, channeled (Nr).—These nearly level soils are generally on long and narrow areas intersected by numerous intermittent drainageways. These drainageways are 100 to 500 feet apart and nearly level at the bottom. Their side slopes are 50 to 100 feet wide, and the bottoms of the drainageways are mostly 35 to 75 feet in width. Areas of these soils range from 30 to 60 acres in size.

These soils have a surface layer of grayish-brown silt loam about 16 inches thick. The underlying material, to a depth of 60 inches, is dark-brown silty clay loam stratified with loamy and sandy material. The surface layer is silty loam in slightly more than 65 percent of the acreage and silty clay loam in the rest.

Included in mapping were areas of Yahola fine sandy loam that make up about 15 percent of the soils on ridges. Also included were some side slopes ranging up to 5 percent.

These soils are well suited to crops, pasture, and orchards. Some areas are sprinkler irrigated. These soils are also well suited to native grass range. (Capability unit I-2, pasture and hayland group 1C, Loamy Bottomland range site)

### **Patrick Series**

The Patrick series consists of shallow to moderately deep, well-drained soils underlain by gravel. These soils have developed on high stream terraces under a cover of mid and tall grasses. Most areas occur immediately below the slope crests in long, narrow areas, but small areas are also on ridges. The slope is dominantly 2 to 6 percent, but it ranges from 1 to 10 percent.

In a representative profile, the surface layer is dark grayish-brown clay about 10 inches thick. The next layer, which extends to a depth of about 22 inches, is brown clay. The underlying material, to a depth of 120 inches, is brownish very gravelly loamy sand that is about 65 percent limestone and gravel.

Patrick soils are moderately permeable, and the available water capacity is moderate.

Representative profile of Patrick clay in an area of Patrick soils, 2 to 5 percent slopes, in a pit 100 feet east of U.S. Highway 183 from a point 500 feet south of its junction with Onion Creek.

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) en moist; moderate, fine, granular structure; hard, friable; few rounded limestone and alert pebbles; calcareous; moderately alkaline; clear, smooth boundary.

B—10 to 22 inches, brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) when moist; weak, fine, blocky structure and moderate, medium, granular structure; hard, friable; a few chert and limestone pebbles; calcareous; moderately alkaline; abrupt, wavy boundary.

IIC—22 to 120 inches, brownish very gravelly loamy sand; massive, slightly cemented and hard in upper part, single grain and loose in the lower part; violently effervescent; calcareous.

The solum ranges from 16 to 24 inches in thickness. Gravel content in the solum ranges from a few scattered pebbles to about 20 percent, by volume; gravel on the surface ranges from a few scattered pebbles to about a 10 percent cover.

The A horizon is 8 to 14 inches thick. Texture is clay, clay loam, gravelly clay, or gravelly clay loam. Color is dark grayish brown or very dark grayish brown.

The B horizon is 4 to 16 inches thick. Color is brown, light brown, grayish brown, light brownish gray, pale brown, brown, light yellowish brown, or yellowish brown.

The IIC horizon contains 50 to 90 percent coarse fragments, which consist of rounded chert and limestone 0.25 to 3 inches in diameter. Cementation of gravel with calcium carbonate ranges from weak to strong.

Patrick soils, 2 to 5 percent slopes (PaC).—These soils occupy smooth, gentle ridges and adjoining side slopes. Areas are 10 to 30 acres in size. These soils have the profile described as representative of the series. Texture of the surface layer is clay, clay loam, gravelly clay, or gravelly clay loam.

Included in mapping were a few areas that have a lighter colored surface layer or where the surface layer is reddish brown and noncalcareous. Also included were soils that are less than 10 inches deep to the underlying material. Inclusions make up about 30 percent of the acreage.

These soils are mainly used as a source of gravel. They are marginally suitable for crops, but are better suited to improved pasture or range. (Capability unit IVe-3, pasture and hayland group 7C, Chalky Ridge range site)

Patrick soils, 5 to 10 percent slopes (PaE).—These soils occur in long and narrow Areas below the less sloping Patrick soils and above other soils that developed in marine sediments. Areas are mostly 10 to 20 acres in size. The surface layer is clay, clay loam, gravelly clay, or gravelly clay loam.

Included in mapping were small areas of other soils that are less than 10 inches deep over gravel. Also included were soils that have a surface layer that is lighter colored or thinner than that of the Patrick soils.

Patrick soils have a surface layer that is dominantly very dark grayish-brown clay about 8 inches thick. The next layer, to a depth of about 15 inches, is brown clay. The underlying material is brown gravelly loamy sand.

These soils are mostly used as a source of sand and gravel. Areas not yet mined are mostly used for pasture or range. These soils are not suitable for crops. They are, however, better suited to improved pasture, hay, or range. (Capability unit VIe-2, pasture and hayland group 7D, Chalky Ridge range site)

Patrick soils and Urban land 1 to 10 percent slopes (PcE).—This undifferentiated group occupies stream terraces. It consists of about 50 percent tall Patrick soils, about 30 percent Urban land, and about 20 percent other soils.

Patrick soils have a surface layer of grayish-brown clay about 14 inches thick. The next layer is about 4 inches of brown clay. It overlies a bed of gravelly loamy sand

About a fourth of this mapping unit, surfaces have been reshaped to accommodate construction. Excavated materials have been spread over adjacent areas, making some soils thicker and some thinner. Gravel has been added to some surfaces, and others have a thin covering of imported calcareous loamy or other soils. These construction changes have not altered the basic characteristics of the soil.

Urban land is mostly occupied by individual dwellings and the adjoining streets, sidewalks, driveways, and patios. Parts of some areas are less than 10 percent covered by buildings and pavement.

Its comparatively high position on the landscape gives this mapping unit some scenic value, but it lacks natural flora, except for a wide scattering of trees.

Characteristics important in urban construction are shrink-swell potential that affects the construction of buildings and pavement, corrosivity that affects the installation of uncoated steel, and percolation rate that affects the use of septic systems. For more information about use of the soils for urban planning, refer to the sections on engineering and community and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Pedernales Series**

The Pedernales series consists of deep, well drained, gently sloping and gently rolling soils 4 that developed in old alluvium high on flood plains. The slope ranges from about 2 to 8 percent, but 4 to 6 percent is dominant. Pedernales soils developed under a cover of mid and tall grasses and a scattered overstory of trees.

In a representative profile, the surface layer is reddish-brown fine sandy loam about 8 inches thick. The next layer is reddish-brown sandy clay about 12 inches thick. The next layer is red sandy clay loam about 30 inches thick. The next layer, about 16 inches thick, is sandy loam that is light red in the upper part and red in the lower part. The next lower layer is brown and pinkish-gray sandy loam about 6 inches thick. The underlying material, to a depth of 74 inches, is hard gray limestone.

This soil is moderately slowly permeable, and the available water capacity is high.

Representative profile of Pedernales fine sandy loam, 1 to 5 percent slopes, 1,000 feet east of the entrance to the Lower Colorado River Authority park, which is 6 miles northeast of junction of Ranch Road 2322 and Texas Highway 71.

- A1—0 to 8 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; hard, friable; noncalcareous; mildly alkaline; abrupt, smooth boundary.
- B21t—8 to 20 inches, reddish-brown (2.5YR 4/4) sandy clay, dark reddish brown (2.5YR 3/4) when moist; patchy clay films on ped faces and in pores; moderate, fine, subangular blocky structure, breaking to granular; hard, friable; few iron-manganese and calcium carbonate concretions in the lower part; noncalcareous; mildly alkaline; gradual, smooth boundary.
- B22t—20 to 50 inches, red (2.5YR 5/8) sandy clay loam, red (2.5YR 4/8) when moist; patchy clay films on ped faces and in pores; moderate, fine, subangular blocky structure, breaking to granular; hard, friable; neutral; gradual, smooth boundary.
- B23t—50 to 54 inches, light-red (2.5YR 6/8) sandy loam, red (2.5YR 5/8) when moist; patchy clay films on ped faces and in pores; weak, fine, granular structure; hard, friable; neutral; gradual, smooth boundary.
- B3—54 to 66 inches, red (2.5YR 5/6) sandy loam, red (2.5YR 4/6) when moist; a few fine waterworn pebbles; peds coated and bridged with clay films; weak, fine, granular structure; hard, friable; noncalcareous; mildly alkaline; gradual, smooth boundary.
- C—66 to 72 inches, brown (7.5YR 5/4) and pinkish-gray (7.5YR 7/2) sandy loam; massive; hard, friable; fine calcium carbonate concretions; calcareous; moderately alkaline. This horizon is discontinuous over the limestone rock.
- R—72 to 74 inches, hard gray limestone.

A horizon is 4 to 12 inches thick. It is reddish brown, dark brown, grayish brown, dark grayish brown, or brown in color. Reaction ranges from moderately alkaline to slightly acid.

The B horizon ranges from sandy clay to sandy loam. Reaction ranges from moderately alkaline to slightly acid. It is weak red, dusky red, reddish brown, dark reddish brown, red, dark red, or yellowish red in the upper part and red, light red, dark red, or yellowish red in the lower part.

The soils of Travis County named in this series are outside the range for the series in that they are noncalcareous to a greater depth than is defined for the series, and they occur in regions of slightly higher rainfall. This does not alter their usefulness or behavior.

Pedernales fine sandy loam, 1 to 5 percent slopes (PdC).—This soil occurs in irregularly shaped areas that are 20 to 50 acres in size. It has the profile described as representative of the series.

Included in mapping were small areas of Travis soils that are acid in reaction, and other soils that have a surface layer of loamy fine sand thicker than 20 inches. Soils that have a calcareous surface layer and soils less than 40 inches thick are also included. Inclusions are as much as 40 percent of the area.

This soil is used mostly for range. Although the erosion hazard is moderately severe, this soil is suitable for crops. It is better suited to improved pasture, hay, or range. (Capability unit Ille-6, pasture and hayland group BA, Sandy Loam range site)

Pedernales fine sandy loam, 5 to 8 percent slopes, eroded (PdD2).—Except that it is more sloping and eroded, this soil is similar to Pedernales fine sandy loam, 1 to 5 percent slopes. V-shaped gullies generally 100 to 400 feet apart, extend into the lower layers in many places. The areas between gullies are generally thinner in the surface layer than normal because of sheet and rill erosion.

This soil has a surface layer of reddish-brown fine sandy loam about 6 inches thick. The next layer is reddish-brown sandy clay about 5 inches thick. The next lower layer is red sandy clay loam about 25 inches thick. The next lower layer is red sandy loam about 30 inches thick. It rests on hard gray limestone.

Included in mapping were small areas of sandy clay loam and other areas that have a surface layer of loamy fine sand more than 20 inches thick. In narrow zones transitional to Brackett soils, many soils are less than 40 inches thick and have a calcareous surface layer. All inclusions make up as much as 40 percent of this soil.

This soil is well suited to range and also to improved pasture or hay. The use of this soil for crops is severely limited by the severe erosion hazard. (Capability unit IVe-6, pasture and hayland group 8A, Sandy Loam range site)

### **Purves Series**

The Purves series consists of shallow, well-drained soils that developed in interbedded limestone and marl. These soils occupy irregularly shaped areas on ridges and bench slopes. Slopes are mostly complex. These soils developed under a cover of mid and tall grasses.

In a representative profile, the surface layer is dark-brown silty clay about 7 inches thick. The next layer, to a depth of about 15 inches, is reddish-brown silty clay. The underlying material, to a depth of 17 inches, is limestone.

Purves soils are moderately slowly permeable, and the available water capacity is low.

Representative profile of Purves silty clay, 1 to 5 percent slopes, in a pasture 50 feet south of a ranch road from a point 4 miles northwest of its junction with U.S. Highway 290, then 1 mile west of Oak Hill.

A1—0 to 7 inches, dark-brown (7.5YR 3/2) silty clay, very dark brown (7.5YR 2/2) when moist; strong, fine and medium, subangular blocky and granular structure; hard, firm; calcareous; moderately alkaline; clear, smooth boundary.

A12—7 to 15 inches, reddish-brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) when moist; moderate, fine, granular structure; hard, friable; calcareous; moderately alkaline; abrupt, smooth boundary.

R—15 to 17 inches, limestone that is weathered and weakly indurated in the upper 2 inches and strongly indurated below, interbedded with calcareous clayey marl.

Thickness of the solum over interbedded limestone and marl ranges from 10 to 20 inches, Reaction of the solum ranges from mildly alkaline to moderately alkaline. Color is reddish brown, dark reddish brown, dark brown, dark grayish brown, very dark grayish brown, or dark brown.

Purves silty clay, 1 to 5 percent slopes (PuC).—This soil occurs on irregularly shaped areas that range from 10 to 20 acres in size.

Included in mapping are soils that have a cover of up to 75 percent broken limestone fragments on the surface and contain about 10 to 20 percent limestone fragments within the solum. These soils are on small knolls where the weathered limestone has been exposed in plowing. In a few soils, the surface layer is lighter colored than typical, and in others it is more than 20 inches thick. A few areas that have up to 7 percent slopes are included.

This soil is used mostly for range. It is easy to work, but few areas are cultivated. It is better suited to improved pasture, hay, or range. (Capability unit IVe-3, pasture and hayland group 13A, Rolling Prairie range site)

### **Riverwash**

Riverwash (Rw) consists of gravels, sands, and 64 loamy materials. It occupies long, narrow areas adjacent to rivers. Most areas are 10 to 20 acres in size.

The surface of these areas is devoid of vegetation, except for a few trees. Riverwash is a source of sand and gravel (plate III).

Where these areas narrow to join the river, the last few hundred feet is generally made up of loamy or clayey material overlying sand and gravel.

Included in mapping were areas of Lincoln soils. (Not placed in a capability unit, pasture and hayland group, or range site)

### **San Saba Series**

The San Saba series consists of moderately well drained, moderately deep, clay soils overlying limestone. These soils occupy irregular areas on high, broad ridges and in long, narrow valleys. The slope is dominantly 1 to 2 percent. These soils developed under a cover of tall grasses.

In a representative profile, the surface layer is very dark gray calcareous clay about 22 inches thick. The next layer is dark-gray clay about 16 inches thick. The underlying material is gray limestone.

The soils are very slowly permeable when wet. The available water capacity is high.

Representative profile of San Saba clay, 1 to 2 percent slopes, in a pasture 50 feet west of U.S. Highway 183, from a point 1 mile south of the Williamson County line.

A11—0 to 22 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, fine and medium, granular structure in the upper part grading to moderate, medium, subangular blocky structure in the lower part; extremely hard, very firm; scattered hard calcium carbonate concretions; a few iron-manganese concretions in the lower part; calcareous; mildly alkaline; gradual, wavy boundary.

A12—22 to 38 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; streaks of color from the All horizon in old filled cracks; parallelepiped structure; many shiny ped faces and intersecting slickensides; extremely hard, very firm; scattered hard calcium carbonate and a few iron-manganese concretions; calcareous; mildly alkaline; abrupt, smooth boundary.

R—38 to 42 inches, gray limestone that has a hardness greater than 3 on Mohs scale.

Thickness of the soil over limestone ranges from 24 to 40 inches. Reaction ranges from mildly alkaline to moderately alkaline throughout the soil.

The A11 horizon is dark gray or very dark gray. The A12 horizon is gray or dark gray.

In some areas the C horizon is light brownish gray, grayish brown, light yellowish brown, light olive brown or light olive gray. It is generally mottled in shades of olive and yellow. Angular small pieces of limestone are mixed with the soil in the 2- to 4-inch layer above the limestone.

San Saba clay, 1 to 2 percent slopes (SaB).—This soil occupies smooth, single and complex slopes on broad uplands and in long, narrow valleys. Areas range from 10 to 40 acres in size. This soil has the profile described as representative of the series.

Included in mapping were a few soils that are noncalcareous. A few others are slightly more than 40 inches thick over limestone. Other included soils have a brownish color within 12 inches of the surface. Also included are small areas that have 3 to 4 percent slopes.

This soil is used mostly for range, but some areas are used for crops. The erosion hazard is moderate. This soil is well suited to cultivation. It is also well suited to improved pasture, hay, or range. (Capability unit 1Ie-1, pasture and hayland group 7A, Deep Upland range site)

San Saba soils and Urban land, 0 to 2 percent slopes (SbA).—This undifferentiated group occupies ridges and valleys. It consists of about 60 percent San Saba soils, about 25 percent Urban land, and about 15 percent other soils.

The San Saba soils have a surface layer of very dark gray clay 22 inches thick. The next layer is dark-gray clay 18 inches thick that rests on gray limestone.

Minimal cutting and shaping is done to prepare building sites and trafficways. Areas not covered by works and structures have about 10 percent of the surface altered by fill from adjacent excavations or other imported loamy materials. Because these soils are clay throughout the solum, the basic characteristics are essentially the same as for unaltered soils.

The Urban land is mostly occupied by single-unit dwellings and adjacent streets, driveways, sidewalks, and patios. A few small shopping centers, service stations, schools and manufacturing plants with buildings and paved parking areas are also on Urban land.

The use of this undifferentiated group for urban development presents problems. These problems are caused by the shrink-swell potential, as it affects design, construction, or maintenance of concrete foundations and asphalt trafficways; corrosivity, as it affects steel pipes; and percolation rate, as it affects septic systems. Except for a few trees, this group lacks natural flora.

For information on use of the soil in urban planning, refer to sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Speck Series**

The Speck series consists of shallow, well-drained soils overlying limestone. Slopes are smooth and complex and are dissected by widely spaced shallow drainageways. The slope is dominantly 1.5 to 3 percent, but it ranges from 0.5 to 5 percent. These soils developed under a cover of mid and tall grasses.

In a representative profile, the surface layer is noncalcareous, reddish-brown clay loam about 14 inches thick. The next layer, which extends to a depth of about 18 inches, is noncalcareous, dark reddish-brown gravelly clay. The underlying material is limestone rock. Many stones and pebbles are on the surface. Because they are shallow to bedrock, Speck soils are droughty during the summer months. They are slowly permeable, and the available water capacity is low.

Representative profile of Speck stony clay loam, 1 to 5 percent slopes, in a pasture 100 feet west of Duval Lane from a point 2.25 miles northeast of its junction with U.S. Highway 183.

A1—0 to 14 inches, reddish-brown (5YR 4/3) stony r clay loam, dark reddish brown (5YR 3/3) when moist; moderate, fine and medium, subangular blocky structure; shiny ped faces; extremely hard, firm; approximately 40 percent of surface is covered by reddish-brown gravel and stones, and the horizon contains scattered gravel; noncalcareous; mildly alkaline; clear, smooth boundary.

Bt—14 to 18 inches, dark reddish-brown (2.5YR 3/4) gravelly clay, dark reddish brown (2.5YR 2/4) when moist; moderate, medium, subangular blocky structure; shiny ped faces; extremely hard, very firm; about 30 percent, by volume, reddish-brown chert gravel; noncalcareous; mildly alkaline; abrupt, smooth boundary.

R—18 to 20 inches, limestone rock, fractured, that has a hardness greater than 3 on Mohs scale.

Thickness of the solum ranges from 14 to 18 inches.

The A horizon is 7 to 14 inches thick. Color is reddish brown, dark reddish brown, dark brown, very dark brown, dark grayish brown or very dark grayish brown.

The Bt horizon is 4 to 13 inches thick. Color is weak red, dusky red, reddish brown, dark reddish brown, dark red or reddish gray.

The R horizon is hard, gray, fractured limestone, but in a few places the uppermost 0.5 inch to 3 inches is soft.

Speck clay loam, 1 to 3 percent slopes (SpB).—This soil occupies smooth areas where slopes are dominantly 1 to 2 percent. The areas range from 10 to 30 acres in size.

The surface layer is reddish-brown clay loam about 12 inches thick. It is about 10 percent gravel. The next layer is reddish-brown clay about 6 inches thick that is about 3 percent gravel. The underlying material is hard limestone.

Included in mapping are small areas that have a surface layer less than 7 inches thick and a few small areas of Crawford clay, 1 to 2 percent slopes. A few areas are gray, calcareous clay less than 20 inches thick. Other minor areas have slopes ranging up to 4 percent. Parts of some mapped areas have a more than 25 percent cover of gravel. All inclusions make up less than 20 percent of the acreage.

Most of this soil is used for range. It has a limited suitability for crops, and is better suited to improved pasture or range. (Capability unit IIIe-5, pasture and hay land group 13A, Redland range site)

Speck stony clay loam, 1 to 5 percent slopes (SsC).—This soil occupies smooth, gently undulating topography. Slopes are complex and dominantly 1.5 to 3.5 percent. Areas are mostly broad and irregular in shape, and range from 100 to 1,000 acres in size. This soil has the profile described as representative of the series.

Reddish-brown chert pebbles and cobblestones 2 to 10 inches in diameter cover 30 to 50 percent of the face in most areas, and up to 80 percent in a few areas. Chert makes up 5 to 10 percent of the A horizon and 15 to 30 percent of the B horizon. Some areas have scattered large, outcropping limestone fragments.

About 15 to 20 percent of the acreage of soils included in mapping is not stony or gravelly. Some soils are only 6 to 11 inches thick. A few included soils are more than 20 inches thick. A few have a grayish surface layer.

This soil is not suitable for cultivation. It is well suited to native grass range. (Capability unit VI s-1, Redland range site, pasture and hayland group not assigned)

### **Stephen Series**

The Stephen series consists of shallow, well drained, silty clay loam soils that developed over chalk. These soils occupy ridges and side slopes. Slopes are smooth and complex. They are dominantly 2 to 4 percent, but range from 1 to 5 percent. Soil areas range from long and narrow to broad and irregular. These soils developed under a cover of mid and tall grasses.

In a representative profile, the surface layer is dark grayish-brown silty clay loam 11 inches thick. The next layer is dark-brown silty clay loam about 6 inches thick. The underlying material is broken, platy, white chalk.

Stephen soils are moderately slowly permeable, and their available water capacity is low.

Representative profile of Stephen silty clay loam, 1 to 3 percent slopes, in a pasture 50 feet north of a field road from a point 0.25 mile east of its junction with Interstate Highway 35, then 6 Miles northeast of junction with Bluestein Boulevard.

A11—0 to 11 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; strong, fine, granular and subangular blocky structure; hard, firm; scattered fine bits of chalk; calcareous; moderately alkaline; clear, smooth boundary.

A12—11 to 17 inches, dark-brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky and granular structure; hard, friable; about 10 percent, by volume, is broken chalk fragments; estimated calcium carbonate equivalent is about 60 percent; calcareous; moderately alkaline; clear, wavy boundary.

R—17 to 22 inches, broken, platy, white chalk, soft in upper part but increasingly harder as depth increases; chalk faces have thin streaks and splotches of brownish yellow; some fine earths in chalk interstices.

Thickness of the solum over platy soft chalk or strongly weathered chalk ranges from 11 to 20 inches. It is dark grayish brown, very dark grayish brown, or dark brown. Chalk fragments range from none to about 10 percent by volume in the upper part. Content of fragments in the lower part dominantly ranges from a few to about 30 percent, but in places it is up to 70 percent, by volume. Below the All horizon the calcium carbonate content ranges from about 50 to 80 percent.

Stephen silty clay loam, 3 to 5 percent slopes is outside the range of the series in that it has a cambic horizon. This, however, does not alter the usefulness or behavior of the soil.

Stephen silty clay loam, 1 to 3 percent slopes (StB).—This soil occupies ridges, saddles, and side slopes. Slopes are smooth. Areas range from long and narrow to broad and irregular in shape and from 10 to 20 acres in size. This soil has the profile described as representative of the series.

Included in mapping were small areas of Austin and Brackett soils. A few soils are less than 7 inches thick. Also included are a few soils that have lighter colored lower layers. All inclusions do not occur in every mapped area, and no mapped area is more than 20 percent included soils.

The erosion hazard is moderate. This soil is suitable for crops, but it is better suited to improved pasture or range. It is marginally suitable for hay. (Capability unit IIIe-5, pasture and hayland group 13A, Chalky Ridge range site)

Stephen silty clay loam, 3 to 5 percent slopes (StC).—This soil occupies side slopes below the less sloping Stephen soils. Most areas are long and narrow and 10 to 20 acres in size.

This soil has a surface layer of dark grayish-brown silty clay loam about 8 inches thick. The next layer is dark-brown silty clay loam to a depth of about 14 inches. The underlying material is strongly weathered chalk.

Included in mapping were small areas of soils that have a lighter colored surface layer and other soils that are less than 7 inches thick. All inclusions together make up about 25 percent of the acreage.

The erosion hazard is moderately severe. This soil is marginally suited to hay. It is better suited to range or improved pasture. (Capability unit IVe-3, pasture and hayland group 13A, Chalky Ridge range site)

## **Tarrant Series**

The Tarrant series consists of shallow to very shallow, well-drained, stony, clayey soils overlying limestone. Large limestone rocks cover 25 to 85 percent of the surface. These soils occupy nearly level to gently sloping ridges, rolling side slopes, steep, hilly breaks. Slopes are complex and range from 0.5 percent on ridges to 40 percent on breaks. Most areas are broad and irregular in shape. Tarrant soils developed under tall grass and open canopy of trees.

In a representative profile, a layer of about 8 inches of dark grayish-brown stony clay is underlain limestone. About 50 percent of the surface is covered with limestone rocks 1 to 3 feet in diameter and the lower part of the solum is about 60 percent smaller limestone fragments mixed with soil material. The soil is calcareous and mildly alkaline throughout. Tarrant soils are moderately slowly permeable, and the available water capacity is low.

Representative profile of Tarrant stony clay in an area of Tarrant soils, rolling, in a wooded range 1,000 feet west of the intersection of Balcones Drive and Steck Avenue.

A11—0 to 5 inches, dark grayish-brown (10YR 4/2) stony clay, very dark grayish brown (10YR 3/2) moist; strong, fine, subangular blocky granular structure; hard, firm; 50 percent cover of limestone rocks 1 to 3 feet in diameter; calcareous; mildly alkaline; clear, smooth boundary.

A12—5 to 8 inches, dark grayish-brown (10YR 4/2) stony clay, very dark grayish brown (10YR 3/2) when moist; medium, fine, subangular blocky granular structure; hard, firm; about 60 percent content of flaggy limestone; calcareous; mildly alkaline; abrupt, smooth boundary.

R—8 to 12 inches, limestone; upper 2 inches weakly indurated, lower part extremely hard but fractured.

The solum ranges from 4 to 14 inches in thickness. Texture ranges from clay loam or silty clay loam to clay or silty clay. Reaction ranges from mildly alkaline to moderately alkaline. Color is dark grayish brown, very dark grayish brown, or dark brown. From 25 to 85 percent of the soil surface is covered with large and small pieces of limestone. The A1 horizon ranges from 40 to 80 percent, by volume, flaggy limestone.

Tarrant soils, rolling (TaD).—This soil occupies complex slopes that are dominantly 5 to 12 percent. Areas are broad and range from 100 to 1,000 acres in size. This soil has the profile described as representative of the series.

Random outcrops of limestone that cover 2 to 3 feet of the surface are common. These rock outcrops, in addition to smaller loose stones, cover 30 to 60 percent of the acreage.

In some areas about 30 percent of the surface is covered with 1- to 3-inch limestone gravel. This inclusion is about 6 percent of the acreage. Small areas of Brackett soils were included in other places, and some slopes up to 18 percent were included.

Because the thin, stony solum prevents the use of farm machinery, this soil is not suitable for crops or improved pasture or hay. It is well suited to native grass range. (Capability unit Vls-1, Rocky Upland range site, pasture and hayland group not assigned)

Tarrant and Speck soils, 0 to 2 percent slopes (TcA).—This undifferentiated group occupies long and narrow and broad and irregular areas on ridges. It consists of about 63 percent Tarrant soils, 32 percent Speck soils, 4 percent dark-gray clay that is 18 inches thick, and a small amount of Crawford clay and rock outcrop. Areas range from 50 to 750 acres in size.

Tarrant soils have a surface layer, 10 inches thick, of dark grayish-brown clay overlying limestone. It contains about 45 percent flaggy limestone fragments, and about 70 percent of the ground surface is covered with large limestone fragments. About 19 percent of the acreage of Tarrant soils has a gravelly surface layer.

Speck soils have a surface layer of reddish-brown clay loam about 14 inches thick. The next lower layer is dark reddish-brown gravelly clay about 4 inches thick. The underlying material is hard limestone. Some of these Speck soils are stony.

Because of stony surfaces and rock outcrop, farm machinery cannot be used on these soils. These soils are not suited to crops or to improved pasture or hay. They are, however, well suited to range. (Capability unit Vls-1, Rocky Upland range site, pasture and hayland group not assigned)

Tarrant soils and Rock outcrop, steep (TdF).—This undifferentiated group occupies breaks and ravines along major rivers. Slopes are mostly single and dominantly 18 to 40 percent. Areas range from 50 to 300 acres in size.

Tarrant soils have a surface layer of dark grayish-brown stony clay or stony clay loam about 7 inches thick over limestone.

Rock outcrop and smaller loose limestone fragments cover 50 to 80 percent of the acreage.

Some nearly vertical escarpments were included in mapping. In other areas some Brackett soils or less sloping Tarrant soils were included. All inclusions make up about 20 percent of the acreage.

This undifferentiated group is not suitable for pasture and has only limited suitability for range. It is better suited to wildlife habitat or recreational uses. (Capability unit VIIIs-1, Steep Rocky range site, pasture and hayland group not assigned)

Tarrant soils and Urban land, 0 to 2 percent slopes (TeA).—This undifferentiated group occupies long, broad ridges. It consists of about 75 percent Tarrant soils, about 20 percent Urban land, and about 5 percent other soils.

Undisturbed areas of Tarrant soils have an 8-inch thick surface layer of dark grayish-brown clay or clay loam. The underlying material is limestone. Stones are on the surface and in the soil.

These soils are only slightly modified by urban development. Underbrush is usually removed with a bulldozer, which disturbs the uppermost few inches of soil. Loose surface stones are generally hauled away. Imported loamy or other soil materials, generally only a few inches thick, are placed on about a fourth of the surface. These additions do not materially alter the basic soil characteristics.

Urban land is mostly occupied by single-unit dwellings and streets, driveways, sidewalks, and patios. Swimming pools, service stations, small shopping centers and schools and their paved parking areas are also on Urban land.

The most urgent requirements of urbanization involve trenching for utilities. In most places, the limestone has to be broken by blasting or with pneumatic hammers. Soil characteristics that affect urban development are shrink-swell potential, as it affects foundations and paving; corrosivity, as it affects uncoated steel; and percolation rate, as it affects septic systems. The natural vegetation is trees.

Information on use of the soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

Tarrant soils and Urban land, 5 to 18 percent slopes (TeE).—This undifferentiated group occupies ridges. It consists of about 70 percent Tarrant soils, about 25 percent Urban land, and about 5 percent other soils.

Tarrant soils have a surface layer of grayish-brown clay or clay loam, about 8 inches thick, that overlies limestone. Stones are on the surface and in the soil.

The basic soil characteristics are not appreciably reshaped in urbanization. In clearing brush, the upper few inches of soil are moved about by bulldozers. Loose surface stones are generally hauled away. Building sites are leveled as necessary for the type of construction, and frequently the mixture of excavated soil and rock resulting from leveling is also hauled away. About a fourth of the Urban land not covered by works and structures has an imported surface layer of loamy or other foreign soil materials. Most imported surface layers are only a few inches thick, but they are as much as a foot or two thick in some places.

Urban land is mostly occupied by single-unit dwellings and adjoining streets, sidewalks, driveways, and patios. Other structures are swimming pools, service stations, small shopping centers, apartment complexes, and paved parking areas.

Trenching for utility lines is slow and difficult, and blasting is often necessary. Soil characteristics that affect urban development are shrink-swell potential, as it affects foundations and paving; corrosivity, as it affects uncoated steel; and percolation rate, as it affects septic systems.

Information on use of the soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

Tarrant soils and Urban land, 18 to 40 percent slopes (TeF).—This undifferentiated group occupy hills and breaks. It consists of about 80 percent Tarrant soils, about 15 percent Urban land, and about 5 percent other soils.

Tarrant soils have a surface layer of dark-brown clay or clay loam, about 6 inches thick, that overlies hard limestone. Stones are on the surface and in the soil.

Extensive reshaping of this group is not practical because of the steep slopes. In urban development loose surface stones are removed and either hauled away or used for building. About a fourth of the yards have a surface layer of imported loam or other soil materials. The foreign surface layer is only a few inches thick in most places, but it is several feet thick in some places.

Urban land is mostly occupied by single-unit dwellings and adjoining streets, driveways, sidewalks, and patios.

The steep slopes and shallow depth to limestone make building sites, access trafficways, and underground utility trenches difficult to prepare. Other soil characteristics that affect construction are shrink-swell potential, as it affects foundations and paving; corrosivity, as it affects unprotected steel pipes; and percolation rate, as it affects septic systems.

Information on use of the soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

## **Travis Series**

The Travis series consists of deep, well-drained, acid soils that developed in old alluvium. These gently sloping and gently undulating to gently rolling soils occupy high terraces. They developed under mid and tall grasses and a scattered overstory of trees.

In a representative profile, the surface layer is fine sandy loam about 14 inches thick. It is brown in the upper part and light brown in the lower part. The next layer, which extends to a depth of 50 inches, is red sandy clay. The underlying material, to a depth of 75 inches, is gravelly sandy clay loam. It is reddish brown in the upper part and yellowish red in the lower part.

These soils are slowly permeable, and the available water capacity is high.

Representative profile of Travis fine sandy loam an area of Travis soils, 1 to 5 percent slopes, 6.5 miles south, 85 degrees east of State capitol in Austin; in a pasture 200 feet west of a private road from a point 1/4 mile southwest of its junction with Farm to Market Road 969, then 1.0 mile southeast of junction with Decker Lane.

A1—0 to 7 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; weak, fine, granular structure; hard, very friable; many roots; few, fine, rounded, siliceous pebbles; slightly acid; clear, smooth boundary.

A2—7 to 14 inches, light-brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) when moist; weak, fine, granular structure; hard, very friable; many roots; few, fine, rounded pebbles; slightly acid; clear, smooth boundary.

B21t—14 to 24 inches, red (2.5YR 4/6) sandy clay, dark red (2.5YR 3/6) when moist; moderate, fine and medium, blocky structure; extremely hard, very firm; few roots; nearly continuous clay films; few pores; few pebbles; medium acid; clear, wavy boundary.

- B22t—24 to 50 inches, red (2.5YR 5/8) sandy clay, red (2.5YR 4/8) when moist; weak, medium, blocky structure; hard, firm; few patchy clay films; few, fine, rounded pebbles; medium acid; clear, wavy boundary.
- B3t—50 to 60 inches, reddish-brown (5YR 5/4) gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; weak, coarse, blocky structure; hard, friable and crumbly; few patchy clay films; contains 20 percent by volume, pebbles ¼ to ½ inch in diameter; medium acid; gradual, smooth boundary.
- C—60 to 75 inches, yellowish-red (5YR 5/6) gravelly sandy clay loam, yellowish red (5YR 4/6) when moist; massive; hard, friable; about 20 percent, by volume, is pebbles ¼ to ½ inch in diameter; medium acid.

The A horizon ranges from 9 to 18 inches in thickness. Color of the A1 horizon is light reddish brown, reddish brown, brown, light brown, light brownish gray, grayish brown, pale brown, light yellowish brown, or yellowish brown. The A2 horizon is slightly lighter in color. Reaction ranges from medium acid to slightly acid. Gravelly phases have 0 to 30 percent gravel in this horizon. The B2t horizon is pale red, weak red, light red, red, light reddish brown, or reddish brown in color. Reaction ranges from strongly acid to slightly acid. The B3 and C horizons are reddish brown, yellowish red, or light red in color.

Travis soils, 1 to 5 percent slopes (TrC).—These soils occupy ridges and side slopes in a smooth, gently undulating topography. Areas are long and narrow and about 10 to 40 acres in size.

Some areas of these soils have the profile described as representative of the series. In eroded areas, however the surface layer is sandy clay loam. In some areas the surface layer is more than 14 inches thick, and in others it is loamy sand.

Included in mapping were small areas of Chaney soils. Another included soil has a reddish-brown clay loam lower layer. A few areas have up to 8 percent slopes. Inclusions of other soils range up to 40 percent of an area.

These soils are used mostly for pasture and range. They are suitable for cultivation, but the erosion hazard is moderate to moderately severe if surfaces are left bare. These soils are better suited to improved pasture, hay, or range. (Capability unit IIIe-6, pasture and hayland group 8C, Sandy Loam range site)

Travis gravelly soils, 1 to 8 percent slopes (TsD).—These soils occupy convex ridges adjoining side slopes high on the landscape. Areas are broad and irregular or long and narrow, and they range from 20 to 60 acres in size.

The surface layer is gravelly fine sandy loam about 18 inches thick. It is brown in the upper part and light reddish brown in the lower part. The next layer, to a depth of 50 inches, is red gravelly sandy clay. The underlying material, to a depth of 70 inches, is light-red gravelly sandy clay loam. In eroded areas the surface layer is sandy clay loam.

Included in mapping were small areas of Hornsby soils, soils that have more than 35 percent gravel in the lower layers, and a few soils that are underlain by gravel beds at a depth of less than 40 inches. A few other areas have a slope of as much as 10 percent. All inclusions make up 20 to 30 percent of the acreage.

This soil is used mostly for pasture or range. It is marginally suitable for crops because of its gravelly surface. It is better suited to improved pasture, hay, or range than it is to tilled crops. (Capability unit IVs-2, pasture and hayland group 8C, Gravelly range site)

Travis soils and Urban land, 1 to 8 percent slopes (TuD).—This undifferentiated group occupies high terraces. It consists of about 45 percent Travis soils, about 35 percent Urban land, and about 20 percent other soils. More than 95 percent of the acreage is gravelly.

Travis soils have a surface layer of gravelly fine sandy loam about 18 inches thick. It is brown in the upper part and light reddish brown in the lower part. The next layer, to a depth of 50 inches, is red gravelly sandy clay.

Few landscape alterations were made during urban development of this group, except in cutting streets to grade. Some of the soils have a thin imported surface layer of loamy or clayey materials.

The Urban land is mostly occupied by single-unit dwellings and streets, driveways, sidewalks, State institutions, shopping centers, and apartment complexes.

Some soil characteristics that affect urban construction are shrink-swell potential, as it affects structures; corrosivity, as it affects metal pipes; percolation rate, as it affects septic systems.

Information on use of the soils for urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Trinity Series**

The Trinity series consists of deep, somewhat poorly drained, clay soils on bottom lands. These soils occupy flood plains along major streams. Areas of these soils are long and narrow. Slopes are smooth and dominantly 0.25 to 0.5 percent. These soils developed under a cover of mid and tall grasses and an overstory of trees.

In a representative profile, the surface layer is 4Wdic-gray clay about 38 inches thick. The next layer, to a depth of 74 inches, is stratified clay, silty clay, and gravelly clay in shades of gray and brown. Mottled, light olive-gray silty clay underlies this layer to a depth of 96 inches. The soil is calcareous and mildly alkaline (plate III).

Trinity soils are very slowly permeable, and the available water capacity is high. These soils crack when dry.

Representative profile of Trinity clay, frequently flooded, in a pasture 400 feet south from Farm 5 Market Road 973, at a point 7 miles northeast of its junction with U.S. Highway 290.

A11—0 to 28 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, medium, granular structure in upper part, and coarse, angular blocky structure breaking to fine, angular, blocky in lower part; shiny pressure faces on peds; nonintersecting slickensides in lower part; extremely hard, very firm; calcareous; mildly alkaline; abrupt smooth boundary.

A12—28 to 38 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; coarse, angular blocky structure breaking to fine, angular blocky; shiny pressure faces on peds; nonintersecting slickensides; extremely hard, very firm; stratified irregularly with several thin ( $\frac{1}{8}$ - to  $\frac{1}{4}$ -inch) lenses of silty material, light brownish gray (10YR 6/2) dry; calcareous; mildly alkaline; abrupt, smooth boundary.

C—38 to 74 inches, stratified very dark gray (N 3/0), dark-gray (10YR 4/1), dark grayish-brown (10YR 4/2), and light brownish-gray (10YR 6/2) clay, silty clay, and gravelly clay; massive; extremely hard, very firm; strongly defined strata and bedding planes; calcareous; mildly alkaline; abrupt, smooth boundary.

IIC—74 to 96 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 5/2) when moist; common mottles of yellow and light brownish gray; massive; calcareous; mildly alkaline.

The A horizon is dark gray or very dark gray. Gray colors extend from a depth of 24 inches to more than 60 inches. Strata are gray, dark gray, light brownish gray, grayish brown, dark grayish brown, brown, dark brown, light yellowish brown, light olive brown, or olive brown.

The IIC horizon is olive-gray to light yellowish-brown silty clay and white chalk. Reaction ranges from mildly alkaline to moderately alkaline.

Trinity clay (Tv).—This nearly level soil occupies long, narrow areas that range from 10 to 150 acres in size. Slopes are smooth and dominantly 0.5 percent.

This soil has a surface layer of dark-gray clay about 45 inches thick. The next layer is gray, light brownish-gray and dark-gray, mottled clay.

Included in mapping were a few sloughs that carry floodwaters when the main stream leaves its banks. These flooded areas are less than 10 percent of any mapped area.

This soil floods once in 7 to 10 years. These floods are of short duration, and seldom cause scouring of the surface or crop damage, except in the sloughs.

This soil is used mostly for crops and pasture. It is well suited to crops. It is also well suited to improved pasture, hay, or range. (Capability unit IIw-1, pasture and hayland group 1A, Clayey Bottomland range site)

Trinity clay, frequently flooded (Tw).—This soil is on flood plains. Surfaces are concave, and the slope is dominantly about 0.5 percent. Individual areas are 100 to 400 feet wide and many miles long, and they cover hundreds of acres. This soil has the profile described as representative of the series. The flooding that occurs several times each year causes a continual change of scouring and depositional patterns.

Included in mapping were parts of some areas that are not flooded annually. Also included were parts of some areas that have a brownish surface layer caused by the recent deposition of sediments from the Heiden and Ferris soils. A few areas that drain the Crockett and Wilson soils are noncalcareous in the surface layer. All inclusions make up less than 15 percent of the acreage.

This soil is not suited to crops. It is well suited to improved pasture or a combination of pasture and orchards. It is also well suited to native grass range. (Capability unit Vw-1, pasture and hayland group 1A, Clayey Bottomland range site)

## **Urban Land**

Urban land (Ur) is in part of Austin. About 75 to 95 percent of the area is covered with such works and structures as the State capitol, office builds, hotels, railroad yards, multiple-unit dwellings, churches, schools, streets, sidewalks, and parking lots. Most of the sales, service, banking, professional, educational, entertainment, and educational functions of the city are concentrated in this area. About 10 or 15 percent of this unit is occupied by single-unit dwellings and their attendant works.

Installation of works and structures has so altered and obscured soil features that they do not resemble soils described in the various series. The original soils developed in limestone, chalk, and alluvium. (Not placed in a capability unit, pasture and hay land group, or range site)

Urban land and Austin soils, 0 to 5 percent slopes (UsC).—This nearly level to gently undulating undifferentiated group occupies smooth ridges and side slopes. It consists of about 60 percent an land, about 30 percent Austin soils, and about 10 percent other soils.

The more sloping areas are cut or filled to a depth of a few inches or up to as much as 2 feet, depending on slope. Although the original soils have been altered, the basic characteristics remain essentially the same.

Austin soils have a surface layer of very dark grayish-brown silty clay about 15 inches thick. The next layer, which extends to a depth of about 3 feet, is brown silty clay. The underlying material is partly weathered chalk.

Urban land is occupied by individual dwellings and adjoining streets, driveways, sidewalks, and ties, as well as small shopping centers and service stations and their paved parking lots.

The principal soil characteristics that affect urban development are shrink-swell potential, as it affects foundations and pavements; corrosivity, as it affects uncoated steel; and percolation rate, as it affects septic systems.

Information on use of the soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

Urban land, Austin and Brackett soils, 1 to 8 percent slopes (UtD).—This undifferentiated group occupies narrow ridges and side slopes. More than 80 percent of the acreage has slopes greater than 2 percent. The Urban land makes up about 40 percent the acreage; Austin soils, about 30 percent; Brackett soils, about 25 percent; and other soils, about 5 percent.

Austin soils have a surface layer of very dark grayish-brown silty clay about 15 inches thick. The next layer, which extends to a depth of about 36 inches, is brown silty clay. The underlying material is partly weathered chalk.

Brackett soils have a surface layer of light brownish-gray clay loam about 6 inches thick. The layer is light yellowish-brown clay loam about 8 inches thick. The underlying material is soft limestone.

About 85 percent of the soils have been altered by cutting and shaping during urban development. Cuts and fills range from a few inches to about 2 to 3 feet, depending on slope. In places, the chalk layer is exposed by this land shaping.

Urban land is mostly occupied by single-unit dwellings and adjoining streets, driveways, sidewalks, and patios. Within residential areas, along thoroughfares, business houses are concentrated in about a two-block wide area. This concentration of large buildings and paved parking lots make up less than 10 percent of the unit.

Some soil characteristics that affect urban development are shrink-swell potential, as it affects foundations and pavings; corrosivity, as it affects unprotected steel pipes; and percolation rate, as it affects septic systems. Information on use of soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

Urban land and Brackett soils, 1 to 12 percent slopes (UuE).—This undifferentiated group occupies narrow ridges and side slopes. It consists of about 40 percent Urban land, about 35 percent Brackett soils, and about 25 percent other soils.

Brackett soils have a surface layer of light brownish-gray clay loam about 6 inches thick. The next layer is light yellowish-brown clay loam about 8 inches thick. The underlying material is soft limestone.

In urban construction about 75 percent of the soils not already covered by structures are altered in leveling for building sites, cutting streets, or bulldozing off unwanted brush. Most cuts are 2 to 3 feet deep, and the excavated spoil is spread over adjoining surfaces. Many yards in the newer developments have 2 to 4 inches or more of loamy or other soil materials added to the surface layer.

The Urban land is mostly occupied by single-unit dwellings and adjoining streets, sidewalks, driveways, patios, and swimming pools. A few small shopping centers and service stations and their paved parking lots are included.

The main problems in use of the soils for urban development involve reshaping the soils and underlying limestone for foundations and trenching for utilities. Some important soil characteristics are corrosivity, as it affects uncovered steel pipes, and percolation rate, as it affects septic systems.

Information on use of the soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

Urban land and Ferris Soils, 10 to 15 percent slopes (UvE).—This undifferentiated group occupies rolling to hilly topography. It consists of about 40 percent Urban land, about 35 percent Ferris soils, and about 25 percent other soils.

Ferris soils have a surface layer of light olive gray clay about 36 inches thick that is mottled in the lower part. The underlying material is pale yellow silty clay.

In preparing areas for construction, gullies have been filled and smoothed and surfaces have been shaped. In places, as much as 2 to 4 feet of it has been removed from the original surface layer. In other places spoil from excavations has been spread back over the soil and has added considerable thickness to the original surface layer. Most yard surfaces have a 2- to 4-inch covering of imported soil materials.

Urban land is mostly occupied by single-unit dwellings and supporting streets, driveways, sidewalks, and patios. There are a few small shopping centers, service stations, and light manufacturing plants and their paved parking lots.

The use of this group for urban development is limited. Some of the soil characteristics that affect urban construction are shrink-swell potential, as it affects foundations and pavings; corrosivity, as it affects uncoated steel pipes; and percolation rate, as it affects septic systems.

Information on use of the soils in urban planning is given in sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Volente Series**

The Volente series consists of deep, well-drained soils that developed in slope alluvium. These soils occupy long and narrow valleys. Most valleys are 200 to 400 feet wide, but some are as wide as 1,000 to 1,500 feet. Slopes are concave and dominantly 2 to 7 percent. Volente soils developed under a cover of mid and tall grasses and a scattered overstory of trees.

In a representative profile, the surface layer is dark grayish-brown silty clay loam about 22 inches thick over dark-brown silty clay about 14 inches thick. The next layer is brown silty clay that extends to a depth of about 46 inches. The underlying material, to a depth of 54 inches, is reddish-yellow clay loam. The soil is calcareous and moderately alkaline.

The Volente soils are moderately slowly permeable, and the available water capacity is high.

Representative profile of Volente silty clay loam in an area of Volente complex, 1 to 8 percent slopes, in a pasture 100 feet west of Ranch Road 2222 from a point 3.2 miles southeast of junction with Ranch Road 620.

A11—0 to 22 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; strong, fine, subangular blocky and granular structure; hard, friable; many fine limestone fragments on surface, few within horizon; calcareous; moderately alkaline; clear, smooth boundary.

A12—22 to 36 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) when moist; moderate, fine and medium, subangular blocky and granular structure; hard, firm but crumbly; few fine fragments of limestone; calcareous; moderately alkaline; clear, smooth boundary.

B—36 to 46 inches, brown (7.5YR 5/4) silty clay; dark brown (7.5YR 4/4) when moist; weak, granular structure; hard, friable; few fine fragments of limestone; calcareous; moderately alkaline; clear, smooth boundary.

C—46 to 54 inches, reddish-yellow (5YR 7/6) clay loam, reddish yellow (5YR 6/6) when moist; massive, breaking to weak, fine, granular structure; very hard, friable; many fine limestone fragments and hard calcium carbonate concretions; calcareous; moderately alkaline.

Thickness of the solum ranges from 34 to about 50 inches. From a few to about 5 percent, fine, ( $\frac{1}{8}$  - to  $\frac{1}{4}$ - inch), broken pieces of limestone are common throughout the solum and C horizon.

The A horizon ranges from 20 to 39 inches in thickness. Color is brown, dark grayish brown, very dark grayish brown, or dark brown.

The B horizon ranges from 8 to 20 inches in thickness. Color is light brown, brown, light brownish gray, grayish brown, pale brown, light yellowish brown, or yellowish brown.

The C horizon is light reddish brown, reddish brown, reddish yellow, yellowish red, brown, light brown, grayish brown, very pale brown, pale brown, or yellowish brown in color.

Volente complex, 1 to 8 percent slopes (VoD).—This complex is mainly in long valleys, where it occupies areas several hundred acres in size. It also occurs in 10- to 20-acre areas at the foot of Brackett and Tarrant soils. This complex includes the soil that has the profile described as representative of the Volente series.

The Volente soils dominate in the valleys. They cover from about 40 percent of the narrow valleys to about 80 percent of the wider valleys. Altoga and Lewisville soils make up about 20 percent of this complex. There are also small acreages of Frio, San Saba, Tarrant, Purves, and Brackett soils, as well as Rock outcrop and Mixed alluvial land. The Lewisville, Altoga, and Brackett soils are mostly on upper slopes, and the San Saba, Purves, and Tarrant soils and Rock outcrop occur near drainageways. Frio soils and Mixed alluvial land are in the drainageways. The complex also includes a varying number of other soils.

Most of this complex is used for range, but parts of it are used for crops. The soils are easy to work, but the erosion hazard is severe. This complex is marginally suitable for crops. It is better suited to improved pasture, hay, or range. (Capability unit IVE-2, pasture and hayland group 7C, Deep Upland range site)

Volente complex, 1 to 8 percent slopes, eroded (VoD2).—This complex occupies long valleys. It also occupies foot slopes. It is similar to Volente complex, 1 to 8 percent slopes, except that it gullied and rilled. Sheet erosion has removed the uppermost 6 to 12 inches of soil in most places, and gullies 200 to 400 feet apart have exposed the C horizon in many other places. This complex is about 60 percent Volente soils, about 35 percent Lewisville and Altoga soils, and about 5 percent other soils. Areas of this complex are 20 to 40 acres in size.

Volente soils in this complex have a surface layer of very dark grayish-brown silty clay loam about 15 inches thick. In some rills and gullies, the next layer, which is brown silty clay, is exposed at the soil surface.

Most of this complex was once cultivated, but because of erosion it has been returned to grass-land. It is better suited to such grasses as improved pasture, hay, or range than to crops. (Capability unit IVE-2, pasture and hayland group 7C, Deep Upland range site)

Volente soils and Urban land, 1 to 8 percent slopes (VuD).—This undifferentiated group occupies valleys and foot slopes. It consists of about 45 percent Volente soils, about 20 percent Urban land, about 25 percent other soils, and about 10 percent Rock outcrop and Mixed alluvial land.

The Volente soil has a surface layer of dark grayish-brown calcareous clay loam about 22 inches thick. The next layer is brown calcareous silty clay that extends to a depth of about 46 inches. The underlying material is reddish-yellow calcareous clay loam.

The Urban land is mostly occupied by single-unit dwellings and adjoining streets, sidewalks, driveways, and patios. There are also several small shopping centers and service stations and paved parking lots. About one-fourth of the area that is not built up has been altered by cutting and filling. Most of this is on the steeper slopes, where spoil from site leveling is placed over the original surface. In other places a few inches of imported loamy materials have been added to the original surface.

Some of the soil characteristics that affect urban construction are shrink-swell potential, as it affects foundations and paving; corrosivity, as it affects unprotected steel pipes; and percolation rate, as it affects septic systems. There is a hazard of flooding in some drainageways.

Information on use of the soils in urban planning is given in the sections on engineering, community development, and recreational development. (Not placed in a capability unit, pasture and hayland group, or range site)

### **Wilson Series**

The Wilson series consists of deep, somewhat poorly drained soils that developed in calcareous Earls and alluvial clays. These soils occupy ridges, adjoining side slopes, and areas along drainageways. Slopes are mostly smooth and dominantly 0.5 to 2 percent. Wilson soils developed under a cover of tall grasses.

In a representative profile, the surface layer is gray clay loam about 6 inches thick. The next layer, about 28 inches thick, is very dark gray, blocky clay. The next lower layer, which extends to a depth of 60 inches, is light brownish-gray blocky clay. The Wilson soils are very slowly permeable, and the available water capacity is high.

Representative profile of Wilson clay loam, 1 to 3 percent slopes, in a cultivated field 501 feet south of a county road from a point 1 mile northeast of its intersection with the Blake-Manor Road, then 2.7 miles southeast of junction with Farm Road 973 at Manor.

- Ap—0 to 6 inches, gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) when moist; 1/4-inch surface crust is light gray (10YR 6/1) when dry; massive, crushing to weak, finer granular structure; very hard, friable; noncalcareous; slightly acid; abrupt, wavy boundary.
- B21tg—6 to 34 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, medium, blocky structure; streaks of material from Ap horizon in filled cracks; numerous clay films; extremely hard, very firm; noncalcareous; slightly acid; gradual, wavy boundary.
- B22tg—34 to 42 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) when moist; moderate, medium, blocky structure; streaks of gray in filled cracks; few brownish-yellow mottles; numerous clay films; extremely hard, very firm; scattered hard calcium carbonate and iron-manganese concretions; non-calcareous; mildly alkaline; gradual, wavy boundary.
- B3g—42 to 60 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; weak, coarse, blocky structure; extremely hard, very firm; scattered hard calcium carbonate and iron-manganese concretions; non-calcareous; mildly alkaline.

The A horizon ranges from 4 to 10 inches in thickness. It is dark gray, gray, grayish brown, and gray in color. Reaction ranges from slightly acid to neutral.

The B horizon ranges from very dark gray or gray in the upper part to dark gray and light brownish gray in the lower part. Reaction ranges from slightly acid in the upper part to mildly alkaline in the lower part.

Wilson clay loam, 0 to 1 percent slopes (WIA).— This soil occupies smooth, nearly level ridges. Areas range from long and narrow to broad and irregular. Slopes are single to complex and about 0.5 percent. Areas range from 15 to 75 acres in size.

The surface layer is gray clay loam 9 inches thick over dense gray clay about 30 inches thick. The next lower layer, to a depth of 60 inches, is light brownish-gray clay.

Included in mapping were similar soils that have a fine sandy loam or loam surface layer. In these soils the surface layer ranges from 5 to 10 inches in thickness, and the color is light brownish gray, grayish brown, pale brown, brown, or dark grayish brown.

This soil is used mostly for pasture or crops, and some areas are used for range. It is suitable for crops, but the choice of crops is limited. It is marginally suited to hay. It is better suited to improved pasture or range. (Capability unit IIIs-2, pasture and hayland group 7H, Grayland range site)

Wilson clay loam, 1 to 3 percent slopes (W1B).—S soil occupies smooth, gentle side slopes and convex ridges and concave areas along drainageways.

Areas range from 25 to 100 acres in size. This soil has the profile described as representative of the series.

About 7 percent of this soil has a surface layer fine sandy loam or loam. This surface layer is to 7 inches thick, and it is dark gray, gray, grayish brown, or dark grayish brown.

This soil is used mostly for pasture and crops. A few areas are managed as range. The erosion hazard is moderate where slopes are left bare. This soil is suited to only a limited number of crops, and it is marginally suited to hay. It is better suited to improved pasture or range. (Capability unit IIIe-3, pasture and hayland group 7H, Grayland range site)

## **Yahola Series**

The Yahola series consists of well-drained soils on bottom lands. These soils occupy long, narrow areas paralleling the river. Some areas are smooth; other areas, in the river bends, are channeled by numerous shallow drainageways. These soils developed under a cover of mid and tall grasses and an overstory of trees.

In a representative profile, the surface layer is s pale-brown, friable, very fine sandy loam 14 inches thick. The next layer is brown silt loam about 6 inches thick. The next lower layer is light brown very fine sand about 14 inches thick. Below this is brown silty clay loam about 6 inches thick, and is underlain to a depth of 52 inches by light-brown very fine sand. Below this very fine sand, to a depth of 60 inches, is brown silt loam.

The Yahola soils are easily worked. They are moderately rapidly permeable, and the available water capacity is high.

Representative profile of Yahola very fine sandy 110ham, in a pasture 0.2 mile north of Fallwell Lane from a point 2 miles northeast of its junction with Texas Highway 71.

- A1—0 to 14 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; moderate, fine, granular structure; hard, friable; calcareous; mildly alkaline; clear, smooth boundary.
- C1—14 to 20 inches, brown (7.5YR 5/2) silt loam, dark brown (7.5YR 4/2) when moist; massive, breaking to weak, fine, granular structure; hard, friable; mildly alkaline; clear, smooth boundary.
- C2—20 to 34 inches, light-brown (7.5YR 6/4) very fine sand, brown (7.5YR 5/4) when moist; massive; slightly hard, friable; visible bedding planes; calcareous; mildly alkaline; clear, smooth boundary.

- C3—34 to 40 inches, brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 4/2) when moist; massive, breaking to weak, fine, granular structure; hard, friable; visible bedding planes; calcareous; mildly alkaline; clear, smooth boundary.
- C4—40 to 52 inches, light-brown (7.5YR 6/4) very fine sand, brown (7.5YR 5/4) when moist; massive; slightly hard, friable; visible bedding planes; calcareous; mildly alkaline; clear, smooth boundary.
- C5—52 to 60 inches, brown (7.5YR 5/2) silt loam, dark brown (7.5YR 4/2) when moist; massive; slightly hard, friable; visible bedding planes; calcareous; mildly alkaline.

The A horizon ranges from 4 to 20 inches in thickness. Color is light reddish brown, reddish brown, light brown, brown, light brownish gray, grayish brown, pale brown, light yellowish brown, or yellowish brown.

Every profile has two or more strata of silty clay loam or silt loam; very fine sandy loam or fine sandy loam; or very fine sand, loamy fine sand, or fine sand.

The various strata are shaded in red and brown. Reaction ranges from mildly alkaline to moderately alkaline.

Yahola very fine sandy loam (Ya).—This soil occupies smooth, long and narrow areas that range from 10 to 100 acres in size. Most of this soil is on smooth, nearly level planes, but a few areas in narrow drainageways are on slopes of up to 2 percent. This soil has the profile described as representative of the series.

Included in mapping were areas where this soil is transitional to Norwood soils and the surface layer is silt loam. Where this soil is transitional to Lincoln soils, the surface layer is thin fine sandy loam overlying a substratum of fine sand. Also included were areas in the bottoms of drainageways where the surface layer is silty clay loam.

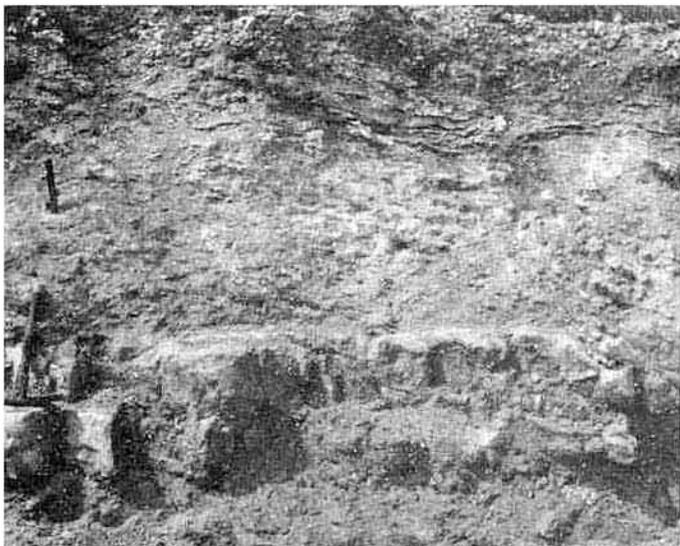
This soil is well suited to crops. It is also well suited to improved pasture, to a combination of pasture and orchard, to hay, and to range. (Capability unit I-2, pasture and hayland group 2A, Loamy Bottomland range site)

Yahola soils, channeled (Yh).—These soils occupy the bends of major rivers. Areas range from 40 to 150 acres in size. Overall, this soil is nearly level, but it is dissected by numerous inactive sloughs. These channels are 30 to 40 feet wide and 100 to 400 feet apart, and they have nearly level bottoms.

These Yahola soils have a surface layer of pale-brown fine sandy loam about 15 inches thick. The underlying material is stratified with layers of brown and light-brown loamy and sandy materials.

Soils in the bottoms of the sloughs have a surface layer of silty clay loam to silt loam 2 to 6 inches thick. Where Yahola soils are transitional to Lincoln soils, the surface layer is generally thin fine sandy loam over fine sand.

These soils are well suited to improved pasture, or to a combination of improved pasture and orchards. If they are to be used for crops, they need to be leveled to provide better moisture distribution and reduce differences in periods of growth and maturity of crops. These soils are also well suited to hay or range. (Capability unit I-2, pasture and hayland group 2A, Loamy Bottomland range site)



Profile of Brackett gravelly clay loam showing the underlying interbedded limestone and marl.



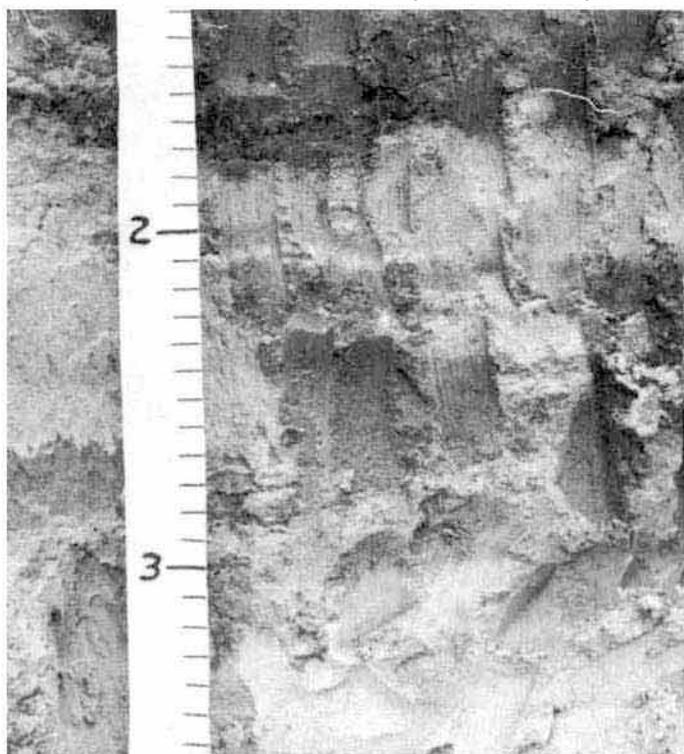
Gilgai microrelief on Houston Black clay, 0 to 1 percent slopes. The microlows are 12 to 18 inches below the microhighs.



Pecan orchard and pasture on Frio silty clay loam.



Surface chert rock makes this Houston Black gravelly clay difficult to cultivate.



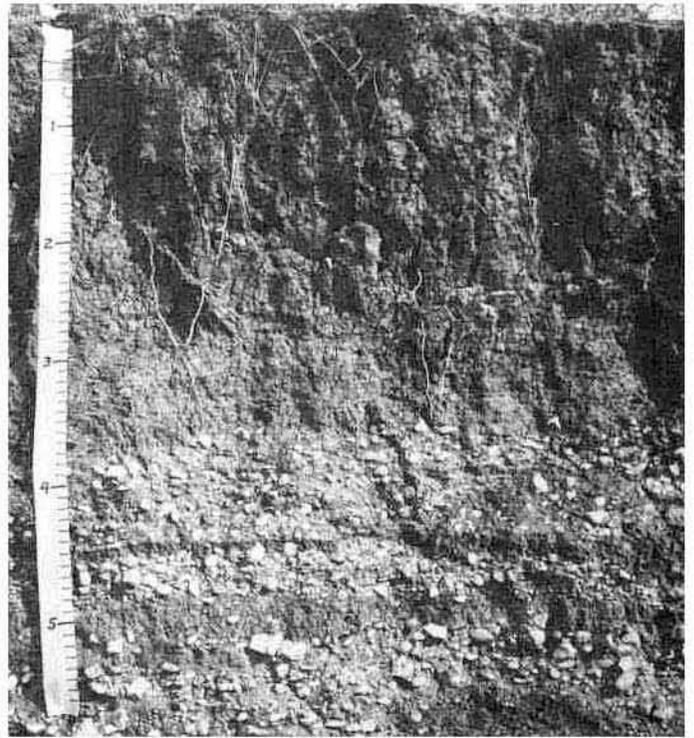
Profile of Lincoln loamy fine sand showing stratification.



View of Mixed Alluvial land.



An area of Riverwash. This land type is a source of sand and gravel



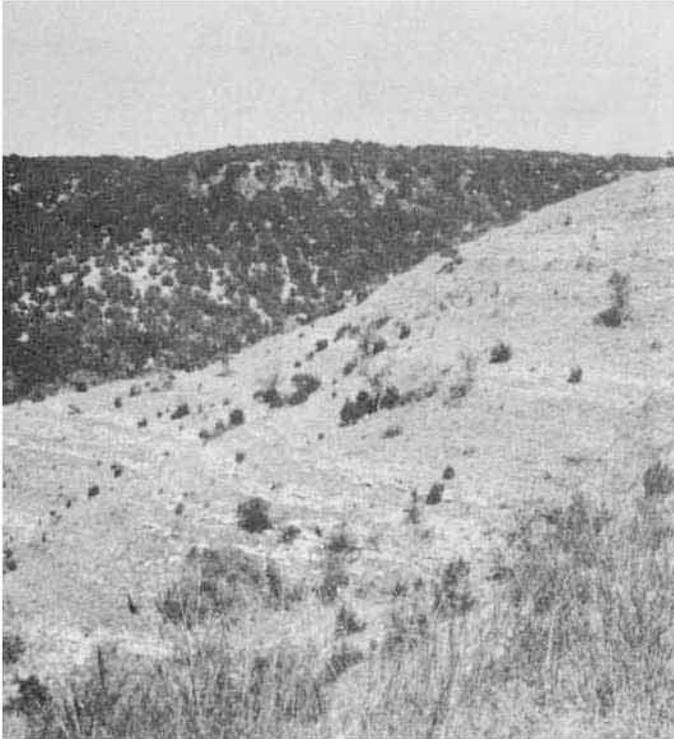
Profile of Trinity clay, frequently flooded, showing stratification.



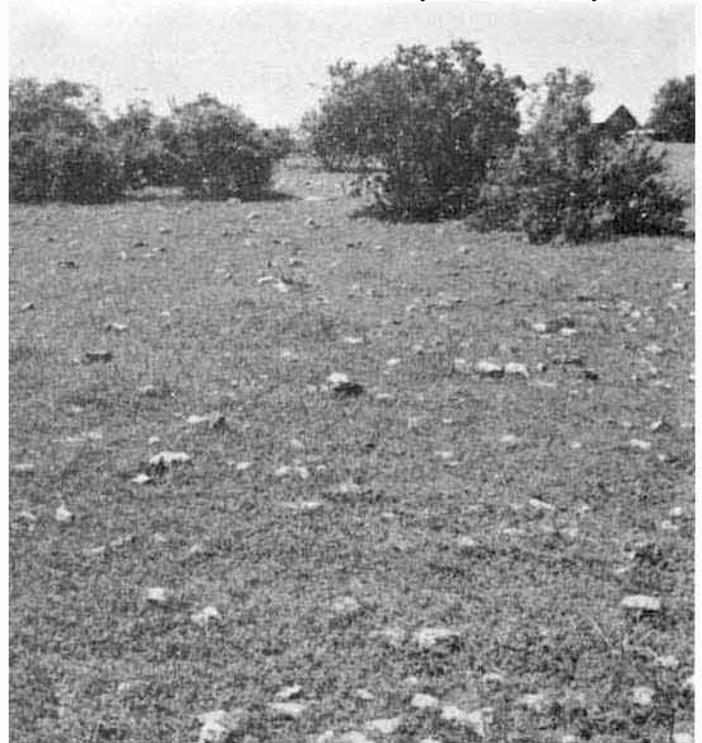
Terraces and contour farming on Houston Black clay.



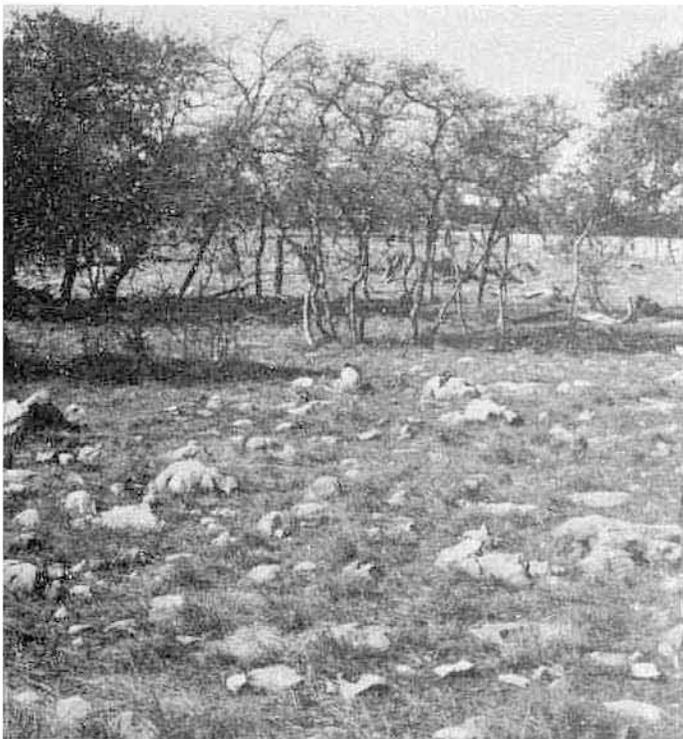
Residue from grain sorghum left on the surface of Houston Black clay.



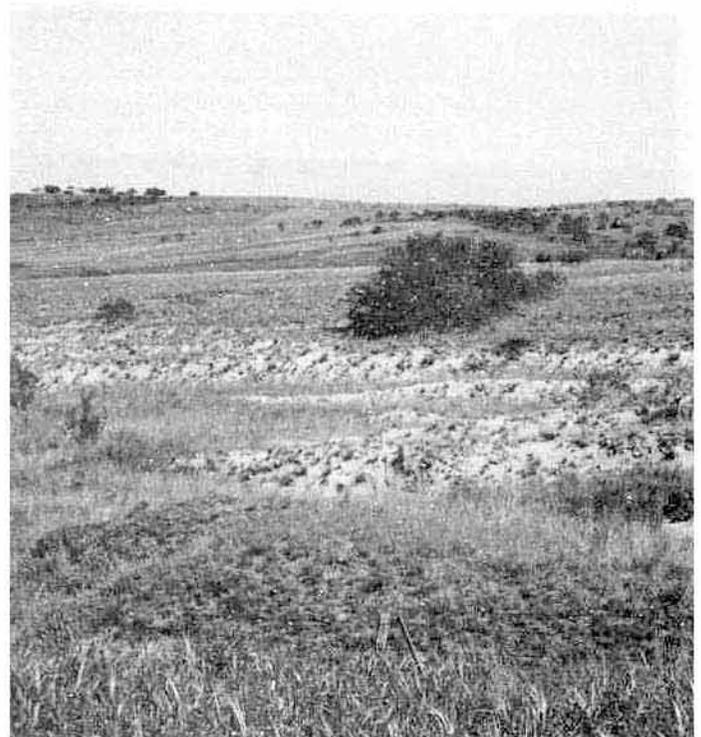
Adobe range site in good condition. The soil is Brackett soils, rolling.



Typical aspect of the Redland range site. The soil is Speck stoney clay loam, 1 to 5 percent slopes.



Rocky Upland range site in fair condition. The soil is Tarrant soils, rolling.



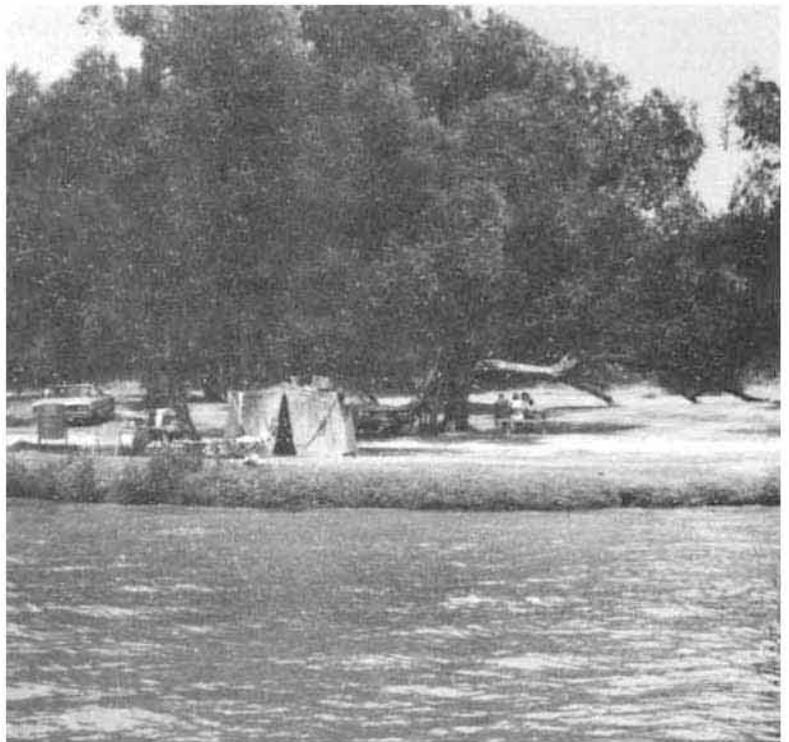
Rolling Blackland range site. The soil is Ferris-Heiden complex, 8 to 20 percent slopes, severely eroded.



Erosion on shaped but unprotected area of Ferris-Heiden complex, 8 to 20 percent slopes, severely eroded.



Construction failure on soils that have a high shrink-swell potential. Top, brick dwelling on Ferris clay; bottom, broken sidewalk on Houston Black clay.



Campsite on public campground along Lake Austin. The soils are of the Yahola series.

## USE AND MANAGEMENT OF THE SOILS

Major uses, limitations, and management needs of the soils in Travis County are described in this section. This includes use of soils for crops, improved pasture, range, and wildlife habitat, and in engineering works and urban development.

### Management of Cultivated Soils

<sup>2/</sup> Arthur L. Bell, conservation agronomist, Soil Conservation Service, Temple, Texas, helped prepare this section.

The need for proper management is apparent in many soils of the county that were once cultivated but are now so eroded, so deteriorated in structure, and so depleted of fertility that under present economic conditions they are no longer useful for cultivation. These soils are mostly in the eastern part of the county. Most of them have a cover of poor annual grasses and weeds and a brush overstory of either mesquite or desert willow.

The main objectives in managing cultivated soils are to control erosion and to maintain or improve tilth and fertility. A suitable cropping system helps to meet these objectives. A suitable cropping system includes in the rotation: (1) crops that leave a large amount of residue, such as grain sorghum or small grains; (2) grasses or legumes, such as KR bluestem or Madrid sweetclover; or (3) annual legumes, such as hubam sweetclover or winter peas, for cover and green manure. Unless managed correctly, these can be soil-depleting crops. Management must provide for sufficient growth so that adequate amounts of residue can be returned to the soil. These crops can be included in the rotation at irregular intervals, but they need to be fertilized consistently. The frequent use of soil-improving crops in the cropping system is considered minimum treatment.

Controlling erosion.—The control of erosion by water is the most pressing management need on cultivated soils in Travis County. The degree of erosion depends on the force with which raindrops detach the soil and the amount and velocity of runoff water.

These, in turn, depend on vegetative cover, texture and structure of the soil, and length and steepness of slope. Conservation practices, such as terracing into protected grassed waterways, contour farming, and producing and properly managing crop residue, help to control erosion.

Terracing.—Field terraces are designed to divide long, cultivated slopes into a number of short slopes. This reduces the velocity of the water, which in turn increases water percolation through the soil and reduces the amount of soil that is carried away in runoff. Gullying is stopped completely if terraces are maintained properly. Gullies that existed before terracing fill with soil, and the soil surface becomes smooth again. Parallel terrace systems, in which most terraces are equidistant from one another, are easy to cultivate and are used in many fields. Terraces are generally not used for grasses, but in places a large diversion terrace is needed to protect a lower lying field or to stop gullying. Terraces are not used on nearly level fields, except to break a concentration of water that could cause erosion.

Contour farming.—If soils are contour farmed, all terraced areas are plowed parallel to the terraces (plate III). Each contour row acts as a miniature terrace, particularly on bedded soils. Where soils are contour farmed, water velocity is greatly reduced, more water soaks in, and less soil and water are lost from the field.

Grassed waterways.—A close-growing cover of grass is needed to protect the soil from erosion in terrace outlets and other places where there is a concentration of water. Waterways are designed, shaped, and seeded or sodded 1 or 2 years before terraces are constructed. Usually this is enough time to establish a good cover of grasses.

Such species as bermudagrass effectively tie d the soil to control soil blowing and erosion. In many places waterways are used for hay or limited pasture, but care must be exercised to maintain, good cover of grasses at all times.

Management of residue.—To control erosion and maintain or improve soil condition, it is important to maintain soil cover and return adequate amounts of residue to the soil. Cover is usually a combination of seasonal growing plants and crop residue left on or near the surface. Such plants as cotton usually provide adequate cover during the growing season, but do not leave enough residue for soil protection and improvement. Cotton crops need to be followed by such cover crops as vetch or winter peas, or be part of a cropping system that includes, at regular intervals, crops that leave a large amount of residue.

Such crops as small grains and grain sorghum that produce a large amount of residue can furnish adequate cover if they are properly managed. While they are growing, they cover a substantial part of the soil. After the grain is harvested, a large amount of residue can be returned and left on the face (plate III).

Another valuable source of residue is cotton burs. These can be obtained from the gins and spread over the surface in large quantities.

Residue left on the surface furnishes shade that lowers soil temperature, which, in turn, reduces evaporation and improves conditions for bacteria and microanimals in the soil. Residue returned to the soil improves tilth and reduces compaction. The use of residue also results in better moisture infiltration, and, consequently, less runoff and loss of soil.

Additions of large amounts of stubble or straw residue often upset the carbon-nitrogen balance in the soil. This results in a lack of nitrogen for the soil bacteria and the succeeding crop, but this deficiency can be overcome by adding nitrogen fertilizer to the soil.

Tillage.—Soils should be plowed no more than is needed to prepare a seedbed and to control weeds. The structure of the soil is destroyed in the plow layer, particularly on clay soils that are plowed when they are too wet. Plowing causes the layer to become massive and dense, which reduces movement of air, water, and roots and increases runoff and erosion.

With the current development of weed-control chemicals and special equipment, the need for plowing is greatly reduced.

Maintenance of fertility.—Chemical tests reveal at most soils in Travis County are deficient in the primary minerals nitrogen and phosphorus, and a few sandy soils are also deficient in potash. Research shows no particular need for secondary or trace minerals. The degree of deficiency varies widely among soils, depending mostly on soil texture, past cropping history, and erosion.

Mineral deficiencies are corrected in several ways, including the application of commercial fertilizer or barnyard manure and the growing of green-manure legume crops.

The need for commercial fertilizer can be deterred by a chemical test of the soil. The amount needed depends on the soil, previous crop, crop to be fertilized, desired yield, season of the year, and available moisture capacity. If row crops are planted, apply fertilizer in a band below the seed alongside the growing plants. Banding is especially important if phosphorus is added to calcareous soils, because the practice reduces the amount of phosphate fertilizer that could go into an insoluble compound with the calcium in the soil.

Animal and green-legume manure and fertilized crops that leave a large amount of residue not only improve fertility but also increase the organic matter content of the soil. Because the supply of animal manure is limited, most farmers use commercial fertilizers on crops and legumes that leave a large amount of residue.

Irrigation.—There is enough rainfall in most years that irrigation is not needed. A number of surface and sprinkler irrigation systems are installed in the county, particularly along the Colorado River, but they are used mainly during excessively dry periods. The Colorado River water is of good quality, and most fields can be leveled and bordered for easy irrigation.

### **Capability Grouping**

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

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes. (None in this county.)

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

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

CAPABILITY UNITS are soil groups within the sub-classes. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the sub-class symbol, for example, IIe-3 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

### **Management by Capability Units**

In this section the capability units are described, and use and management are briefly discussed. The general treatments cited are minimum treatments to correct or reduce the problems of the soils in the capability unit. To find the names of the soils in any capability unit, refer to the "Guide to Mapping Units."

#### Capability Unit I-1

This nearly level unit consists of deep, well-drained soils in bottom lands and on low terraces. These soils have a surface layer of friable silty clay or silty clay loam. Permeability is moderate and moderately slow.

The available water capacity is high. The soils are easily worked, and surface crusts and plowpans are generally weak and ineffective in reducing plant growth.

Most of the acreage is used for cotton and grain sorghum, but some corn is also grown. This unit is well suited to cultivation.

Maintenance of tilth and fertility are the primary concerns in managing the soils for crops. There are several ways in which tilth and fertility can be improved. One way is to grow a crop that produces a large amount of residue; another way is to grow a cool-season legume.

#### Capability Unit I-2

This unit consists of deep, well-drained, nearly level soils in bottom lands and on low terraces. These soils have a surface layer of friable silt loam, fine sandy loam, and very fine sandy loam. Permeability is moderately rapid and moderate.

The available water capacity is high. These soils are easy to work, although crusts form on the surface. Plowsole layers also form under cultivation, but these are generally weak and ineffective in reducing plant growth.

This unit is mainly used for cotton and grain sorghum, but some corn is also grown. This unit is, well suited to the most intensive soil use.

Maintenance of fertility and improvement of tilth are the main concerns in managing these soils for crops. This can be done by growing a crop that produces a large amount of residue or by growing a cool-season legume. Plowpans, and surface crusting, particularly crusting of silt loams, are greatly reduced by soil-improving crops. The bottom-land soils that are dissected by numerous shallow drainageways need to be leveled for better moisture distribution.

#### Capability Unit IIe-1

This unit consists of gently sloping and gently undulating soils. These soils are moderately deep and deep clays. They are very slowly permeable, but are well drained or moderately well drained.

The available water capacity is high. These soils are difficult to work. When wet they are sticky, and when dry they are extremely hard and plow out cloddy. Dense plowsole layers form in cultivated areas and impede the downward movement of plant roots. In spite of these disadvantages, most of the soils in this unit are cultivated. Cotton and grain sorghum are the main crops, but corn and small grain are also suited.

In management of the soils for crops, the main objectives are to control erosion and improve tilth. One way, which includes terracing and contouring, is to grow crops that produce a large amount of residue, such as grain sorghum, in the rotation. Another way, without terraces, is to grow small grains in the rotation. These practices help control rilling or gulying and improve the tilth of the soils.

#### Capability Unit IIe-2

This unit consists of moderately deep to deep, well-drained, gently sloping soils. These soils have a surface layer of friable silty clay and silty clay loam. They are slowly to moderately permeable.

The available water capacity is high. These soils are easily plowed, and they crumble to form good seedbeds. The weak surface crusts and plowsole layers that form are generally ineffective in reducing plant growth.

This unit is used mainly for cotton and grain sorghum, but corn and small grain are also commonly grown. This unit is well suited to crops. The erosion hazard is moderate.

In managing these soils for crops, the main objectives are to control erosion and improve soil tilth. This can be done by terracing and by growing crops that produce a large amount of residue in the rotation. It can also be done, without terracing, by growing close-spaced small grain in the rotation. These practices reduce rilling or gulying to a minimum and improve the tilth of the soils.

#### Capability Unit IIe-3

Only one soil, Bergstrom silt loam, 1 to 3 percent slopes, is in this unit. This is a deep, well drained soil on low terraces. The surface layer is silt loam. This soil is moderately permeable.

The available water capacity is high. Light rain showers are effective in renewing plant growth. Mace crusts and plowsole layers have no appreciable effect on plant growth. The erosion hazard is moderate.

Cotton and grain sorghum are the main crops grown. This soil is well suited to crops.

In management of the soil for crops, the main objectives are to maintain tilth and fertility and control erosion. Most areas of this unit are too narrow for terracing. Growing fertilized small grain in the rotation is one way of controlling erosion, improving the tilth, and improving fertility.

#### Capability Unit IIe-4

This unit consists of deep, gently sloping soils that have a surface layer of clay or gravelly clay. These soils are very slowly permeable and moderately well drained.

The available water capacity of these soils is high. When wet, they are sticky and plastic, and when dry, they are extremely hard and plow out cloddy. Root movement is very slow, and it is even more restricted in the dense plowsole layers that form in cultivated areas. Surface crusts are common. The erosion hazard is moderate.

These soils are cropped mostly to grain sorghum and cotton.

Controlling erosion and improving tilth are the main objectives in management of the soils for crops. Most fields need terracing. Organic matter is needed to improve tilth. These objectives of management can be met in several ways. One method is to terrace and grow grain sorghum or small grain in the rotation. Another method, without terraces, is to grow continuous small grain or a close-spaced legume. Areas where water concentrates need to be seeded to a close-growing perennial grass. These practices help to control erosion and improve the tilth of the soils.

#### Capability Unit IIw-1

This unit consists of Trinity clay, a deep, nearly level, bottom-land soil. This soil is very slowly permeable and somewhat poorly drained.

The available water capacity is high. Parts of this unit receive extra runoff water from surrounding slopes. This soil floods on an average of once in every 7 to 10 years, but these floodwaters cover it for only a few days and seldom cause damage.

This soil is hard to work. It stays wet longer than adjoining similar but sloping soils. It is too sticky and gummy to plow when wet. When dry it is extremely hard and plows out in large clods that are slow to pulverize. Dense plowsole layers form in cultivated areas, and these further restrict the ordinarily slow movement of roots, water, and air through the soil.

In some areas native pecan trees grow in association with pasture.

In managing the soil for crops, the main objectives are to improve tilth and control erosion along the sloughs. Drainageways need to be sodded to bermudagrass or kept in broadcast crops. There are several ways of maintaining or improving tilth, such as to grow grain sorghum or a legume crop in the rotation. The action of roots and the organic residue from these crops helps to break up the plowsole layer.

#### Capability Unit IIw-2

This unit consists of deep, nearly level, moderately well drained soils that have a surface layer of clay. These soils are very slowly permeable.

The available water capacity is high. The soils in this unit are difficult to work. When dry, they are hard and plow out cloddy, and when wet, they are very sticky. Most cultivated areas have a dense plowsole layer.

Most of the soils of this unit are used for cotton, grain sorghum, and corn.

In management of the soils for crops, the main objectives are to maintain tilth and fertility. One way to do this is to grow grain sorghum or some other crop that produces a large amount of residue. Another way is to grow a legume crop in the rotation. If properly managed, these crops help to break up surface mists and plowpans.

#### Capability Unit IIs-1

This unit consists of deep and moderately deep, nearly level, well-drained soils that have a surface layer of clay. These soils are very slowly permeable.

The available water capacity is high. These soils are difficult to work. When wet, they are sticky, and when dry, they are extremely hard and plow out cloddy. Dense plowsole layers are common over most cultivated areas.

Most areas are cultivated. Cotton and grain sorghum are the main crops, and some corn also is grown.

The main objectives of management are maintaining tilth and fertility. There are several ways of doing this. One way is to grow crops that produce a large amount of residue, such as fertilized grain sorghum, in the rotation. Another way is to grow a legume crop in the rotation. These crops help to break up plowpans.

#### Capability Unit IIIe-1

This unit consists of gently sloping to sloping and gently undulating to gently rolling soils that have a surface layer of clay and gravelly clay. These soils are very slowly permeable, but they are well drained and moderately well drained.

The available water capacity is high. These soils are difficult to work. When wet, they are sticky and plastic, and when dry, they are hard and plow out cloddy. Dense plowsole layers are common in cultivated areas. The erosion hazard is moderately severe.

These soils are used mainly for grain sorghum and cotton.

In management of the soils for crops, the main objectives are to control erosion and improve tilth. These objectives can be met by several alternative cropping systems. On terraced fields, grow fertilized grain sorghum or small grain; or, without terraces, grow continuous small grain or a close spaced legume. Areas where water concentrates need to be seeded to perennial grass. All of these practices help control gullying and rolling, and also improve the tilth of the soil.

#### Capability Unit IIIe-2

This unit consists of gently sloping and gently undulating to gently rolling, well-drained soils that are moderately deep and deep. These soils have a surface layer of silty clay. Permeability is moderately slow, moderate, and slow. Most of the soils in this unit are gullied and rilled.

The available water capacity is high. These soils are easy to work, and they crumble to form good seedbeds. When dry, they are hard and plow out cloddy, but the soil lumps are pulverized by rains. The weak surface crusts and plowsole layers common to cultivated areas have only a moderate effect on root development and plant growth.

These soils are used mainly for grain sorghum and small grain, but corn and cotton are also grown.

In management of the soils for crops, the main objective is to control erosion. Lesser objectives are to improve fertility and soil tilth. Several cropping systems can be used to help control erosion and improve tilth. On terraced fields, a fertilized crop that produces a large amount of residue can be included in the rotation. If there are no terraces, a closely spaced cool-season legume can be grown. These practices help reduce erosion and improve the tilth of the soil.

#### Capability Unit IIIe-3

This unit consists of gently sloping and gently undulating, deep soils. The soils have a fine sandy loam and clay loam surface layer. Permeability is very slow and slow, and soils in this unit are somewhat poorly drained to moderately well drained.

The available water capacity is high. Root penetration is slow and difficult in the underlying layers. The surface layer is easy to cultivate, but in many places large lumps of the underlying layer are plowed out. These lumps pulverize slowly under natural conditions.

In management of the soils for crops, the main objectives are to control erosion, improve soil tilth, and improve fertility. Large additions of organic matter are needed to reduce surface crusting and to improve tilth. Terraces are needed. A cropping system is needed that includes a crop that provides a large amount of residue or a deep-rooted legume in the rotation.

#### Capability Unit IIIe-4

The only soil in this unit is Hardeman fine sandy loam, 2 to 5 percent slopes. This soil is deep, moderately rapidly permeable, and well drained.

The available water capacity is high. Root development is good throughout the solum. This soil is easy to cultivate, but cultivated areas are limited to small garden plots.

In managing this soil for crops, the chief objectives are to control erosion, improve fertility, and improve tilth. This can be done by adding fertilizer and growing closely spaced small grain year after year. If the soil is row cropped, a winter legume cover crop can be grown.

#### Capability Unit IIIe-5

This unit consists of gently sloping, shallow soils that have a clay loam or silty clay loam surface layer. These soils are slowly permeable to moderately slowly permeable, and they are well drained.

The available water capacity is low. The erosion hazard is moderate. These soils are easily worked, but deep plowing often brings up pieces of rock or gravel.

These soils are used for small grain, as well as for cotton, grain sorghum, and corn.

In management of the soils for crops, the main objectives are to control erosion, improve fertility; improve soil tilth. This unit can be terraced, in many places the amount of soil required to build terraces leaves little soil to farm between the terraces. One way to control erosion and improve fertility and tilth of the soils is to add fertilizer and plant a closely spaced crop that provides a large amount of residue.

#### Capability Unit IIIe-6

This unit consists of deep, well-drained, gently sloping and gently undulating soils that are slowly permeable to moderately slowly permeable. These soils have a surface layer of fine sandy loam.

The available water capacity is high. Soils in its unit are easy to work. The hazard of erosion is moderately severe.

The principal crops are small grain and grain sorghum. Most fields in this unit were once intensively cropped, but erosion has made this impracticable. The signs of erosion —gullies and a thin surface layer— are visible in many fields.

In management of the soils for crops, the main objectives are to improve fertility and control erosion. One way to do this is to terrace the soil, add fertilizers, and grow a cool-season legume in the rotation. Another way, without terracing, is to add fertilizers and grow closely spaced small grain year after year.

#### Capability Unit IIIe-7

The only soil in this unit is Altoga silty clay, 1 to 3 percent slopes. It is a deep, well-drained soil that has a silty clay surface layer.

The available water capacity is high. This soil is easily plowed and crumbles to form a good seedbed. The weak surface crust and the plowsole layer that forms in cultivated areas have no appreciable effect on plant growth. The erosion hazard is moderate.

Cotton and grain sorghum are the main crops. Corn and small grain are also grown.

In management of the soil for crops, control of erosion and improvement of tilth are the main objectives. These objectives can be reached in several ways. One way requires terracing and growing a crop that produces a large amount of residue. Without terraces, a closely spaced cool-season legume can be included in the rotation. These practices will improve tilth and hold erosion to a minimum.

### Capability Unit IIIs-1

Lincoln loamy fine sand is the only soil in this unit. It is a deep, rapidly permeable, somewhat excessively drained, nearly level to gently sloping soil on bottom land. The surface layer is friable loamy fine sand.

Cotton, corn, grain sorghum, and small grain are suitable crops.

The available water capacity is low. In management of the soil for crops, the main objectives are to conserve moisture and maintain fertility of the soil.

### Capability Unit IIIs-2

Only Wilson clay loam, 0 to 1 percent slopes, is in this unit. This soil has a surface layer of clay loam. It is very slowly permeable and somewhat poorly drained.

The available water capacity is high. Surface crusts and dense plowsole layers are common in cultivated areas. When dry, this soil is extremely hard. If the soil is plowed deep, large clods are plowed out in most places.

Some areas of this soil are used for grain sorghum and cotton. Small grain and corn are only marginally suitable.

In management of the soil for crops, the main objectives are to maintain fertility and improve tilth. One way to do this is to grow fertilized grain sorghum in the rotation. Another way is to add fertilizer and grow a deep-rooted legume. Residues of crops left on the surface help to minimize surface crusting. Channels left in the soil by decaying roots help speed up moisture penetration and improve aeration.

### Capability Unit IIIs-3

Only one soil, Dougherty loamy sand, 0 to 2 percent slopes, is in this unit. This soil has a surface layer of thick loamy sand. This soil is well drained and moderately permeable.

The available water capacity is moderate. This soil is easy to work, but only small areas are used for crops.

The few acres that are cultivated are in corn and vegetables. Grain sorghum is another suitable crop.

In management of the soil for crops, the main objectives are to improve the moisture holding capacity and to maintain fertility. One way this can be done is to add fertilizer and include in the rotation a crop that provides a large amount of residue. Another way is to add fertilizer and grow a cool-season legume. By adding organic matter, these crops help the soil hold more water.

### Capability Unit IVe-1

Heiden clay, 5 to 8 percent slopes, eroded is the only soil in this gently rolling unit. It is very slowly permeable and well drained.

The available water capacity is high. This soil is difficult to work. When wet it is sticky and plastic, and when dry it is extremely hard and plows out cloddy. The soil lumps are slow to pulverize under natural conditions. Dense plowsole layers develop in cultivated areas and further restrict the very slow movement of water, air, and roots through the soil. The erosion hazard is severe.

Cotton and grain sorghum are the main crops. Corn and small grain are also suitable and are sometimes grown on this soil.

In management of this soil for crops, the main objective is to control erosion. To improve tilth is also important. One way to meet these objectives is to build terraces and grow a fertilized crop that provides a large amount of residue. Another way, without a terrace system, is to add fertilizer and grow small grain year after year. These practices help control erosion and add to the organic-matter content and fertility of the soil.

#### Capability Unit IVe-2

This unit consists of gently undulating to gently rolling, deep to shallow, well-drained soils. These soils have a surface layer of silty clay or clay loam. Permeability is moderately slow.

The available water capacity is low to high. These soils are easy to work, but the hazard of erosion is moderately severe to severe. Many areas, particularly those once cropped, are gullied and rilled. A few areas are used for grain sorghum and stall grain. Cotton and corn are poorly suited.

Control of erosion is the main objective in management of the soils for crops, but improvement of fertility is also important. One way of doing this is to terrace the soil and grow a fertilized crop, such as grain sorghum, that provides a large amount of residue. Another way, without terraces, is to add fertilizers and grow small grain year after year. These practices help to control gullying and rilling, add organic matter to the soil, and add to natural fertility.

#### Capability Unit IVe-3

This unit consists of gently undulating, shallow to moderately deep, well-drained soils. These soils have a surface layer of silty clay, silty clay loam, clay loam, or clay. They are moderately permeable to moderately slowly permeable.

The available water capacity is low to moderate. These soils are easily worked and have good tilth, but deep plowing brings up rock or gravel in many places. The erosion hazard is moderate to moderately severe.

These soils are used mainly for small grain. They are also suitable for cotton, corn, or grain sorghum.

In management of the soils for crops, the main objectives are to control erosion, maintain fertility, and improve tilth. Although these soils can be terraced, the amount of soil required to build the terraces often leaves little soil to farm. If these soils are terraced, a fertilized crop that provides a large amount of residue, such as grain sorghum, should be included in the rotation. Without terraces, the soils need to be fertilized and have a cover of small grain every year. These practices help control erosion, add organic matter to the soils, and improve fertility.

#### Capability Unit IVe-4

This unit consists of gently sloping and gently undulating, deep, moderately well drained soils. The soils have a surface layer of fine sandy loam. They are very slowly permeable to slowly permeable.

The available water capacity is high. The erosion hazard is moderate to severe. Erosion has thinned the surface layer and created gullies over most areas of this unit.

This unit was once cropped, but most areas are now used for improved pasture or managed as range.

In management of the soils for crops, the main objectives are to control erosion and improve tilth. There are several ways of doing this. One way requires a terrace system and including in the rotation a crop of grain sorghum or some other crop that produces a large amount of residue. Another way, without terraces, is to grow closely spaced crops year after year.

#### Capability Unit IVe-5

Only one soil, Hardeman fine sandy loam, 5 to 12 percent slopes, is in this unit. This is a deep soil that has a surface layer of friable fine sandy loam. This soil is well drained, and permeability is moderately rapid.

The available water capacity is high. This soil is easy to work. Most of this unit, however, is being urbanized. Areas of this soil not already urbanized are in grassland. If this soil is irrigated, it has a good potential for grain or vegetables.

Improving fertility and soil tilth are the main objectives of management. This can be done by adding fertilizer and growing a closely spaced crop each year. Grass needs to be seeded in areas where water concentrates.

#### Capability Unit IVe-6

Pedernales fine sandy loam, 5 to 8 percent slopes, eroded is the only soil in this unit. This is a deep, moderately slowly permeable, well-drained, gently rolling soil. The surface layer is fine sandy loam. Erosion has thinned the surface layer and gullied most areas of this soil.

The available water capacity is high. This soil is easily worked, but the erosion hazard is severe.

This soil has a marginal suitability for crops. If crops are grown, management practices should be keyed to controlling erosion. There are several ways of doing this. If there is a system of terraces, a crop that produces a large amount of residue is suitable. Without terraces, the soil needs a continuous cover of closely spaced crops that produce a large amount of residue.

#### Capability Unit IVs-1

Eddy gravelly loam, 0 to 3 percent slopes, is the only soil in this unit. It is a very shallow to shallow, moderately slowly permeable, well-drained soil. The surface layer is gravelly loam.

The available water capacity is low. Plowing brings a large number of chalk fragments to the surface.

This soil is only marginally suitable for crops, but if it is cultivated, management should be keyed to controlling erosion. One way to do this would be to provide cover of closely spaced small grain year after year.

#### Capability Unit IVs-2

This unit consists of deep, gravelly soils that are gently sloping to gently undulating or gently rolling. The surface layer is gravelly fine sandy loam and gravelly loamy sand. The soils are slowly permeable to moderately slowly permeable, but they are well drained to moderately well drained.

The available water capacity is low to high. The gravelly surface layer is difficult to cultivate. Suitable crops are limited to small grain, which can be planted by broadcasting the seed.

Most of the acreage is in improved pasture or is managed as range.

The main concerns of management are improving fertility and soil tilth. A practical way to accomplish this is to add fertilizer and grow small grain year after year.

#### Capability Unit Vw-1

This unit consists of bottom-land soils that are flooded several times in most years. Soils in this unit are mostly deep, very slowly and moderately slowly permeable clays and silty clay loams. These soils are somewhat poorly drained to well drained. The available water capacity is high.

Loss of soil and crops because of flooding makes these soils unsuitable for cultivation. They are, however, well suited to improved pasture, hay, or range.

The main objective in managing these soils is to prevent scouring and consequent soil loss. This can be done by maintaining a good cover of perennial, grasses.

#### Capability Unit VIe-1

This unit consists of gently rolling to hilly, deep to shallow, well-drained to somewhat excessively drained soils. Most areas are severely eroded. These soils are very slowly permeable to moderately slowly permeable.

The available water capacity is low to high. Because the erosion hazard is severe on barren areas, these soils are not suitable for crops.

These soils are used for pasture or managed as range. They are well suited to improved pasture, hay, or native range grasses.

The main objectives in managing these soils are to control erosion and improve fertility. This can be done by adding fertilizers and maintaining a good cover of perennial grasses.

#### Capability Unit VIe-2

This unit consists of very shallow to moderately deep, moderately permeable to moderately slowly permeable, gently sloping to strongly sloping soils. These soils have a surface layer of gravelly loam or clay.

The available water capacity of these soils is low to moderate. In areas where the surface is left bare, the hazard of erosion is severe. These soils are not suitable for cultivation.

Soils of this unit are suitable only for pasture or range. In management for grazing, the main objectives are to control erosion and maintain fertility. This can be accomplished by adding fertilizers and keeping the soils under a cover of perennial grasses.

#### Capability Unit VIIs-1

This unit consists of nearly level to gently sloping and gently undulating to rolling, shallow and very shallow soils. These soils have a surface layer of clay loam, gravelly clay loam, stony clay loam, stony clay, or gravelly clay. Flaggy limestone or chert stones are on the surface.

The available water capacity is low. The soils in this unit are not suitable for crops or for improved pasture. They are suitable for range and wildlife habitat. These soils produce native range grasses for grazing livestock and they provide a natural habitat for wild game and birds.

In managing these soils the main objective is to maintain a good grass coverer

#### Capability Unit VIIIs-1

This unit consists of the undifferentiated group, Tarrant soils and Rock outcrop, steep. This is a very shallow, moderately steep and hilly, stony unit that occupies steep breaks and ravines along major rivers. The soils have a stony clay or stony clay loam surface layer.

The available water capacity is low. Because ordinary farm machinery cannot be used on this unit, it is not suitable for crops or for improved pasture. It is better suited to wildlife habitat. This unit is used for range, and it has a secondary use for wildlife.

The main management need is to maintain a good cover of perennial grasses.

#### Capability Unit VIIIs-2

This unit consists of Brackett soils, rolling. These are shallow soils. The surface layer is gravelly clay loam, gravelly loam, loam, or clay loam. The surface has a cover of soft limestone fragments.

The available water capacity is low. This unit is not suitable for crops or for pasture.

This unit is best suited to range or wildlife habitat. The main management need is to maintain a good cover of perennial grasses.

#### Capability Unit VIIIs-3

This unit consists of the undifferentiated group, Brackett soils and Rock outcrop, steep. These are shallow, hilly, gravelly soils. The surface layer is gravelly clay loam or gravelly loam. The surface has about a 75 percent cover of small pieces of limestone.

The available water capacity is low. This unit is not suitable for crops or pasture. It is better suited to range or wildlife habitat. The main management need is to maintain a good grass cover.

### **Predicted Yields**

Crop yields vary from one soil to another, but they all depend upon the tillth and fertility of the soils and a sufficient supply of moisture at planting time and during the growing season. Although rainfall cannot be controlled, the effects of it can. Soils can be managed, for example, to hold more water. Fertility can be added by applying inorganic manufactured fertilizer, and fertility and tillth can be improved by growing crops that produce high residue. Loss of fertility through erosion can be reduced by mechanical and agronomic practices.

Table 2 shows the predicted average yield per acre of the soils normally cultivated in the country. These predictions are for a high level of management based on records of experiment stations and on information from farmers and others familiar with the soils and their yields. The predictions for yield under a high level of management are based on the consistent use of the following management practices:

1. Crop residue is kept on or near the surface to control erosion and maintain tillth.
2. Regular large amounts of organic residue are added to the soils. Residue can be obtained from certain crops included in the rotation, or from grasses or legumes grown specifically for this purpose.
3. Maximum erosion control is obtained through mechanical and vegetative practices designed to reduce surface compaction, slow surface movement of water, and increase soil permeability.
4. Fertility is maintained in a proper relationship with the ability of the soil to supply moisture to the plants.
5. Control of insects, diseases, and weeds is timely and effective.
6. Improved crop varieties suited to the soils are grown.
7. Tillage is kept to a minimum, and is done only during times of optimum moisture conditions.

### **Use of the Soils for Range**

Range is land on which the natural plant community consists principally of grasses, grass-like plants, forbs, and woody plants valuable for grazing, and these plants are present in sufficient quantity to justify grazing. Nearly 342,000 acres, or about 51 percent of Travis County, is in such range.

Ranching and livestock farming are important enterprises in Travis County. Ranches are concentrated in the western part of the county, whom approximately 700 of them are primarily livestock operations. The average ranch is about 400 acres in size.

Most ranches have some cultivatable land in the 'valleys and in small upland patches. This land is used mostly for hay or such supplemental grazing crops as grain sorghum, small grains, and hybrid sorghum. These crops are used to supplement grazing on the native range.

There are few ranches in the rest of the county, but considerable acreage in small tracts is managed as range.

Livestock operations in the western part of the county include cow-calf, stocker cattle, and sheep-goat enterprises, and many ranches have two or more kinds of enterprise. Cow-calf enterprises are the most common, and several ranches specialize in breeding and selling purebreds and crossbreeds.

Raising goats is a favored enterprise on steep or brushy range. Animals are wintered on the native range, which is supplemented by hay, concentrated protein, or small grain.

Grassed areas managed as range in the eastern part of the county are mostly in mesquite brush, though some areas are in other brush and in hard-woods. Cow-calf operations are the most common enterprise on these ranches. Cattle are wintered on cool-season grasses and small grains, which are supplemented by hay and concentrated protein feeds.

The production of habitat for wild game birds and animals is a significant secondary use for range.

### **Range Sites and Condition Classes**

A range site is a distinctive area that differs from others in its potential to produce kinds or proportions of native plants or in its total annual yield. A site has a native plant community characterized by an association of species, and this plant community is different from that of all other sites. The association of species on a site has developed over a long period of time and is usually the most productive that the site and its climate can support. Differences in kinds and amounts of plants are important in some aspects of management, such as the stocking rate. Most range sites include several soils that have very similar vegetation and management needs.

Most of the native grass in the county has been heavily grazed for several generations. The type of plants that grew here in 1867, when settlers first moved into the western part of the county has changed.

Range condition describes the vegetation of a site in relation to the climax plant community for that site. Range condition classes reflect, in percentage, the degree of departure of the present plant composition from the potential for that site. Four range condition classes are used to indicate the percentage of vegetation that is the same as that of the original stand; excellent means 76 to 100 percent; good means 51 to 75 percent; fair means 26 to 50 percent; and poor means 0 to 25 percent.

Range condition classes are determined by measuring and grouping plants under their response to grazing on specific range sites. These groups of plants are decreaseers, increasers, and invaders.

Decreaser plants are species in the potential plant community that decrease in abundance under continuous moderately heavy grazing to heavy grazing. Decreaser plants are highly palatable, and livestock graze these in preference to others. Overgrazing of these more palatable species results in a decrease of these plants. The total of all such species is counted in determining range condition class.

Increaser plants are those species in the potential plant community that increase in abundance under moderately heavy grazing to heavy grazing. These increase in the plant population as the decreaseer plants become fewer. Some of these plants, more palatable than others, increase in kind and amount for a while, but decrease under continued grazing. Less palatable plants continue to increase in kind and amount under continued grazing. Only the percentage of increaser plants normally expected to occur in the potential plant community are counted in determining range condition.

The terms decreaseer and increaser indicate the initial response of a plant to continuous heavy grazing. Animals are selective grazers; they eat those plants they like best. Different kinds of grazing animals, however, prefer different forage plants. Hence, it is necessary to specify the kind grazing animal that exerts the grazing pressure when a plant is designated as a decreaseer or an increaser. Big bluestem, for example, is a decreaseer under continuous heavy grazing by cattle, but likely would be an increaser when grazed by goats or deer. The designation as used in this survey reflects the initial response of plants to grazing by cattle.

Invader plants are not native to the site. They usually come into the plant community as a result of a disturbance of the plant population. Disturbances are mostly in the forms of overgrazing, prolonged drought, fire, and bulldozing. Invader plants can be annuals or perennials and they can be grasses, weeds, or woody plants. They are not members of potential plant community. Although some have relatively high grazing value, most of them are worthless. Invader plants are not counted in determining range condition class.

Generally, the better the range condition class, the greater is the quality and amount of forage available for grazing.

A number of management practices are designed to improve a range or to keep it in a high condition class. Two of the key practices are proper grazing and deferred grazing. Proper grazing is the removal of no more than half, by weight, of the annual growth of the desirable grasses. Deferred grazing means simply not to graze the pasture. This is usually done during the maturity and reseeding cycle of grass growth, or the pasture is deferred or rested for an entire year. Ranges that have deteriorated to the good class can usually be restored by deferred grazing. Those deteriorated to fair class usually need deferred grazing, proper grazing, some reseeding, and possibly some brush clearing. Ranges in the poor usually need brush clearing, reseeding, deferred grazing, and proper grazing for restoration.

Although excellent condition range is the most productive, it is not necessarily the best home for wild game birds and animals. This is especially for prairie sites. As a result of the economic esthetic significance of wildlife, the management objective today need not be to restore a site to excellent range condition. The land users can manipulate the plant community to keep it in the intermediate stages of plant succession. These intermediate stages are usually fairly productive for domestic livestock, yet they provide good cover and food plants for game birds and animals.

3/

### **Descriptions of Range Sites**

3/ Technical range site information furnished by Bob R. Reagan, range conservationist, Soil Conservation Service, Austin.

Nineteen range sites are classified in Travis County. These sites consist of one or more soil types or phases of soil types. Soils in any given range site have about the same potential plant community and produce about the same amount of forage.

These range sites are described in the following paragraphs.

#### Adobe Range Site

This site is an open savanna. The soils are shallow gravelly clay loams underlain by limestone. Outcrops of limestone give this site a stairstep topography. The available water capacity is low. In many places, water seeps out of the soil along the limestone beds. Motts of live oak and Texas oak are widely scattered, and most of the vegetation grows on 100- to 500- foot wide benches between the rock outcrops (plate IV).

If this site is in excellent condition, the most common decreasers are little bluestem, sideoats grama, tall grama, hairy dropseed, and indiagrass. Increaser plants are such grasses as silver and pinhole bluestem, Lindheimer and seep muhly, and Wright three-awn and such forbs as orange zexmenia, bush sunflower, velvet bundleflower, and dotted gay feather, Woody increasers are evergreen sumac, kidneywood, and colubrina.

As the range condition deteriorates, it is invaded by puffsheath dropseed, Texas grama, red three-awn, prairie-coneflower, western ragweed, and queen's-delight, Texas persimmon, and agrito. Invasions of brush are also a sign of deterioration of this site.

If this site is in excellent condition, the total annual yield of air-dry forage is 3,500 to 4,500 pounds per acre, depending on rainfall. The forage is generally less palatable and nutritious than that grown on other sites. A phosphorus supplement, such as bone meal, should be supplied to livestock.

#### Bottomland Range Site

This site consists of narrow bands along streams. In this site gravel deposits and exposed limestone beds and boulders are randomly interspersed with alluvial lands. The soil material is calcareous and loamy. The site receives extra water as overflow, or as runoff from the higher lying areas.

This site is an open savanna that has a 20- to 25-percent canopy of elm, live oak, hackberry, and pecan trees. Because it is near water, this site has an abundance of large trees. It is a preferred grazing area and is generally the first site in a pasture to be overused.

If this site is in excellent condition, little bluestem, indiangrass, and Virginia wildrye usually are dominant in the understory. Big bluestem, switchgrass, and eastern gamagrass are other decreaser plants that occur in lesser amounts. Some increaser plants on the site are meadow dropseed, side-oats grama, feathery bluestem, vine-mesquite, Texas wintergrass, buffalograss, and climax forbs.

As the range condition declines, the site is invaded by three-awns, Texas grama, ragweed, snow-on-the-mountain, prairie coneflower, white crownbeard, broomweed, croton, mesquite, and other woody plants.

If this site is in excellent condition, the total annual yield of air-dry forage is 4,000 to 6,500 pounds per acre, depending upon rainfall and growing conditions.

#### Chalky Ridge Range Site

This site consists of soils that are clayey and loamy and underlain by chalk and gravel. The available water capacity is low to moderate.

If this site is in excellent condition, the decreaser plants are little bluestem, big bluestem, and indiangrass. Some increaser plants are such grasses as side-oats grama, silver bluestem, buffalograss, Wright three-awn, purple three-awn, and hairy dropseed, and such forbs as dotted gayfeather, Maximilian sunflower, and wild alfalfa.

As the range condition deteriorates, plants such as red grama, hairy grama, red three-awn, Texas grama, queen's delight, puffsheath dropseed, Texas croton, and burclover invade. Many deteriorated ranges have a scattering of mesquite, redcedar, and narrowleaf baccharis brush.

If this site is in excellent condition, the total annual yield of air-dry forage is 2,000 to 4,500 pounds per acre, depending on rainfall.

#### Clayey Bottomland Range Site

This site consists of bottom lands along streams. The soils are deep and clayey. Some of the areas are flooded regularly, and other areas receive additional runoff from adjacent slopes. The available water capacity is high. Except for a high density of trees adjacent to the streams, this is an open savanna that has a scattering of elm, hackberry, cottonwood, and native pecan trees.

If the site is in excellent condition, decreaser plants, such as sedges and Virginia wildrye, are dominant. Other decreaseers are switchgrass, indiangrass, rustyseed paspalum, and beaked panicum. Increaser plants are Texas wintergrass, vine-mesquite, meadow dropseed, longspike tridens, perennial forbs, and native woody plants.

As the range condition deteriorates, the site is invaded by buffalograss, sumpweed, blood ragweed, baccharis, winged elm, broomweed, prairie coneflower, snow-on-the-prairie, beebalm, eastern bitterweed, and maypop passionflower.

If this site is in excellent condition, the total annual yield of air-dry forage ranges from 5,500 to 7,500 pounds per acre, depending on rainfall.

#### Deep Upland Range Site

This site consists mostly of long, narrow valleys. The soils have a clay, silty clay, and silty clay loam surface layer. The available water capacity is moderate to high.

If this site is in excellent condition, it is dominated by decreaser grasses, such as little bluestem, big bluestem, indiagrass, switchgrass, plains bristlegrass, and Canada wildrye. Increaser plants are such grasses as silver bluestem, pinhole bluestem, side-oats grama, vine-mesquite, Texas wintergrass, buffalograss, tall dropseed, and hairy dropseed and such forbs as Maximilian sunflower and Illinois bundleflower.

As the range condition deteriorates, the site is invaded by hairy tridens, Texas grama, red three-awn, western ragweed, broomweed, fogfruit, and upright prairie coneflower. Mesquite, agrito, cedar, and Texas persimmon are other brushy invaders on deteriorated range.

If this site is in excellent condition, the total annual yield of air-dry forage is 4,000 to 7,500 pounds per acre, depending on rainfall.

#### Gravelly Range Site

This site consists of high terraces. The soils have a gravelly fine sandy loam and gravelly loamy sand surface layer. The available water capacity is high.

If this site is in excellent condition, such decreaser plants as little bluestem, indiagrass, beaked panicum, and purpletop are dominant. Some increaser plants are brownseed paspalum, hairy dropseed, fall witchgrass, silver bluestem, sideoats grama, tickclover, lespedeza, bush sunflower, and Maximilian sunflower.

As the range condition deteriorates the site is invaded by annual three-awn, windmillgrass, tumblegrass, croton, ragweed, some mesquite, lotebush, tasajillo, and retama.

If this site is in excellent condition, the total annual yield of air-dry forage is 1,500 to 3,500 pounds per acre, depending on rainfall.

#### Gravelly Loam Range Site

This site consists of ridges and broad, smooth r valleys. The soils are deep gravelly clays. The available water capacity is high. The site is a true prairie that has scattered oak and elm trees along the draws.

If this site is in excellent condition, decreaser grasses are little bluestem and indiagrass. Texas wintergrass, meadow dropseed, silver bluestem, and side-oats grama are the dominant increaser plants on the site. Perennial legumes and forbs, such as Engelmann daisy, Maximilian sunflower, sensitive brier, bundleflower, wild alfalfa, and prairie-clover, and sumac make up as much as 10 percent of the annual growth; oak, elm, elbowbush, and sumac make up about 5 percent.

As the range condition deteriorates, mesquite, winged elm, ragweed, broomweed, snow-on-the-prairie, croton, curlycup gumweed, Texas grama, and tumblegrass invade the site.

If this site is in excellent condition, the total annual yield of air-dry forage is 2,500 to 4,500 pounds per acre, depending on rainfall.

#### Grayland Range Site

This site consists of soils that are deep and very slowly permeable. The available water capacity high.

If this site is in excellent condition, little bluestem, indiagrass, big bluestem, Canada wildrye, and switchgrass are the main decreaser grasses. Some increaser grasses include vine-mesquite, side-oats grama, Texas wintergrass, silver bluestem, brownseed paspalum, tall dropseed, and meadow dropseed. Some increaser forbs are Maximilian sunflower and bush sunflower.

As the range condition deteriorates, the site is invaded mainly by Texas grama, red lovegrass, broomweed, windmillgrass, fogfruit, croton, and western ragweed. Mesquite, huisache, tasajillo, and pricklypear are other invaders.

If this site is in excellent condition, the total annual yield of air-dry forage is 2,000 to 6,000 pounds per acre, depending on rainfall.

#### Gullied Blackland Range Site

This site consists of areas that have been cultivated in the past. The clay soils are dissected by sheet, rill, and gully erosion. The available water capacity is high. Originally, this site was a true tall-grass prairie dominated by big bluestem and indiangrass. This climax vegetation, however, was destroyed by cultivation, and the potential plant growth was reduced by erosion.

If this site is in excellent condition, it is dominated by little bluestem and indiangrass and has lesser amounts of big bluestem, switchgrass, and Virginia wildrye. Several palatable forbs that are native to the site are Engelmann daisy, sensitive brier, bundleflower, wild alfalfa, and prairie-clover. Meadow dropseed, silver bluestem, side-oats grama, and Texas wintergrass are increasers on the site.

As the range condition deteriorates, invading grasses and forbs, such as tumblegrass, Texas grama, windmillgrass, three-awn, western ragweed, fogfruit, snow-on-the-prairie, and Eastern bitterweed, occupy the site. Woody plants, such as mesquite, skunkbush, hawthorn, sumac, bumelia, and pricklypear, are also common invaders on the site.

If the site is in excellent condition, the total annual yield of air-dry forage is 2,000 to 4,500 pounds per acre, depending on rainfall.

#### Loamy Bottomland Range Site

This site consists of bottom lands and adjacent low terraces. The soils are loamy and sandy. Extra water is received as runoff from adjacent slopes. The available water capacity is low to high. This site has an open canopy of cottonwood, pecan, elm, and hackberry trees.

If this site is in excellent condition, decreaser plants are principally sedges, rustyseed paspalum, Virginia wildrye, purpletop tridens, switchgrass, indiangrass, and little bluestem. Increaser plants are Texas wintergrass, nimblewill, twoflower melic, Carolina jointtail, and low varieties of panicum and paspalum. Several palatable forbs are native to the site.

As the range condition deteriorates, buffalograss, broomsedge bluestem, sumpweed, blood ragweed, broom weed, cocklebur, frostweed, and sunflower invade the site. Several woody plants, such as huisache, baccharis, winged elm, and greenbrier, invade and form dense thickets in many places.

If this site is in excellent condition, the total annual yield of air-dry forage is 5,000 to 7,000 pounds per acre, depending on rainfall and growing conditions. Because of the palatable and nutritious forage and large shade trees on this site and the proximity of the site to water, it is usually a preferred grazing area.

#### Redland Range Site

This site consists of shallow and moderately deep soils. In most places few to many stones are on the surface and within the soil (plate IV). The available water capacity is low to high.

If this site is in excellent condition, common decreaser plants are little bluestem, big bluestem, indiangrass, switchgrass, and Canada wildrye. The main increaser grasses are Texas wintergrass, buffalograss, side-oats grama, silver bluestem, pinhole bluestem, hairy dropseed, tall dropseed, purple three-awn, and Wright three-awn.

Palatable forbs and woody plants on the site include orange zexmenia, sunflower, sagewort, kidney wood, skunkbush, Texas oak, and live oak.

As the range condition deteriorates, the site is generally invaded by red three-awn, Texas grama, hairy tridens, tumblegrass, western ragweed, and broomweed. Other common woody invaders include mesquite, agrito, cedar, and persimmon.

If this site is in excellent condition, the total annual yield of air-dry forage is 3,300 to 5,500 pounds per acre, depending on rainfall.

#### Rocky Upland Range Site

This site consists of stony, shallow and very shallow soils. The vegetation is mostly mid and tall grasses, and about 20 percent of the site has a canopy of live oak trees. Large slabs and smaller pieces of limestone are on the surface (plate IV). The available water capacity is low.

If this site is in excellent condition, the most common decreaser plants include little and big bluestem, indiagrass, green sprangletop, and Canada wildrye. Increaser plants are such grasses as Texas wintergrass, buffalograss, side-oats grama, silver bluestem, pinhole bluestem, purple three-awn, Wright three-awn, hairy dropseed, and tall dropseed and such forbs as orange zexmenia, velvet bundleflower, and sagewort.

As the range condition deteriorates, it is usually invaded by hairy tridens, Texas grama, prairie-coneflower, western ragweed, silverleaf nightshade, tumblegrass, little barley, and burclover. Many deteriorated ranges have from a scattering to a dense stand of persimmon, scrub live oak, agrito, sumac, and some redcedar.

If this site is in excellent condition, the total annual yield of air-dry forage is 3,000 to 5,000 pounds per acre, depending on rainfall.

Many deer roam over this site.

#### Rolling Blackland Range Site

This site is a tall-grass prairie (plate IV). Soils on this site are clay loams, silty clays, gravelly clays, and clays. The available water capacity is low to high.

If this site is in excellent condition, decreaser grasses, such as little bluestem, big bluestem, indiagrass, switchgrass, Canada wildrye, and Virginia wildrye, are dominant in the plant population. Some increaser grasses are vine-mesquite, meadow dropseed, tall dropseed, Texas wintergrass, silver bluestem, pinhole bluestem, and side-oats grama. Dotted gayfeather, Englemann daisy, and Maximilian sunflower are a few of the increaser forbs.

As the range condition deteriorates, the site is invaded by broomweed, western ragweed, buffalograss, and Texas grama. Mesquite, huisache, cactus, and narrowleaf baccharis also invade when range condition deteriorates.

If this site is in excellent condition, the total annual yield of air-dry forage is 3,800 to 6,500 pounds per acre, depending on rainfall.

#### Rolling Prairie Range Site

This site consists of ridges, knolls, and benched slopes. The clayey, shallow soils are underlain by limestone. The available water capacity is low.

If this site is in excellent condition, little bluestem and indiagrass are the dominant decreaser plants and there are lesser amounts of switchgrass and big bluestem. Side-oats grama, tall dropseed, and silver bluestem are the main increaser grasses. Others are slim tridens, rough tridens, tall grama, Texas cupgrass, and buffalograss. Palatable forbs include gayfeather, Englemann daisy, Maximilian sunflower, wild alfalfa, bundleflower, black samson, prairie-clover, ratany, daleas, and sensitivebrier. Woody plants, such as live oak, hackberry, elm, elbowbush, and sumac, are also on this site.

As the range condition deteriorates, the site is invaded by Texas grama, hairy tridens, three-awn, broomweed, ragweed, stillingia, milkweed, and prickly-pear. As the range continues to deteriorate, rabbit tobacco, filaree, other annual grasses, and forbs, mosses, and lichens become the dominant ground cover.

If this site is in excellent condition, the total annual yield of air-dry forage is 3,000 to 5,000 pounds per acre, depending on rainfall and growing conditions. This site is a true prairie, less than 5 percent of which has a canopy of live oak trees. These trees are scattered and in motts on ridges and draws.

#### Sandy Loam Range Site

This site consists of deep soils that have a fine sandy loam surface layer. The available water capacity is high.

If this site is in excellent condition, little bluestem, indiagrass, beaked panicum, Virginia wildrye, and Canada wildrye are dominant in the plant population. Increaser grasses, such as brownseed paspalum, hairy dropseed, tall dropseed, pinhole bluestem, silver bluestem, and side-oats grams, are in most areas. Increaser forbs are tickclover, lespedeza, bush sunflower, and Maximilian sunflower.

As the range condition deteriorates, the site is invaded by annual three-awn, bullnettle, grassbur, red lovegrass, tumblegrass, windmillgrass, broomsedge bluestem, western ragweed, false indigo, croton, yankeeweed, and gummy lovegrass.

If this site is in excellent condition, the total annual yield of air-dry forage is 2,500 to 6,000 pounds per acre, depending on rainfall.

#### Sandy Range Site

This site consists of broad, nearly level to gently sloping ridges. The soil is deep, well-drained loamy sand. The available water capacity is moderate.

If this site is in excellent condition, such decreaser grasses as little bluestem, indiagrass, switchgrass, and beaked panicum dominate. Increaser plants are such grasses as brownseed paspalum, purple lovegrass, fringeleaf paspalum, tall dropseed, and fall witchgrass and such forbs as tickclover, lespedeza, bush sunflower, and Maximilian sunflower.

As the range condition deteriorates, the site is invaded by annual three-awn, broomsedge bluestem, red lovegrass, bullnettle, croton, and grassbur. Many deteriorated ranges have an infestation of huisache, mesquite, and retama.

If this site is in excellent condition, the total annual yield of air-dry forage is 2,400 to 5,000 pounds per acre, depending on rainfall.

#### Steep Adobe Range Site

This site is a savanna. The soils are shallow, gravelly clay loams underlain by limestone. Outcrops of limestone give the site a stairstep topography, and the benches between these outcrops are 15 to 20 feet wide. Because of steep slopes, a large part of the annual rainfall runs off this site. Other water is lost through seepage from the beds of limestone or the interbeds of limestone and marl. The available water capacity is low.

About 15 percent of this site has a canopy of Texas oak and live oak. Most of the vegetation grows on benches between the rock outcrops. Plants are generally less nutritious and palatable than those grown on other range sites. Because these plants are deficient in phosphorus, some such supplement as bonemeal needs to be supplied to livestock.

If this site is in excellent condition, the most common decreaser grasses are little bluestem, side-oats grama, tall grama, hairy dropseed, and indiagrass. Some increaser plants are such grasses as seep muhly, Lindheimer muhly, Wright three-awn, silver bluestem, and pinhole bluestem. Palatable climax forbs and woody plants on this site are orange zexmenia, velvet bundleflower, bush sunflower, dotted gayfeather, evergreen sumac, skunkbush sumac, and Lindheimer silktassel.

Under deteriorating range conditions, such low quality plants as puffsheath dropseed, red three-awn, red grama, and queen's-delight invade the site. Many deteriorated ranges are invaded by brush and, in many places, by crotons and sunflowers.

If this site is in excellent condition, the total annual yield of air-dry forage is 1,800 to 3,000 pounds per acre, depending on rainfall.

### Steep Rocky Range Site

This site consists of long, narrow ravines and other steep breaks. The very shallow soils are stony and clayey. Large slabs and smaller pieces of limestone are on the surface. The available water capacity is low. Many areas are wooded; the trees are mainly live oak and Texas oak.

If this site is in excellent condition, little bluestem, side-oats grama, green sprangletop and indiagrass are the main decreaser grasses. Increaser plants are such grasses as tall dropseed, hairy dropseed, purple three-awn, Wright three-awn, silver bluestem, pinhole bluestem, plains lovegrass, and Texas wintergrass and such forbs as Engelmann daisy, orange zexmenia, and Maximilian sunflower. Palatable forbs and woody plants native to the site include Engelmann daisy, orange zexmenia, bundleflower, Maximilian sunflower, bush sunflower, kidneywood, evergreen sumac, skunkbush sumac, and Lindheimer silktassel.

As the range condition deteriorates, the site is invaded by such less palatable and less nutritious plants as Canada thistle, prairie coneflower, golden aster, hairy tridens, and tumblegrass. Many deteriorated areas have varying amounts of persimmon and redcedar.

If this site is in excellent condition, the total annual yield of air-dry forage is 1,500 to 3,500 pounds per acre, depending on rainfall.

### Tight Sandy Loam Range Site

This site consists of high terraces. The soils are deep fine sandy loams that are slowly permeable. The available water capacity is high. The site is a savanna, about 20 percent shaded by an overstory of post oak and blackjack oak.

If this site is in excellent condition the understory is dominated by such decreaser plants as little bluestem, indiagrass, and purpletop. Oak and brownseed paspalum are the main increaser plants. Others are hairy dropseed, splitbeard bluestem, low paspalum, and panicum. Several palatable forbs that are native to the site are Engelmann daisy, bundleflower, sensitive brier, and prairieclover.

As the range condition declines, numerous plants invade the site. Among these are red lovegrass, rattail smutgrass, tumblegrass, baccharis, false indigo, broomsedge bluestem, ragweed, and eastern bitterwood.

If this site is in excellent condition, the total annual yield of air-dry forage is 2,500 to 4,500 pounds per acre, depending on rainfall.

## **Use of the Soils for Pasture and Hay**

Most farms in Travis County have some improved pasture, and some are used for a combination of crops and pasture. Some of the livestock farms are entirely in pasture. On others, cropland is used to produce crops that can be grazed or cut for hay and in this way supplement the grazing obtained from improved pasture. Improved pasture is also used to supplement range grazing. The acreage in improved pasture has steadily increased over the past two decades, and this trend is continuing.

## **Management of the Soils for Pasture and Hay**

Suitability of grasses to soils is the foremost consideration in developing a pasture. Careful consideration should also be given to the possibility of developing a year-long forage program by use of a combination of forage species. This program can include grazing both warm- and cool-season grasses during their season of growth, or wintering the animals on field-cured, warm-season species. One possible combination is to provide improved bermudagrass forage from May to November, and to provide weeping lovegrass, K. R. bluestem, or kleingrass-75 forage from November to May. If pasture is used with range, improved bermudagrass can be used for warm- season grazing and livestock can winter on field-cured native grasses and protein supplement.

Greater yields of higher quality forage can be had from all soils if fertilizer is applied in several split applications. Sustained high production is achieved only through proper management of both grass and soil. This includes fertilization, weed control, and regulation of grazing.

The need for fertilizer varies among different groups of soils, depending primarily upon the past use of the soil and erosion. Generally, all improved grasses on all soils benefit from applications of nitrogen and phosphorus. Most soils contain enough potash, except certain sandy soils and some shallow bamy soils. The kind and amount of fertilizer needed in relation to the plants to be grown and the desired yield is best determined by a chemical soil test. Fertilizers should be applied to the surface two or three weeks before grasses are seeded.

Controlling weeds reduces the competition for moisture, fertility, and growing space for the desirable grasses and legumes. This can be done by mowing.

Grazing needs to be regulated. One way to avoid undergrazing and overgrazing is to have proper distribution of livestock water. Another way is to have several pastures and rotate the grazing among them.

To maintain vigorous plants that provide for sustained production, grasses should not be grazed too short. The quick regrowth of various species of grasses after they are grazed and the amount of forage they provide depend on the amount of foliage left. For example, to obtain a quick, vigorous regrowth on KR bluestem or Coastal bermudagrass, a stubble height of 6 inches should be maintained. Common bermudagrass can ordinarily be grazed down to a 4-inch height before its quick regrowth is impaired. Supplementary grazing crops, such as sudangrass and small grain, are often grown on soils used for crops to provide seasonal forage and to avoid overgrazing the permanent pasture. To prevent compaction of soil surfaces, grazing should be restricted on soils that are wet.

### **Pasture and Hayland Suitability Groups**

The soils in Travis County have been 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 and to produce about the same yield. They have about the same limitations and hazards and have similar management problems. The pasture and hayland suitability groups in the county are identified by symbols, such as "7H."

#### **Pasture and Hayland Group 1A**

This group consists of somewhat poorly drained and well-drained bottom-land soils. The soils have a surface layer of clay. They crack and take in water rapidly when dry, but expand and are very slowly permeable when wet. The available water capacity is high. Some areas receive extra water from flooding.

Suitable grasses are such species as improved bermudagrass, common bermudagrass, johnsongrass, and kleingrass-75. Yields vary according to the level of management and the amount of rainfall. Under management that includes fertilization, good weed control, and strict control of grazing, about 6 to 9 animal-unit-months of grazing can be produced.

Johnsongrass and improved bermudagrass produce abundant nutritious hay. In most years several cuttings of hay, or about 4 to 6 tons per acre, can be produced.

#### **Pasture and Hayland Group 1C**

This group consists of well-drained bottom-land soils. These soils have a surface layer of silty clay or loam. The available water capacity is high. Plant roots can easily penetrate the soil. Some areas receive extra water from frequent flooding.

Suitable grasses are such species as improved bermudagrass, common bermudagrass, johnsongrass, and kleingrass-75. Under management that includes fertilization, grazing, and weed control, about 5 to 8 animal-unit-months of grazing can be produced in most years.

Such species as johnsongrass and improved bermudagrass produce abundant nutritious hay. In most years several cuttings of hay, or about 3 to 5 tons per acre, can be produced.

#### Pasture and Hayland Group 2A

This group consists of deep, loamy soil, ran bottom lands and low terraces. The available water capacity is high.

Suitable grasses are such species as improved bermudagrass, kleingrass-75, weeping lovegrass, indiagrass, switchgrass, and Kleberg, KR, Gordo, and Medio bluestems. Under management that includes fertilization, weed control, and regulation of grazing, this group produces about 4 to 7 animal-unit-months of grazing in most years.

Improved bermudagrass, kleingrass-75, weeping lovegrass, or johnsongrass are planted for hay. In most years several cuttings, or about 2 to 4 tons of hay per acre can be produced.

#### Pasture and Hayland Group 3A

The only soil in this group is Lincoln loamy fine sand. This soil is deep. Its available water capacity is low.

There are special hazards to establishing grasses by seeding. It is difficult to prepare a firm seedbed on this soil, and seedlings emerging from a clean seedbed can be cut down by blowing sand. Applications of a complete fertilizer of nitrogen phosphorus, and potassium are needed. They should be split and applied at intervals to keep soil moisture and fertility in balance and prevent loss of nutrients through leaching.

The choice of grasses is limited, because only the most drought-resistant grasses can be grown successfully on this soil. Under management that includes fertilization, weed control, and proper grazing, about 3 to 6 animal-unit-months of grazing can be produced in most years.

Improved bermudagrass is a suitable species for hay. In most years several cuttings of hay, or about 2 to 4 tons per acre, can be produced.

#### Pasture and Hayland Group 7A

This group consists of clayey soils that are gravelly in some places and eroded in other places. When dry, these soils crack and take in water rapidly; when wet, they expand and are very slowly permeable. They become puddled if grazed while they are too wet. The available water capacity is moderate to high, but penetration of plant roots is limited.

Suitable grasses are such species as improved bermudagrass, kleingrass-75, KR bluestem, and Kleberg bluestem. Under management that includes fertilization, weed control, and regulated grazing, about 5 to 8 animal-unit-months of grazing can be produced in most years.

This group produces good quality hay. In most years such species as johnsongrass and improved bermudagrass produce several cuttings of hay, or about 3 to 5 tons per acre.

#### Pasture and Hayland Group 7B

This group consists of clayey soils. These soils are mainly gullied, and some areas are gravelly. The available water capacity is high. Much of the rainfall runs off these soils if they are wet. If they are grazed when wet, these soils puddle, and runoff and erosion are increased.

Suitable grasses are such species as KR bluestem, improved bermudagrass, Kleberg bluestem, and kleingrass-75. Under management that includes fertilization, weed control, and regulated grazing, about 6 animal-unit-months of grazing can be produced in most years.

Improved bermudagrass is suitable for hay. In most years several cuttings of hay, or about 2 to 4 tons per acre, can be produced.

#### Pasture and Hayland Group 7C

This group consists of shallow to deep clayey and loamy soils. The available water capacity is low to high.

Suitable grasses are such species as improved bermudagrass, kleingrass-75, weeping lovegrass, indiagrass, switchgrass, and Kleberg, KR, Gordo, and Medio bluestems. Under management that includes fertilization, weed control, and regulation of grazing, about 4 to 7 animal-unit-months of grazing can be produced in most years. Such species as improved bermudagrass, kleingrass-75, and weeping lovegrass are suitable for hay production. Johnsongrass is suitable on the less sloping soils of this group. In most years several cuttings of hay, or about 2 to 4 tons per acre, can be produced.

#### Pasture and Hayland Group 7D

This group consists of clayey and loamy soils. The available water capacity is low to high. Some areas are gullied and need shaping before grass is seeded.

Grass species such as KR bluestem, weeping lovegrass, Kleberg bluestem, improved bermudagrass, and kleingrass-75 are suitable under management that includes fertilization, weed control, and regulation of grazing, about 3 to 6 animal-unit-months of grazing can be produced in most years.

Such species as improved bermudagrass and kleingrass-75 are suitable for hay production. Several cuttings of hay, or about 2 to 4 tons per acre, can be produced in most years.

#### Pasture and Hayland Group 7H

This group consists of loamy soils that are very slowly permeable and moderately well drained to somewhat poorly drained. The available water capacity is high.

Establishing grass is difficult because of crusting and rapid loss of surface moisture. In most places applications of a complete fertilizer of nitrogen, phosphorus, and potassium are needed. Suitable grasses are such species as improved bermudagrass, kleingrass-75, KR bluestem, and Kleberg bluestem. Under management that includes proper fertilization, weed control, and regulation of grazing, about 2 to 5 animal-unit-months of grazing can be produced in most years.

Such species as improved bermudagrass and kleingrass-75 are suitable for hay production. In most years about 2 to 3 tons of hay can be produced.

#### Pasture and Hayland Group 8A

This group consists of soils that have a sandy or loamy surface. Some areas are gravelly. The available water capacity is high. Permeability is slow to moderately slow. Most areas need a complete fertilizer of nitrogen, phosphorus, and potassium.

Grass species, such as improved bermudagrass, kleingrass-75, and weeping lovegrass, are suitable. Under management that includes fertilization, weed control, and regulation of grazing, about 3 to 6 animal-unit-months of grazing can be produced in most years.

Such species as kleingrass-75, weeping lovegrass, and improved bermudagrass can be used for production of hay. About 2 to 4 tons per acre can be produced in most years.

#### Pasture and Hayland Group 8C

This group consists of soils that have a surface layer of fine sandy loam. Some areas are gravelly. Permeability is moderately rapid to slow.

Suitable grasses are improved bermudagrass, kleingrass-75, and weeping lovegrass. Under management that includes split applications of fertilizer, weed control, and regulated grazing, about 5 to 8 animal-unit-months of grazing can be produced in most years.

Such grass species as improved bermudagrass, kleingrass-75, and weeping lovegrass can be used for hay production. Several cuttings, or about 3 to 5 tons per acre, can be produced in most years.

#### Pasture and Hayland Group 9A

Only Dougherty loamy sand, 0 to 2 percent slopes, is in this group. This soil is well drained and moderately permeable. The available water capacity is moderate. Root development is good throughout the soil.

Establishing grass is difficult. Split applications of complete fertilizers are needed to keep a good balance between soil moisture and fertility and to prevent loss of nutrients through leaching. A firm seedbed for planting grass seeds is difficult to prepare, and there is a danger of losing seed to the cutting action of blowing sand.

Grasses such as improved bermudagrass and weeping lovegrass are suitable. Under management that includes proper fertilization, weed control, and regulated grazing, about 4 to 7 animal-unit-months of grazing can be produced in most years.

Such species as improved bermudagrass and weeping lovegrass are suitable for hay production. Several cuttings, or a total of about 2 to 4 tons of hay per acre, can be produced in most years.

#### Pasture and Hayland Group 13A

This group consists of shallow soils overlying chalky limestone. These soils are silty clay, silty clay loam, and clay loam. The available water capacity is low. Permeability is moderately slow and slow.

If grasses are to be seeded, split applications of fertilizer are needed to keep a proper balance between the moisture supply and fertility of the soil. Such grasses as KR bluestem or Kleberg bluestem are suitable for grazing. Under management, that includes proper fertilization, weed control, regulated grazing, about 2 to 4 animal-unit-months of grazing can be produced in most years.

This group is only marginally suitable for hay.

#### Pasture and Hayland Group 14A

This group consists of well-drained, very shallow to shallow soils overlying chalk. These soils have surface layer of gravelly loam. The available water capacity is low, and permeability is moderately slow.

If grasses are seeded, split applications of a complete fertilizer are needed to keep a proper balance between soil moisture and fertility. Species such as KR bluestem, kleingrass-75, and Kleberg bluestem are suitable for grazing. Under management that includes proper fertilization, weed control, and grazing regulation, about 1 to 3 animal-unit-months of grazing can be produced in most years. This group is poorly suited to hay.

## Engineering Uses of the Soils<sup>4/</sup>

<sup>4/</sup> By Bronson C. Hanks, civil engineer, Soil Conservation Service, Austin.

This section provides information of special interest to engineers, contractors, farmers, and ranchers who use soil as structural material or as foundation material upon which structures are built. It gives information about those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties important in engineering are permeability, compressibility, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction. Information concerning these and related soil properties is furnished in tables 3, 4, and 5.

The estimates and interpretations of soil properties in these tables can be used in—

1. Planning and designing farm drainage systems, farm ponds, irrigation systems, diversion terraces, and structures for controlling water and conserving soil.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational areas.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works, especially those involving heavy loads or excavations deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms as they are used in soil science.

### Engineering Classification Systems

The two systems most commonly used in classifying soils for engineering purposes are the AASHO system adopted by the American Association of State Highway Officials (1) and the Unified system (10) used by the Soil Conservation Service, Department of Defense, and others.

AASHO system is used to classify soils according to those properties that affect use in highway construction. In this system, a soil is placed in one of seven basic groups, ranging from A-1 through A-7, on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing capacity, or the best soils for subgrade (foundation), and, in group A-7 are clayey soils that have low strength when wet, or the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are subdivided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, and A-7-5, A-7-6. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A-2 or A-4. Within each group, the relative engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are identified as coarse grained (GW, GP, GM, GC, SW, SP, SM, and SC); fine grained (ML, CL, OL, MH, CH, and OH); and highly organic (Pt). Soils on the borderline between two classes are designated by symbols for both classes; for example, CH-MH. The AASHO classification, with index numbers in parentheses, and the Unified classification of the soils in Travis County are shown in table 5. The test data shown in this table were derived from tests performed by the Texas Highway Department or samples collected by soil scientists in the county. Data in table 3 are ranges for the soil characteristics based on the data in table 5 and many field observations of the soil properties.

### Estimated Engineering Properties

Table 3 provides estimates of soil properties significant to engineering. The estimates are based on field classification and descriptions, test data given in table 5, test data from comparable soils in adjacent areas, and on detailed experience in working with the individual kinds of soil in Travis County.

Hydrologic soil groups give the runoff potential rainfall. Four major soil groups are used the soils are classified on the basis of water intake during storms of long duration that occur after prior wetting in areas that lack vegetation. These hydrologic soil groups are—

- A. (Low runoff potential.) Soils that have rapid infiltration rates even when thoroughly wetted. These consist chiefly of deep, well-drained to excessively drained sand or gravel. These soils have a rapid rate of water transmission in that water readily passes through them.
- B. Soils that have moderate infiltration rates thoroughly wetted. These consist 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.
- C. Soils that have slow infiltration rates when thoroughly wetted. These are chiefly soils in which a layer impedes the downward movement of water or soils that are moderately fine to fine textured. These soils have a slow rate of water transmission.
- D. (Rapid 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 soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

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

Permeability refers only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other impediments resulting from use of the soils were not considered.

Available water capacity (available moisture capacity) is the ability of soils to hold water for use by most plants. It is the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crops.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are given in the glossary.

Shrink-swell potential is an indication of the volume change to be expected in the soil material as the moisture content changes. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

## Engineering Interpretations

Table 4 contains information useful to engineers and others who plan to use soil material in the construction of highways, farm facilities, buildings, sewage disposal systems, and for other uses. Detrimental or undesirable features are emphasized. The ratings in this table are based on estimated engineering properties of the soils given in table 3; on available test data, including those in table 5; and on field experience. In general, the information applies to soil depths shown in table 3.

Topsoil designates a fertile soil or soil material, ordinarily rich in organic matter, used as topdressing for lawns, gardens, roadbanks, and the like. The ratings indicate suitability for such use.

Road subgrade or road fill is the soil material on which a subbase is laid and a pavement is built. Suitability ratings are based on the performance of the soil material as subgrade when it is excavated and compacted, or compacted and used in place. In general, sandy material containing adequate binder is the best.

Highway location is based on features of the undisturbed soil that reflect load-supporting capacity and stability of the subgrade and the workability and quality of cut and fill material.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that influence its capacity to support load and resist settlement under load and features that relate to ease of excavation. Engineers and others should not apply specific values to the estimates for bearing capacity of soils.

Septic tank filter fields are affected mainly by seepage, location of water table, and susceptibility to flooding. The degree of limitations and principal reasons for assigning moderate or severe limitations are given.

Sewage lagoons are influenced chiefly by seepage, location of water table, and slope. The degree of limitation and principal reasons for assigning moderate or severe limitations are given.

Farm pond reservoir areas are affected mainly by seepage, and the soil properties are those that influence such seepage.

Farm pond embankments serve as dams. They are affected by soil properties that influence the ease of excavation and compaction of embankment material.

Irrigation is affected mainly by slope, permeability, depth, and potential flooding that might wash out irrigation borders.

Terraces and diversions are affected mainly by cracking, depth of the soil for use in construction, and slope. These structures ordinarily are not used on some soils.

Waterways are shaped watercourses, covered with close-growing grasses that are used to carry off excess water from the terrace system. Soil properties that affect waterways are mainly cracking, available water capacity, structure, depth, slope, and erodibility.

Corrosivity of soils is rated at a depth of 4 feet. Among properties that affect corrosion of uncoated steel pipe are drainage, texture, acidity, resistivity, and conductivity. Properties that affect corrosion of concrete are mainly texture and reaction and the content of sodium, magnesium sulfate, and sodium chloride.

Some soils are a source of sand and gravel, and others are a source of rock that can be crushed for use in building roads. The quantity and quality of sand and gravel or rock can only be determined by onsite investigation. Patrick soils and Riverwash are particularly good sources of sand and gravel, and limestone can be mined from the Tarrant soils. Other possible sources of sand and gravel are the Altoga, Hornsby, Lewisville, and Lincoln soils, and Mixed alluvial land. San Saba and Speck soils are a source of limestone.

## Engineering Test Data

Table 5 contains the results of engineering tests performed by The Texas Highway Department on some of the soils in Travis County. The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

As moisture is removed, the soil shrinks and decreases in volume in direct proportion to the loss in moisture until a condition of equilibrium, called the shrinkage limit, is reached. At this point shrinkage stops, although additional moisture is removed. Shrinkage limit is reported as the percentage of moisture in oven-dry soil.

Lineal shrinkage is the decrease in one dimension of the soil mass that occurs when the moisture content is reduced from the liquid limit to the shrinkage limit. It is expressed as a percentage of the original dimension.

Shrinkage ratio is the volume change that results from the drying of soil material divided by the moisture loss caused by drying. It is expressed numerically.

Volume shrinkage is the volume change that occurs when the moisture content is reduced from the liquid limit to the shrinkage limit. It is expressed as a percentage.

Mechanical analysis shows the percentages, by weight, of soil particles that pass sieves of specified sizes. Sand and other coarser materials do not pass the No. 200 sieve, as do the finer silt and clay particles.

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 solid to plastic. If the moisture content is further increased, the material changes from plastic to liquid. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. 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.

## Use of the Soils for Community Development

Information about the suitability of the soils is important in planning urban development of all kinds. Decisions about the location of building sites, extension of utilities, and establishment of recreational facilities are better made if the basic facts about the soils are known. The more important limitations to use of the soils in urban development are discussed in the following paragraphs.

### Foundations

Shrink-swell characteristics of the soil need to be considered in designing a building foundation, particularly if piers are not used below the slab. Such clay soils as those of the Houston Black, San Saba, and Ferris series are particularly poorly suited to building sites. They swell when wet and shrink when dry. This shrinking and swelling exerts such pressure that walls and foundations crack unless they are specially reinforced, sidewalks and driveways crack, and streets and sidewalks deteriorate more quickly (plate V).

### Sewage Disposal Systems

The construction and proper functioning of septic systems is dependent on permeability, absorptive capacity, and depth and slope of the soils within the filter field. Also important are the ground water level and proximity to streams or lakes. The suitability of soils for individual home filter fields or for group sewage lagoons varies considerably.

### Areas Subject to Flooding and Erosion

The characteristics of a watershed are drastically changed when a substantial part of it is covered with pavement and buildings. Not only is the amount of runoff greatly increased, but also the drainage pattern is changed. Many areas in Travis County are unsuitable for building because of the hazard of flooding, but other areas become unsuitable as the density of buildings and pavement increases.

Erosion and pollution accompany increased runoff unless special efforts are made to control them. Erosion results from shaping building lots and cutting streets to grade. These fresh cuts, especially the deeper ones, erode very rapidly (plate V), and the soil is deposited in the street, where it becomes a traffic hazard or clogs the sewer system or eventually pollutes the nearest stream.

Establishing grass on cut banks and drainageways, erecting retaining walls, building drop inlets, and leveling benches are some ways of controlling urban erosion.

Potential flooding because of increased runoff pavement and buildings should be carefully considered in planning urban developments. Costly flood prevention projects or extensive relocation of flood victims can be avoided by using some kinds of soil for much-needed parks rather than for building sites.

### Underground Utility Lines

Water mains, gas pipelines, communication cables, and sewer pipes buried in the soil corrode to varying degrees and may actually break unless protected against certain electrochemical soil reactions (9).

The rate of corrosion depends on the type of buried material and on the physical, chemical, electrical, and biological characteristics of the soil. Corrosion is a moderate limitation to the burial of concrete in a few soils of Travis County, but it is a severe limitation to the burial of metal in many soils.

Stresses caused by volume changes in clay soils are strong enough to break cast iron pipes or to separate them at their joints. To prevent breakage, the pipes can be cushioned in a bed of sand. Cushioning in sand also increases oxygen supply around the pipe, reduces the number of anaerobic bacteria, and reduces the soil moisture that causes corrosion.

Gravelly and stony soils that have a high shrink-swell potential are limited in their use for iron pipes. In many places volumetric changes in the clay cause the gravel and stones to rub the protective coatings off iron pipes.

Limitations to use of the soils for installation of utilities can be foreseen and planned for if the nature of the material underlying the soils is known.

The information in this section is presented as general guidance to urban users of the soil survey. Because most urban tracts are very small and mapping detail is limited by the map scale, onsite investigation is needed, particularly if soils are to be used for foundations and septic systems. In the soils used for urban development, the common occurrence of surface compaction, concrete spillage, and buried pieces of brick, wood, and other foreign material is temporary or minor.

<sup>5/</sup>

### Landscaping and Gardening

<sup>5/</sup> The table in this section was prepared by Howard Locke, Landscape Section, Texas Highway Department, Austin, and William B. McCutcheon, conservation technician, Soil Conservation Service, Austin.

Natural shrubbery and trees are lacking in many places, and in others they are mainly destroyed in preparing sites for construction. Most homeowners landscape with flowers, shrubs, and trees. Most yard plants have a wide suitability, but some are suitable only for certain kinds of soil. Most soils in the county require some chemical or physical modification if the plants are to grow at their highest potential.

Table 6 rates the soils for landscaping and gardening. In it the soils are grouped according to surface texture, internal drainage, reaction, and thickness of rooting zone. Climatically suited commonly grown plants are listed, and the limitations to their growth in the various soils are cited. Native trees, shrubs, flowers, and vines that grow wild on the different soils and that are commonly used in local landscaping are also listed.

Although the available water capacity varies widely, the table assumes that plants will be watered according to their needs. It is also assumed that insects and plant diseases will be controlled.

The ideal soils for yard and garden plants are those that have a deep rooting zone, a loamy texture, a balanced supply of plant nutrients, adequate available water capacity, good internal drainage, and a granular structure that permits free movement of water, air, and roots.

Reaction of the soil is important to a degree. The intensity of acidity or alkalinity is expressed in pH values as follows: pH 7 is neutral; lower values indicate acidity; and higher values indicate alkalinity. Acid soils have more iron and aluminum than others, and alkaline soils are higher in calcium carbonate. Although most plants grow in most soils, some do not. Many plants show the lack of iron and other acidifying minerals through chlorosis of the leaves, stunted growth, and poor flowering. Availability of most plant nutrients and trace elements is influenced by soil pH. In particular, the important trace elements of boron, copper, zinc, iron, and manganese are reduced in availability as the pH approaches 8.0. The pH in soils can be lowered by adding elemental sulfur, sulfuric acid, iron sulfate (copperas), or aluminum sulfate. Application of barnyard manure or compost also reduces the pH. Some ammonium fertilizers, such as ammonium sulfate, also help reduce soil pH.

The kind and amount of fertilizer to apply is best determined by a soil test, but the fertilizer should at least contain nitrogen, phosphorus, and potassium.

Hard-to-work clayey surfaces can be mellowed by working in organic materials such as compost, peat moss, or grass clippings. Deeply placed organic material helps relieve internal drainage problems created by a dense clay subsoil.

## Use of the Soils for Recreation Facilities

More and more urban dwellers are turning to outdoor activities for recreation. Many recreational activities are already available in the county, and more will be added as the urban population grows. Many people use the four lakes in the county for sailing, skiing, scuba diving, or fishing. There are also a number of public picnic grounds near the lakes. Hunting for deer and turkey or for small game, such as squirrels and rabbits, is a popular sport. Camping grounds, golf courses, and riding stables are a few other kinds of outdoor recreation facilities available.

The nature of the soils affects the suitability of an area for recreational uses. Table 7 lists the soils in Travis County and shows the limitation of each for some of the principal recreational activities. These limitations are described as none to slight, moderate, or severe. The rating is determined by the most limiting factor, even if all other factors are favorable.

Campsites for overnight or week-long camping need to be on soils that do not require hard surfacing for parking and that have no hard layers to interfere with setting tent pegs. Load-bearing strength of the natural soil, as influenced by soil texture and soil moisture, is particularly important in this rating. Flooding, soil blowing or muddiness, slope, and stoniness are other factors used in rating the soils for campsites. Grass-covered, tree-shaded grounds are desirable (plate V).

Paths and trails include footpaths, hiking trails, and bridle paths. In making the rating, it is assumed that only enough natural vegetation is removed to provide a pathway, and that there are few, if any, excavations or fills along the pathway. Since a grass cover cannot be maintained on the pathway, puddling or soil blowing are particularly important soil features considered in the rating. Other important soil features include stony or gravelly surfaces, steep slopes, flooding, and erodibility.

Picnic areas are tree-shaded, park-like areas, complete with tables and cooking grills and readily accessible by automobile. It is assumed that vehicular traffic will be confined to access roads. Flooding, slope, texture of the surface, and amount of coarse fragments on the surface are considered in making the evaluation.

Playgrounds are natural soil areas to be used intensively as playing grounds for sports such as baseball, football, volleyball, soccer, and other similar organized games. Subject to intensive foot traffic, these areas need to be nearly level, have good drainage, and have a firm surface free of rock outcrops and stones.

## **Use of the Soils for Wildlife**

Travis County abounds in fish and game. Four large lakes in the county have a combined surface area of more than 22,000 acres and are stocked with fish. At least 90 percent of the hundreds of farm ponds are also stocked. In addition, the Colorado and Pedernales Rivers provide a steady supply of fish. Species include bass, sunfish, catfish, carp, crappie, Rio Grande perch, mullet, shad, carp, sucker, gar, darter, and drumfish.

The county is well supplied with white-tailed deer, and hunting is permitted both by gun and bow and arrow. Small animals hunted for meat, fur, or sport are rabbits, skunk, opossum, squirrel, raccoon, bobcat, coyote, and fox. Many armadillos live in the county, but they are seldom hunted. Many kinds of snakes are in the county; the rattle-snake is hunted for sport and meat. Many coveys of quail, dove, and wild turkey inhabit the uplands, and migratory ducks, geese, and other waterfowl frequent the lakes and farm ponds.

The soils of Travis County have been placed in three wildlife sites. Each consists of one or more of the soil associations. The soils differ in topography, productivity, vegetation, kinds of wildlife, and treatment needed to maintain or improve a desired wildlife habitat. In each site the topography and the wildlife food and cover are described, and the principal wildlife species are named.

### Wildlife Site 1

This site is coextensive with the Houston Black-Heiden, Austin-Eddy, Bureson-Wilson, and Ferris-Heiden associations. The soils are deep clays and loams. They are nearly level to moderately steep. Most of the cultivated soils in the county are in this site.

The native vegetation consists of mid and tall grasses and an overstory of brush and a few trees. Crops grown in the cultivated areas supply seasonal food for quail, doves, songbirds, and rabbits. Weeds and brush growing on cropland and in fence rows provide food and cover for rabbits, quail, and songbirds. Sufficient cover for wildlife is not always available on this site, especially in the large cultivated fields. Food is in good supply during certain periods. Water is available in most areas of this site, except in some of the larger cultivated areas.

The principal wildlife species are rabbits, quail, doves, and songbirds.

### Wildlife Site 2

This site is coextensive with the Bergstrom-Norwood, Travis-Chaney, and Lewisville-Patrick associations. The soils are deep loams and clays on terraces and bottom lands. Most of the soils are in pasture or are cultivated. Many areas that were formerly cultivated have been returned to grass or are idle.

The native vegetation is mostly tall and mid grasses with an overstory of cottonwood, pecan, elm, and hackberry. This site provides good food and cover for wildlife. Water is in good supply. Crops grown in cultivated fields provide food for wildlife for a part of the year.

The principal wildlife species are rabbits, squirrel, quail, doves, deer, and songbirds.

Wildlife Site 3

This site is coextensive with the Brackett, Tarrant, and Speck-Tarrant associations. The soils are loams and clays on uplands. The topography is marked by nearly level to steep ridges and knolls that have a well-defined drainage system. Most of this site is in native range.

The native vegetation consists of mid and tall grasses and an overstory of brush and oak trees. Food and cover are generally plentiful for most wildlife species in the county. Water is generally adequate.

The principal wildlife species are deer, rabbits, quail, doves, turkey, and songbirds.

## **FORMATION, CLASSIFICATION, AND MORPHOLOGY OF THE SOILS**

This section explains how soils form and what factors are involved in their formation. It describes briefly the system of soil classification and shows how the soils of Travis County have been classified.

### **Factors of Soil Formation**

Soil is produced by the action of soil-forming factors (7) on materials deposited or accumulated by geologic agents. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the plant and animal life on and in the soil; (3) the climate under which the soil material has accumulated and existed since accumulation; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have been active.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief.

The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. Usually, a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

6/

### **Parent Material**

6/ The geologic information in this section was furnished by Dr. Peter U. Rodda, Bureau of Economic Geology, University of Texas, Austin.

The soils of Travis County formed in several kinds of parent material. In the western part of the county, the parent material was mainly limestone, dolomite, interbedded limestone and marl, and clay. In the central part of the county, it was chalk, marl, limestone, and mainly limestone. In the eastern part of the county, it was clay, chalky marl, and silty clay. Along the Colorado River, the parent material was alluvium.

In the western part of Travis County, the soils formed in place over parent materials of Lower Cretaceous and Upper Cretaceous age. These are the Glen Rose Formation, Walnut Clay, Edwards Limestone, Georgetown Limestone, Del Rio Formation, and Buda Limestone of Lower Cretaceous age and the Eagle Ford Formation of Upper Cretaceous age.

The Glen Rose Formation is about 700 feet thick. It consists mostly of interbedded fine-grained, hard to soft limestone, mainly limestone, and dolomite. It is mostly thinly bedded in the upper part and forms a stairstep topography, which is less pronounced or even lacking in the more thickly bedded lower part. Soils of the Brackett series are dominant over the Glen Rose Formation.

Walnut Clay ranges in thickness from about 50 feet in the southern part of the county to 150 feet in the northern part. It consists both of fine-grained and medium-grained limestone that is mostly hard, and of mainly limestone and marl that is mostly soft and shows nodular weathering. Soils of the Tarrant series developed over the harder parts of this formation, and Brackett soils are dominant over the softer parts.

Edwards Limestone is 250 to 300 feet thick. It consists of hard granular limestone and dolomite and contains abundant chert nodules. It also contains substantial amounts of flaggy, fine-grain limestone. Soils of the Tarrant series are dominant over this formation, but many areas are made up of Speck or Crawford soils.

Georgetown Limestone is about 40 feet thick. It consists of interbedded hard, fine-grain limestone and softer, nodular, mainly limestone. Where the uppermost bed is soft limestone, the Eddy soils are dominant; and where the uppermost layer is hard limestone, soils of the Purves, Denton, and Tarrant series are dominant.

The Del Rio Formation is relatively narrow and about 70 feet thick. It consists of calcareous clay that contains an abundance of the ram's horn oyster shells. Soils of the Ferris and Heiden series are dominant over the formation.

Buda Limestone is about 40 feet thick. It consists of limestone that commonly has a reddish stain. This limestone is hard in the upper part and slightly less hard and somewhat nodular in the lower part. Tarrant and Purves soils are dominant over this formation.

The Eagle Ford Formation is about 35 feet thick. It consists of thin interbeds of clay, calcareous clay, sandy flaggy limestone, chalk, and bentonite. It is the parent material of the Stephen and Austin soils.

In the central part of the county, soils formed, over Austin Chalk and Taylor Marl of Upper Cretaceous age.

Austin Chalk is made up of the Atco, Vinson, Jonah, Dessau, and Burditt Formations. The Atco formation consists of chalk and marly limestone and the Vinson Formation is chalk. The Jonah Formation is limestone, the Dessau Formation is chalk, and the Burditt Formation is marl and marly limestone. These beds of chalk are generally about 350 feet thick. They are soft in the upper few feet and become increasingly harder as depth increases. They are extremely wavy. Chalk beds on ridges and knolls are generally wavy near the surface, and those on side slopes at a greater depth, but the waviness extends to near the surface in many places. Soils of the Eddy series formed on ridges; soils of the Austin and Brackett series formed on side slopes.

In the eastern part of the county, the soils formed over Taylor Marl and the Navarro Group of Upper Cretaceous age and the Midway Group of Paleocene age.

Taylor Marl has been further broken down into Bergstrom Clay, Pecan Gap Chalk, and Sprinkle Clay. These formations are about 700 feet thick. Sprinkle Clay and Bergstrom Clay consist of calcareous clay, and Pecan Gap Chalk is chalky marl. The Houston Black soil is dominant over Taylor Marl. An important feature of this geologic group and the soils above it is the high shrink-swell potential.

The Navarro Group is about 500 feet thick. It consists of Kemp Clay and Corsicana Marl. Kemp Clay is silty clay that contains a few discrete siltstone beds. Corsicana Marl is clay that has a prominent zone of calcareous concretion and a few discrete siltstone beds in the lower part. Heiden and Houston Black soils and their gravelly phases are dominant over Navarro Group.

The Midway Group consists of Wills Point Clay and Kincaid Formation. This group is about 600 feet thick, and consists mostly of glauconitic clay and other clay and minor amounts of sandy clay and sand. Only the Kincaid Formation is exposed in the county. Soils of the Wilson and Crockett series are dominant over Midway Group.

Along the Colorado River, the soils formed over alluvium of Recent and Pleistocene age. The underlying alluvial deposits contain large amounts of chert, quartz grains, cobblestones, and other rocks. These alluvial deposits range from a few feet to as much as 60 feet in thickness. Soils of the Travis series formed over gravelly alluvium of Pleistocene age; soils of the Norwood and Bergstrom series are of recent age.

### **Plants and Animals**

Plant and animal life are important in the formation of soils. The kinds and amounts of plants are determined partly by climate and parent material. The soils of Travis County developed mostly under mid and tall grasses and a scattered overstory of 30rdwoods. Decaying leaves, stems, and roots contain large amounts of organic matter to the soils and stained them dark. The physical action of growing roots and channels left after decay provide numerable channels for water and air. Animal life in the form of bacteria, actinomycetes, fungi, other micro-organisms, insects, and earthworms also contributed to the fertility and physical condition of the soils.

These processes of soil development continue, but at a greatly reduced rate. The cultivation of soils has reduced or completely destroyed the original plant cover. As a result, pore space for water and air movement is decreased, animal life is decreased, fertility is lowered, soil and water losses increase, and there is an invasion of undesirable brush and grasses. Earthworms and soil insects are in most grasslands in the county, but rarely in cultivated fields.

### **Climate**

Travis County has a humid, subtropical climate winters are usually short and mild; summers are long, with hot days and warm nights.

In winter precipitation is mostly in the form of persisting fogs, drizzles, and light showers. These contribute to low soil temperature, poor aeration of soils, and reduction of animal activity and plant growth. In spring, rains of short duration and high intensity retard soil development through erosion. During hot, dry summers the clay soils crack deeply, field subsequent rains wash the surface soil into the cracks. This constant mixing of soils prevents development of a B horizon.

The amount of rainfall is enough to leach the calcium carbonate from the upper horizons of some soils, but not enough to leach it out entirely. Most of the soils in the county have specks, threads, or nodules of calcium carbonate throughout the profile. In a few soils, most of the lime and plant nutrients are leached to a depth below the rooting cone, and clay particles have moved down to form very slowly permeable horizons.

### **Relief**

Slope and shape are characteristics that affect soil development by controlling drainage and runoff. If other factors of soil development are equal, profile development depends on the amount of water that enters the soil. Steep soils absorb less moisture and usually have less well-developed profiles than gently sloping soils. Depressions receive runoff water from adjacent slopes, and some soils in depressions are wet for long periods.

On some steep soils, runoff is so great that geologic erosion almost keeps pace with soil development. Soils that develop from the same kind of parent material, but in different positions on the landscape, are apt to have unlike profiles.

Distinctness of horizons within a profile and thickness of the solum are closely related to relief. Gently sloping soils generally have a thick solum and a distinct profile; steeper soils have a thinner solum and less distinct horizonation.

### **Time**

The degree of soil development that takes place through the interaction of parent material, plants and animals, climate, and relief depends upon time. Mature profiles that have well-defined, genetically related horizons developed only after long period of time.

Soils of the Travis series are well developed and have marked horizon differentiation. Soils of the Norwood series are younger and less developed.

### **Processes of Horizon Differentiation**

The differentiation of soil horizons is the result of several processes. These processes include (1) accumulation of organic matter, (2) but reaching of carbonates and salts, (3) reduction rate, transfer of iron, and (4) translocation of silicate clay minerals. In most soils more than one of these processes have been active in the development of horizons.

Accumulation of organic matter is important in the formation of the A horizon. The soils in the eastern part of the county have a dark surface layer that is high in organic-matter content. These soils formed under mid and tall grasses rich in organic-matter content. Other soils in the county formed under hardwoods or under a grassy savanna. Surface layers range from light to dark in color and from low to high in organic-matter content.

Considerable leaching of carbonates and salts has occurred in the Wilson and Crockett soils. Some leaching has also occurred in the Burleson soils because they do not have free lime in the upper part. Most soils in the county are only slightly leached. Houston Black clay, for example, has a thick A horizon that is high in carbonates. Leaching occurs so slowly in this soil that not enough time has passed for the removal of the carbonates.

Reduction and transfer of iron, or gleying, is evident in the poorly drained soils. Grayish colors in subsoil horizons indicate the reduction and loss of iron. Mottles of yellowish red or brown and iron-manganese concretions indicate iron segregation. The B horizon of the Crockett soils shows evidence of this process.

Translocation of clay minerals occurs in soils of the Travis and Chaney series. The B horizon has an accumulation of clay (clay films) in the pores and on the surface of peds. Carbonates and soluble salts were probably leached out before translocation of silicate clays took place.

### **Classification of the Soils**

The current system of soil classification was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and September 1968 (8). This system is under continual study, and readers interested in the development of the system should refer to available literature (2, 5). This system is used in table 8.

Table 8 shows the classification of each of the soil series in Travis County, according to the comprehensive system. Placement of some of the soil series in this system, particularly in families, may change as more precise information becomes available.

The current system defines classes in terms of observable or measurable properties of soils. The properties chosen are primarily those that permit the grouping of soils that are similar in genesis. The classification is designed to encompass all soils. It has six categories. Beginning with the most inclusive, these are the order, the suborder, the great group, the subgroup, the family, and the series (4). These are briefly defined in the following paragraphs.

**ORDER.**—Ten soil orders are recognized: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are generally those that tend to give broad climatic groupings of soils. Entisols and Histosols are exceptions; they occur in many different climates. Five of the ten soil orders are represented in Travis County: Alfisols, Entisols, Inceptisols, Mollisols, and Vertisols.

**SUBORDER.**— Each order is divided into suborders, primarily on the basis of characteristics that indicate genetic similarity. Mainly, these are characteristics that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation. The climatic range is narrower than that of the orders.

**GREAT GROUP.**— Each suborder is divided into great groups, on the basis of uniformity in the kinds and sequence of major horizons and similarity of the significant features of corresponding horizons. The horizons considered are those in which clay, iron, or humus has accumulated and those that have pans that interfere with the growth of roots or the movement of water. The features selected are the self-mulching properties of clays, soil temperature, chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like.

**SUBGROUP.**— Each great group is divided into subgroups, one representing the central (typic) segment of the group, and other groups, called intergrades, that have properties of one great 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 the range of any other great group, suborder, or order.

**FAMILY.**— Families are established within a subgroup primarily on the basis of properties that affect the growth of plants or the behavior of soils in engineering use. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

**SERIES.**— The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

## **Additional Facts About the County**

This section gives general information about Travis County. It discusses briefly the history and nature and climate of the county.

### **History**

Travis County was formed in 1840 from Bastrop County, and was formally organized in 1843 (3). It was named for William B. Travis, the commander of the Texans at the Alamo. Settlement actually began about 10 years earlier, and by 1839 Austin had been laid out and the first capitol of Texas built. Indian raids, buffalo hunts, and the establishment of State government were of primary interest at that time.

Most parts of the county were settled by the 1880's. The farmers settled on the prairies around Manor, Pflugerville, Cole, Elroy, and Littig between 1850 and 1894. They settled in the hill country in the vicinity of Bee Caves, Oak Hill, Cedar Valley, and Manchaca between 1867 and 1882. Some settled in the bottom lands of the Colorado River in the vicinity of Webberville and Garfield by 1837.

7/

## **Climate**

7/ By Robert B. Orton, State climatologist, National Weather Service, U.S. Department of Commerce.

Travis County is located astride the Balcones Escarpment, which separates the Texas Hill country of western Texas from the Blackland Prairie of eastern Texas. Elevations within the county range from 400 feet in the eastern part to 1,400 feet in the western part of the county. Native trees are cedar, oak, walnut, mesquite, and pecan.

The climate of Travis County is humid subtropical, and summers are hot. Table 9 shows the climatological summary of Travis County. Winters are mild, and below-freezing temperatures occur on an average of less than 25 days each year. Rather strong northerly winds accompanied by sharp drops in temperature occur in winter in connection with cold fronts, but cold spells rarely last more than 2 days. Daytime temperatures in summer are hot, but summer nights are pleasant, and the average daily minimum is in the low seventies.

Precipitation is fairly evenly distributed throughout the year. The largest amounts of rainfall occur late in spring, and there is a secondary peak in September. Precipitation from April through September usually takes the form of thundershowers, and fairly large amounts fall within short periods of time. Although thunderstorms and heavy rains occur in all months of the year, most of the precipitation in winter falls as light rain. August is the driest and hottest month. Snow is insignificant as a source of moisture, and it usually melts as rapidly as it falls. The county has had several seasons in succession with no measurable snowfall.

Prevailing winds are southerly throughout the year. Northerly winds that accompany the colder air masses in winter soon shift to southerly winds as these air masses move out over the Gulf of Mexico.

The average length of the growing season (freeze free period) is 270 days. Based on data from 1943 to 1961, the average date of the last occurrence of a temperature of 32° F. in spring is March 3; the average date of the first occurrence in fall of 32° is November 28. Previous records show that 32° or below has occurred as late as April 13 (1940), and as early as October 26 (1924).

Destructive winds and damaging hailstorms are infrequent. On rare occasions, dissipating tropical storms bring strong winds and heavy rains to the county.

## LITERATURE CITED

- (1) American Association of State Highway Officials.  
1970. Standard Specifications for Highway Materials and Methods of Sampling and Testing. Ed. 10, 2 v., illus.
- (2) Baldwin, Mark; Kellogg, Charles E.; and Thorp, James.  
1938. Soil Classification. U.S. Dept. Agr. Ybk. 979-4001, illus.
- (3) Barkley, Mary Starr.  
1966. History of Travis County and Austin, 1839-1899. Ed. 2, 388 pp., illus.
- (4) Simonson, Roy W.  
1962. Soil Classification in the United States. Science, v. 137, No. 3535: 1027-1034, illus.
- (5) Thorp, James and Smith, Guy D.  
1949. Higher Categories of Soil Classification: Order, Suborder, and Great Soil Groups. Soil Sci. 67: 117-126.
- (6) United States Department of Agriculture.  
1951. Soil Survey Manual. U.S. Dept. Agr. Handbook No. 18, 503 pp., illus., with 1962 supplement.
- (7) 1957. Soil. U.S. Dept. Agr. Thk. 784 pp., illus.
- (8) 1960. Soil Classification, A Comprehensive System, 7th Approximation. 265 pp., illus. (Supplements issued in March 1967 and in September 1968)
- (9) United States Department of Commerce.  
1957. Underground Corrosion. National Bureau of Standards Circular No. 579, 227 pp., illus.
- (10) United States Department of Defense.  
1968. Unified Soil Classification System for Roads, Airfields, Embankments and Foundations. MIL-STD-6198, 30 pp., illus.

## GLOSSARY

- Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.
- Alluvium.** Soil material, such as sand, silt, or clay, which has been deposited on land by streams.
- Available water capacity (also termed available moisture capacity).** The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.
- 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.
- 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.
- 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, 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. trains under very slight pressure.  
**Cemented.**—Hard and brittle; little affected by moistening.
- Depth, soil.** In this soil survey, the following depth classes are used:  
**Very shallow:** 3 to 8 inches of soil over bed-rock or other impervious layer that severely restricts growth of roots.  
**Shallow:** 8 to 20 inches of soil over bedrock or other impervious layer that severely restricts growth of roots.  
**Moderately deep:** 20 to 40 inches of soil over bedrock or other impervious layer that restricts growth of roots.  
**Deep:** More than 40 inches of soil.
- 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.

Flat cut. Cedar and other brush cut near the ground line and left lying on the surface where it fell.

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.

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.

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

0 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 0 horizon. This horizon is the one in which living organisms are at most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

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

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

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

Loam. The textural class name for a soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Marl. An earthy, unconsolidated deposit formed in fresh-water lakes that consists chiefly of calcium carbonate mixed with various amounts of clay or other impurities.

Mohs scale. A scale of hardness for minerals, in which 1 represents the hardness of talc; 2, of gypsum; 3, of calcite; and on up to 10, of diamond.

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

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

**Organic matter.** A general term for plant and animal material, in or on the soil, in all stages of decomposition. Levels reported for soils are for the decomposed stable forms, and are described as follows: Very low, 0.7 percent or less; low, 0.8-1.3 percent; medium, 1.4-2.2 percent; high, 2.3-4.0 percent; and very high, 4.0 percent or more.

**Parallelepipeds.** Six-sided prisms having faces that are parallelograms.

**Parent material.** Disintegrated and partly weathered rock from which soil has formed. to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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

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

**Plowpan.** A compacted layer formed in the soil immediately below the plow layer.

**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
Very strongly acid -----	4.5 to 5.0
Strongly acid -----	5.1 to 5.5
Medium acid-----	5.6 to 6.0
Slightly acid-----	6.1 to 6.5
Neutral-----	6.6 .to 7.3
Mildly alkaline -----	7.4 to 7.8
Moderately alkaline -----	7.9 to 8.4

**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.

**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.

**Slickensides.** Polished and grooved surface 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.

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

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—

platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. **Structureless** soils are either single grain (each grain by itself, as in dune sand) or massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

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

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

**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."

**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.

**Variant, soil.** A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believe to be justified.

# **NRCS Accessibility Statement**

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