SOIL SURVEY OF

# Bell County, Texas

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

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

Major fieldwork for this soil survey was completed in the period 1961-71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. 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 Central Texas and Little River-San Gabriel Soil and Water Conservation Districts.

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

# HOW TO USE THIS SOIL SURVEY

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

### Locating Soils

All the soils of Bell 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 number of the pasture and hay 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 that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

*Farmers and those who work with farmers* can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the pasture and hay groups, and the range sites.

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

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

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

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

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

*Newcomers in Bell County* will 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 and in the section on climate.

*Cover:* Terraces, contours, and grassed waterways used in conservation farming on Houston Black soils.

# Contents


| | Page |
|---|---|
| **How this survey was made** | 1 |
| **General soil map** | 2 |
| 1. Houston Black-Heiden-Branyon association | 3 |
| 2. Speck-Tarrant-Purves association | 3 |
| 3. Austin-Stephen-Altoga association | 3 |
| 4. Denton-Purves association | 3 |
| 5. Trinity-Frio-Bosque association | 4 |
| 6. San Saba-Crawford association | 4 |
| **Descriptions of the soils** | 4 |
| Altoga series | 5 |
| Austin series | 6 |
| Axtell series | 7 |
| Bastrop series | 8 |
| Bosque series | 8 |
| Brackett series | 9 |
| Branyon series | 10 |
| Burleson series | 11 |
| Chigley series | 12 |
| Crawford series | 13 |
| Denton series | 13 |
| Eddy series | 14 |
| Ferris series | 16 |
| Frio series | 16 |
| Heiden series | 17 |
| Houston Black series | 19 |
| Krum series | 20 |
| Lewisville series | 22 |
| Lindy variant | 23 |
| Menard series | 23 |
| Patrick series | 24 |
| Payne series | 24 |
| Pedernales series | 25 |
| Purves series | 26 |
| Real series | 27 |
| Riesel series | 27 |
| San Saba series | 28 |
| Speck series | 29 |
| Stephen series | 29 |
| Tarrant series | 30 |
| Trinity series | 31 |
| Urban land | 32 |
| Venus series | 32 |
| Wilson series | 33 |
| **Use and management of the soils** | 34 |
| Use of the soils for crops | 34 |
| Capability grouping | 34 |
| Use of the soils for pasture and hay | 40 |
| Pasture and hay groups | 40 |
| Predicted yields | 42 |
| Irrigation | 43 |
| Range | 43 |
| Range sites and condition classes | 43 |
| Descriptions of the range sites | 44 |
| Wildlife | 48 |
| Recreation | 51 |
| Engineering uses of the soils | 54 |
| Engineering classification systems | 55 |
| Estimated properties | 55 |
| Engineering interpretations | 66 |
| **Formation and classification of the soils** | 69 |
| Factors of soil formation | 69 |
| Climate | 69 |
| Living organisms | 69 |
| Parent material | 69 |

Relief ---------- 70
Time ---------- 70
Processes of horizon differentiation ---------- 70
Classification of soils ---------- 70
**Climate** ---------- 72
**Glossary** ---------- 73
**Guide to mapping units** ---------- Following 75

Issued March 1977

# SOIL SURVEY OF BELL COUNTY, TEXAS

BY JOHN W. HUCKABEE, JR., DAVID R. THOMPSON, JIM C. WYRICK, AND E. G. PAVLAT, SOIL CONSERVATION SERVICE

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

BELL COUNTY is in the east-central part of Texas (fig. 1). It has a total area of 690,560 acres, or 1,079 square miles. Belton is the county seat.

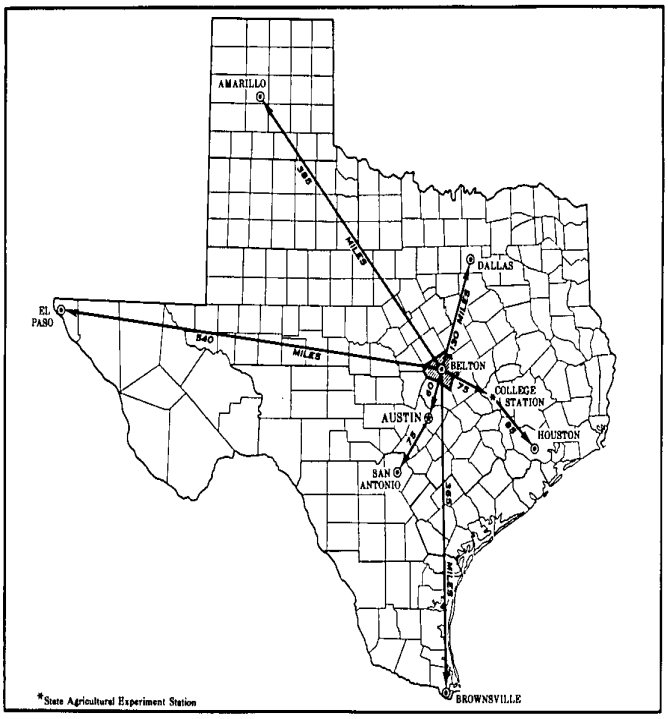


*Figure 1.*—Location of Bell County in Texas.

The eastern half of the county is in the Texas Blackland Prairie. The soils in this area are mostly deep and are underlain by marl, marly clay, and soft limestone. The western half of the county is in the Grand Prairie. The soils in this area are on a limestone plain, and most are deep to shallow over soft or hard limestone.

Remnants of stream terraces are throughout the county. Lenses and pockets of sand and gravel generally are at a depth of 5 to 40 feet. There are hills, or knobs, near Rogers in the southeastern part of the county. Uplands on the limestone plain are dissected by stream valleys, and in many places there are bluffs and slopes that are stony. In some places, nearly all of the highland area has been eroded away, except for small mesas that range from 50 feet to 200 feet in height.

Most of Bell County is drained by the Little River, which flows out of the county and empties into the Brazos River. The Little River is formed from the confluence of the Leon and Lampasas Rivers in the central part of the county.

About 56 percent of the county is in crops, and about half of this area is in row crops, mainly grain sorghum and cotton. Smaller areas produce corn, oats, and wheat. The oats are mainly grazed by livestock; only a small acreage is harvested for grain. Grazing land for cattle, sheep, and goats and land in the Fort Hood Military Reservation make up most of the remaining 44 percent of the county.

Fishing, hunting, and recreation contribute to the county's economy, and the factories in the Temple-Belton area are also of considerable economic importance. Sale of dairy and poultry products and of wool and mohair contributes to the local economy.

## *How This Survey Was Made*

Soil scientists made this survey to learn what kinds of soil are in Bell County, where they are located, and how they can be used. The soil scientists went into the county knowing they would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

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

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

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

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

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Eddy-Stephen complex, 0 to 3 percent slopes, is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Tarrant-Purves association, rolling, 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 areas shown on the map may be made up of only one of the dominant soils, or of two or more. Speck soils, 1 to 3 percent slopes, is an undifferentiated soil group in this county.

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

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

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

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and 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 Bell County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

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

The six soil associations in Bell County are described in this section.

### *1. Houston Black-Heiden-Branyon association*

*Nearly level to sloping, deep, clayey soils over clayey material, shale, or marl; on uplands*

This association makes up about 38 percent of the county. It is about 32 percent Houston Black soils, 18 percent Heiden soils, and 14 percent Branyon soils. The remaining 36 percent is less extensive areas of Burleson, Ferris, Patrick, Payne, and Venus soils.

Houston Black soils are nearly level to gently sloping. They have a surface layer of very dark gray and dark-gray, calcareous clay about 46 inches thick. The next layer is gray clay that extends to a depth of 68 inches. Below this is mottled, light-gray and yellow clay that extends to a depth of 110 inches.

Heiden soils are gently sloping to sloping. They have a surface layer of dark grayish-brown calcareous clay about 36 inches thick. The next layer is olive-gray clay that extends to a depth of 58 inches. The underlying material is mottled, olive and yellow shaly clay that extends to a depth of 70 inches.

Branyon soils are nearly level to gently sloping. They have a surface layer of dark-gray calcareous clay about 45 inches thick. The next layer is gray clay about 20 inches thick. The underlying material is light-gray clay that extends to a depth of 70 inches.

Burleson and Payne soils are on high alluvial terraces, and Patrick soils are on old alluvial terraces. Ferris soils are in cuts that lead to drainageways, and Venus soils are on stream terraces.

This association is well suited to crops, and about 65 percent of it is cultivated. The rest is used mostly for pasture. A few areas are in native plants. The soils are suited to all the crops commonly grown in the county. Many farmers raise beef cattle. Farms average about 165 acres in size, but they range from 20 acres to more than 1,000 acres in size.

### *2. Speck-Tarrant-Purves association*

*Gently sloping to sloping and undulating to rolling, very shallow to shallow, gravelly, loamy and clayey soils over limestone; on uplands*

This association makes up about 25 percent of the county. Speck soils make up 29 percent of the association, Tarrant soils 24 percent, and Purves soils 18 percent. The remaining 29 percent is less extensive areas of Brackett and Real soils. Belton and Stillhouse Lakes are also in this association.

Speck soils are gently sloping and undulating. They have a surface layer of very dark grayish-brown gravelly clay loam about 8 inches thick. The next layer, about 8 inches thick, is reddish-brown clay. Below this is dark reddish-brown clay that extends to a depth of 19 inches and rests on indurated limestone bedrock.

Tarrant soils are undulating to rolling. They have a surface layer of dark grayish-brown silty clay about 16 inches thick that rests on hard limestone bedrock. Stones and boulders are on the surface and in the soil.

Purves soils are gently sloping to sloping and undulating. They have a dark-brown, calcareous silty clay surface layer about 14 inches thick that rests on hard limestone bedrock.

Brackett soils are on narrow, hard limestone escarpments. Real soils are on the upper part of steeper slopes on hillsides.

This association is used mostly as range. It is well suited to use as range and wildlife habitat because many kinds of desirable forage are available for livestock and deer. Some small areas of deeper loamy soils at the base of hills are cultivated.

### *3. Austin-Stephen-Altoga association*

*Gently sloping to strongly sloping, very shallow to deep, clayey soils over chalk or chalky marl; on uplands*

This association makes up about 12 percent of the county. Austin soils make up 50 percent of the association, Stephen soils 21 percent, and Altoga soils 12 percent. The remaining 17 percent is less extensive areas of Brackett, Eddy, Pedernales, and Riesel soils.

Austin soils are gently sloping. They have a dark grayish-brown, calcareous silty clay surface layer about 16 inches thick. The next layer is grayish-brown and brown silty clay about 19 inches thick. The underlying material is mottled, light-gray, marly clay that extends to a depth of 48 inches.

Stephen soils are gently sloping to sloping and are mainly near the top of slopes. They have a dark grayish-brown, calcareous silty clay surface layer about 14 inches thick. The next layer is light-gray, soft, platy chalk that extends to a depth of 26 inches. The underlying material is white hard chalk that extends to a depth of 36 inches.

Altoga soils are gently sloping to strongly sloping. They have a light brownish-gray silty clay surface layer about 6 inches thick. The next layer is about 22 inches of very pale brown silty clay. Below this is light-gray silty clay that extends to a depth of 58 inches. The underlying material extends to a depth of 62 inches and is light gray. It is chalky marl and has silty clay in crevices between the chalky fragments.

Brackett soils are on limestone hillsides, and Eddy soils are on ridgetops. Pedernales soils are on stream terraces, and Riesel soils are on old high terraces.

Most of this association is cultivated, and the soils are suited to most crops commonly grown in the county. Many areas are planted to improved grasses for pasture. A few small areas are in native vegetation. Farms average about 150 acres in size, but they range from 15 acres to more than 800 acres in size.

### *4. Denton-Purves association*

*Nearly level to sloping, very shallow to moderately deep, clayey soils over limestone; on uplands*

This association makes up about 11 percent of the county. It is about 47 percent Denton soils and 29

percent Purves soils. The remaining 24 percent is less extensive areas of Brackett, Krum, Lewisville, and San Saba soils.

Denton soils are nearly level to gently sloping. They have a dark grayish-brown, calcareous silty clay surface layer about 6 inches thick. The next layer extends to a depth of 40 inches and is dark-brown silty clay that rests on fractured hard limestone.

Purves soils are gently sloping to sloping and are above the Denton soils. They have a dark-brown silty clay surface layer about 14 inches thick that rests on hard limestone bedrock.

Brackett soils are on narrow hard limestone escarpments. Krum and Lewisville soils are on stream terraces and foot slopes, and San Saba soils are in narrow valleys.

Most of this association is in the Fort Hood Military Reservation. Most areas of this association are used for livestock. A few areas are cultivated, and a few areas are in improved pasture.

### 5. *Trinity-Frio-Bosque association*

*Nearly level, deep, loamy to clayey soils formed in alluvium; on flood plains*

This association makes up 8 percent of the county. It is 41 percent Trinity soils, 34 percent Frio soils, and 25 percent Bosque soils.

Trinity soils have a very dark gray clay surface layer about 20 inches thick. The next layer is black clay that extends to a depth of 42 inches. The underlying material is dark-gray clay that extends to a depth of 72 inches.

Frio soils have a dark grayish-brown silty clay surface layer about 36 inches thick. The next layer is brown silty clay that extends to a depth of 88 inches.

Bosque soils have a grayish-brown clay loam surface layer about 5 inches thick. The next layer is dark grayish-brown clay loam that extends to a depth of 45 inches. Below this is brown clay loam that extends to a depth of 60 inches. The underlying material extends to a depth of 80 inches and is light brownish-gray silty clay.

The width of the flood plains ranges from about 100 feet along the small streams to more than a mile where Little River leaves the county. Most areas of this association are now protected from damaging floods by the Belton Dam on the Leon River and the Stillhouse Hollow Dam on the Lampasas River.

This association is used mostly for crops and pasture. The soils are well suited to all the row crops commonly grown in the county, and Bosque and Frio soils are well suited to pecan trees. This association has potential for development as irrigated cropland. The lower lying areas of bottom lands that are subject to flooding are mostly covered with woods, and they are used mostly for grazing. Farms in this association average about 160 acres in size, but they range from about 20 to 500 acres in size.

### 6. *San Saba-Crawford association*

*Nearly level to gently sloping, moderately deep, clayey soils over limestone; on uplands*

This association makes up about 6 percent of the county. It is 54 percent San Saba soils and 19 percent Crawford soils. The remaining 27 percent is less extensive areas of Lindy and Speck soils.

San Saba soils are nearly level to gently sloping. They have a dark-gray clay surface layer about 4 inches thick. Below this is very dark gray clay that reaches to a depth of 19 inches. The next layer extends to a depth of 35 inches and is dark-gray clay. Below this is gray indurated limestone.

Crawford soils are nearly level to gently sloping. They have a dark-brown clay surface layer about 16 inches thick. The next layer extends to a depth of 36 inches and is dark reddish-brown clay that rests on limestone bedrock.

Lindy soils are on high plateaus, and Speck soils are on stony and gravelly uplands.

Most areas of this association are used for cultivated crops, but a few small areas are in native vegetation. The soils are suited to most crops commonly grown in the county. Farms average about 200 acres in size, but they range from 40 to 500 acres in size.

## *Descriptions of the Soils*

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

An important part of each series description is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, the differences are stated in the description of the mapping unit, or they are differences that are apparent in the name of the mapping unit. Soil colors in this section are expressed both in words and in Munsell color notations and are for dry soil unless otherwise stated.

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

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, pasture and hay group, and range site in which the mapping unit has been placed. The page for the description of each capability unit,

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

| Soil | Acres | Percent | Soil | Acres | Percent |
|---|---|---|---|---|---|
| Altoga silty clay, 2 to 5 percent slopes | 4,950 | 0.7 | Krum-Lewisville association, undulating | 6,580 | 1.0 |
| Altoga silty clay, 5 to 10 percent slopes, eroded | 4,570 | .7 | Lewisville silty clay, 1 to 3 percent slopes | 8,330 | 1.2 |
| Austin silty clay, 1 to 3 percent slopes | 18,850 | 2.8 | Lewisville silty clay, 3 to 5 percent slopes | 7,800 | 1.2 |
| Austin silty clay, 3 to 5 percent slopes | 20,820 | 3.1 | Lewisville-Altoga complex, 2 to 5 percent slopes | 6,200 | .9 |
| Austin-Urban land complex, 1 to 5 percent slopes | 2,750 | .4 | Lewisville-Urban land complex, 1 to 5 percent slopes | 950 | .1 |
| Axtell fine sandy loam, 1 to 3 percent slopes | 790 | .1 | Lindy clay loam, dark subsoil variant, 0 to 2 percent slopes | 1,520 | .2 |
| Bastrop fine sandy loam, 0 to 2 percent slopes | 1,140 | .2 | Menard soils, 5 to 8 percent slopes. eroded | 500 | .1 |
| Bosque clay loam | 10,820 | 1.6 | Patrick soils, 1 to 8 percent slopes | 1,830 | .3 |
| Bosque clay loam, frequently flooded | 3,130 | .5 | Payne loam, 0 to 1 percent slopes | 2,330 | .3 |
| Brackett clay loam, 1 to 3 percent slopes | 820 | .1 | Payne loam, 1 to 3 percent slopes | 4,850 | .7 |
| Brackett-Urban land complex, 3 to 12 percent slopes | 220 | (1) | Pedernales fine sandy loam, 1 to 3 percent slopes | 2,660 | .4 |
| Brackett association, rolling | 28,600 | 4.2 | Purves silty clay, 1 to 4 percent slopes | 22,900 | 3.4 |
| Branyon clay, 0 to 1 percent slopes | 21,280 | 3.2 | Purves-Urban land complex, 1 to 8 percent slopes | 1,800 | .3 |
| Branyon clay, 1 to 3 percent slopes | 17,580 | 2.6 | Purves association, undulating | 22,510 | 3.3 |
| Burleson clay, 0 to 1 percent slopes | 5,200 | .8 | Real association, hilly | 15,660 | 2.3 |
| Burleson clay, 1 to 3 percent slopes | 2,450 | .4 | Riesel gravelly soils, 1 to 3 percent slopes | 2,000 | .3 |
| Chigley gravelly fine sandy loam, 1 to 3 percent slopes | 530 | .1 | San Saba clay, 0 to 1 percent slopes | 3,110 | .5 |
| Crawford clay, 0 to 1 percent slopes | 1,150 | .2 | San Saba clay, 1 to 3 percent slopes | 18,760 | 2.8 |
| Crawford clay, 1 to 3 percent slopes | 6,920 | 1.0 | San Saba-Urban land complex, 0 to 3 percent slopes | 1,350 | .2 |
| Denton silty clay, 0 to 1 percent slopes | 470 | .1 | Speck association, undulating | 49,010 | 7.3 |
| Denton silty clay, 1 to 3 percent slopes | 29,490 | 4.4 | Speck soils, 1 to 3 percent slopes | 5,140 | .8 |
| Denton-Urban land complex, 1 to 3 percent slopes | 2,130 | .3 | Stephen silty clay, 1 to 3 percent slopes | 8,420 | 1.3 |
| Denton association, undulating | 9,300 | 1.4 | Stephen silty clay, 3 to 5 percent slopes | 4,300 | .6 |
| Eddy-Stephen complex, 0 to 3 percent slopes | 1,760 | .3 | Stephen-Urban land complex, 1 to 6 percent slopes | 2,280 | .3 |
| Eddy-Stephen complex, 3 to 8 percent slopes | 7,210 | 1.1 | Tarrant association, undulating | 24,770 | 3.7 |
| Ferris-Heiden complex, 5 to 12 percent slopes, eroded | 7,480 | 1.1 | Tarrant-Purves association, rolling | 32,220 | 4.8 |
| Frio silty clay | 8,810 | 1.3 | Trinity clay | 2,280 | .3 |
| Frio silty clay, frequently flooded | 10,590 | 1.6 | Trinity clay, frequently flooded | 20,640 | 3.0 |
| Heiden clay, 1 to 3 percent slopes | 23,920 | 3.5 | Urban land | 240 | (1) |
| Heiden clay, 3 to 5 percent slopes | 3,520 | .5 | Venus clay loam, 0 to 1 percent slopes | 1,430 | .2 |
| Heiden stony clay, 3 to 8 percent slopes | 820 | .1 | Venus clay loam, 1 to 3 percent slopes | 2,760 | .4 |
| Heiden-Ferris complex, 3 to 8 percent slopes, eroded | 26,680 | 4.0 | Venus clay loam, 3 to 5 percent slopes | 3,070 | .4 |
| Houston Black clay, 0 to 1 percent slopes | 13,820 | 2.0 | Wilson clay loam, 0 to 1 percent slopes | 3,060 | .4 |
| Houston Black clay, 1 to 3 percent slopes | 55,320 | 8.2 | Wilson clay loam, 1 to 3 percent slopes | 3,300 | .5 |
| Houston Black clay, 3 to 5 percent slopes | 13,760 | 2.0 | Wilson clay loam, 3 to 5 percent slopes | 880 | .1 |
| Houston Black-Urban land complex, 1 to 5 percent slopes | 2,900 | .4 | Total land area | 675,820 | 100.0 |
| Krum silty clay, 0 to 1 percent slopes | 2,100 | .3 | Water area[2] | 14,740 | |
| Krum silty clay, 1 to 3 percent slopes | 7,410 | 1.1 | Total area | 690,560 | |
| Krum-Urban land complex, 0 to 3 percent slopes | 320 | (1) | | | |

[1] Less than 0.1 percent.
[2] The water area is that of Belton and Stillhouse Hollow Lakes.

pasture and hay group, and range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

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

[1] United States Department of Agriculture. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus., 1951. [Supplement issued in May 1962]

## Altoga Series

The Altoga series consists of deep, gently sloping to strongly sloping, clayey soils on foot slopes below limestone hills and ridges. These calcareous soils formed in marly and clayey material.

In a representative profile the surface layer is light brownish-gray silty clay about 6 inches thick. The next layer is silty clay that extends to a depth of 58 inches. It is very pale brown in the upper 22 inches and light gray in the lower 30 inches. The underlying material extends to a depth of 62 inches.

It is light-gray marl and has light-gray silty clay in crevices between chalky fragments.

Altoga soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is medium.

These soils are used mostly for crops, but some areas are used for pasture. Small isolated areas are used as native range. These soils are better suited to grazing crops and pasture than to most other uses.

Representative profile of Altoga silty clay, 2 to 5 percent slopes, 2.5 miles north on Interstate Highway 35 from its intersection with the Atchison, Topeka and Santa Fe Railway line in north Temple, then 0.6 mile east, 0.35 mile north, 1.25 miles east, 0.4 mile north, 0.28 mile east, and 0.12 mile north on a county road and 500 feet east of the road, in a field:

Ap—0 to 6 inches, light brownish-gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; weak, very fine, subangular blocky and granular structure; slightly hard, friable; few worm casts; calcareous; moderately alkaline; clear, smooth boundary.

B2—6 to 28 inches, very pale brown (10YR 7/3) silty clay, pale brown (10YR 6/3) moist; moderate, fine, subangular blocky and granular structure; slightly hard, friable; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—28 to 58 inches, light-gray (10YR 7/2) silty clay, same color moist; common fine mottles of very pale brown (10YR 7/4); moderate, fine, subangular blocky and granular structure; slightly hard, friable; common, small, soft masses of calcium carbonate; common chalk fragments; calcareous; moderately alkaline; clear, irregular boundary.

C—58 to 62 inches, light-gray (10YR 7/1) chalky marl; few thin tongues of light-gray silty clay in crevices between chalky fragments.

The solum ranges from 35 to 65 inches in thickness. The A horizon ranges from 2 to 11 inches in thickness and from grayish brown to brown or light brownish gray. The B and C horizons range from brown to very pale brown, dark yellowish brown, grayish brown, or light gray. The zone of visible calcium carbonate accumulation is at a depth of 12 to 28 inches. The calcium carbonate consists of soft masses, slightly hard concretions, and films and threads. Limestone gravel beds and lenses are below a depth of 40 inches in some places.

**Altoga silty clay, 2 to 5 percent slopes** (AlC).—This gently sloping soil is on rounded hilltops, hillsides, and oblong foot slopes. The areas are 10 to 35 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Austin, Brackett, Lewisville, and Stephen soils. Also included are some areas that have gullies. Not all areas included in mapping are in a single mapped area, but any one or two of them make up as much as 10 percent of some mapped areas.

This soil is used mostly for cultivated crops. Some areas are in improved pasture. The hazard of erosion is moderate. This soil is droughty in years when rainfall is average or below average. In some places, shallow gullies have been cut, but these gullies can be crossed by farm machinery. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

**Altoga silty clay, 5 to 10 percent slopes, eroded** (AlE2).—This sloping to strongly sloping soil is in areas that are mostly oblong and are 6 to 50 acres in size. This soil is eroded and has many large and small gullies. The gullies are shallow, but some cannot be crossed by farm machinery.

The surface layer is brown silty clay about 11 inches thick. The next layer is dark yellowish-brown silty clay, is about 24 inches thick, and is underlain by chalky marl.

Included with this soil in mapping are small areas of Altoga silty clay, 2 to 5 percent slopes, and small areas of Austin and Lewisville soils.

Most areas of this soil have been cultivated but are now idle or planted to improved grass. Most of these areas are used for pasture. Some small areas are cultivated. Because the hazard of erosion is severe, a good cover of vegetation is needed. This soil is droughty. Capability unit VIe-2; pasture and hay group 7D; Clay Loam range site.

## Austin Series

The Austin series consists of gently sloping, moderately deep, clayey soils on uplands. These calcareous soils formed in clayey marl or material weathered from chalky limestone.

In a representative profile the surface layer is dark grayish-brown, calcareous silty clay about 16 inches thick. The next layer is calcareous silty clay that reaches to a depth of 35 inches. It is grayish brown in the upper 9 inches and brown in the lower 10 inches. The underlying material is marly clay and soft chalky marl that extends to a depth of 48 inches.

Austin soils are well drained. Permeability is moderately slow, and available water capacity is high. Runoff is medium to rapid.

These soils are suited to crops, and most areas are cultivated. Some areas are used for pasture and hay.

Representative profile of Austin silty clay, 1 to 3 percent slopes, about 3.6 miles south of Temple on Farm Road 1741 to Taylors Valley Church, then 1.3 miles east on a county road and 25 feet north of the road, in a field:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky and granular structure; hard, firm but crumbly, sticky and plastic; few fine pieces of snail shell; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—6 to 16 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky and granular structure; hard, firm but crumbly, sticky and plastic; many fine and very fine pores; few to common worm casts; few fine pieces of snail shell; calcareous; moderately alkaline; gradual, smooth boundary.

B21—16 to 25 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky and granular structure; hard, firm but crumbly, sticky and plastic; many fine pores; few worm casts; few, fine to medium, soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B22—25 to 35 inches, brown (10YR 5/3) silty clay; moderate, fine, subangular blocky structure; hard, firm but crumbly, sticky and plastic; many fine pores; common worm casts; common, fine to medium, soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—35 to 48 inches, mottled light-gray (10YR 7/2) and light brownish-gray (10YR 6/2) marly clay and soft chalky marl; common, fine, pale-yellow (2.5Y 8/4) mottles.

The solum ranges from 22 to 40 inches in thickness. The A horizon ranges from 12 to 19 inches in thickness. It is very dark grayish brown, dark brown, dark grayish-brown, brown, or grayish brown. The B horizon is 10 to 26 inches thick. This horizon is pale brown, brown, yellowish brown, grayish brown, and light brownish gray. The C horizon is white marly clay or white, chalky, soft limestone. In places it is mottled in shades of gray, brown, or yellow.

**Austin silty clay, 1 to 3 percent slopes** (AsB).—This gently sloping soil is on convex knolls and ridges. The areas are irregular in shape and average about 30 acres in size. Slopes are mostly about 2 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Altoga, Houston Black, and Stephen soils. The included soils make up less than 18 percent of any mapped area.

This soil is suited to crops, and most areas are cultivated. Some areas are in improved pasture. Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

**Austin silty clay, 3 to 5 percent slopes** (AsC).—This gently sloping soil is on the sides of hills and at the heads of drainageways. The areas are irregular in shape and are 5 to 50 acres in size.

The surface layer is dark grayish-brown silty clay about 14 inches thick. The next layer is silty clay about 15 inches thick. It is grayish brown in the upper part and brown in the lower part. The underlying material is marly clay.

Included with this soil in mapping are areas of Austin silty clay, 1 to 3 percent slopes, and areas of Stephen soils. Also included are small areas of soils that have gullies.

This soil is better suited to improved pasture than to most other uses. Nearly all areas were cultivated at one time, and most areas are still in cultivation. Some areas are in improved pasture, and some are abandoned fields. Runoff is rapid, and the hazard of erosion is severe. In some places shallow gullies have been cut, but these can be crossed by farm machinery. Capability unit IVe-2; pasture and hay group 7C; Clay Loam range site.

**Austin-Urban land complex, 1 to 5 percent slopes** (AuC).—This complex is made up of gently sloping soils on broad ridgetops and slopes. Mapped areas are 10 to 200 acres in size. Austin silty clay makes up about 70 percent of this mapping unit and Urban land about 30 percent. The soils and Urban land cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

The Austin soil in this complex has a surface layer of dark grayish-brown, calcareous silty clay about 16 inches thick. The next layer is silty clay about 24 inches thick. It is grayish brown in the upper part and pale brown in the lower part. The underlying material is beds of chalk or marly clay.

Urban land areas are covered with such works and structures as streets, sidewalks, buildings, driveways, cemeteries, and patios. The percentage of Urban land in this complex covered by works and structures ranges from 25 to 75. The structures are mostly single-unit dwellings. Because the topography is smooth, much of the soil has not been disturbed during construction.

Features of the soils in this complex that affect urban development are shrink-swell potential, which can cause cracking and shifting of structures; corrosivity, which results in deterioration of pipelines and steel in the ground; high pH value, which limits the kinds of ornamental shrubs, trees, and flowers that can be grown; and clay texture, which becomes sticky and plastic when wet. Nearly all new dwellings are built on a floating reinforced concrete slab so that the effects of the shrink-swell behavior of these soils are reduced. Additional fill is brought in to level the ground foundation before the concrete slab is poured. Not placed in interpretive groups.

## Axtell Series

The Axtell series consists of deep, gently sloping, loamy soils on uplands. These noncalcareous soils formed in alkaline clay interbedded with sandy material.

In a representative profile the surface layer is grayish-brown, medium acid fine sandy loam about 3 inches thick. The subsurface layer is light-gray, medium acid fine sandy loam about 5 inches thick. The next layer is clay that extends to a depth of 54 inches. It is yellowish red and has yellowish-brown mottles in the upper 8 inches, is light brownish gray and has yellowish-red and brownish-yellow mottles in the next 11 inches, and is pale brown in the lower 27 inches. The underlying material is clay that extends to a depth of 78 inches. It is mottled yellowish red, pale brown, and brownish yellow in the upper part and pale brown in the lower part.

Axtell soils are well drained. Permeability is very slow, and available water capacity is medium. Runoff is medium.

These soils are used mostly as pasture.

Representative profile of Axtell fine sandy loam, 1 to 3 percent slopes, 3.25 miles north of Whitehall on Farm Road 2409, then 2.5 miles west on Farm Road 2601, then 1 mile south on a county road, then 0.25 mile west on another county road, then 10 feet south of a fence, in a pasture:

Ap—0 to 3 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable; medium acid; clear, smooth boundary.

A2—3 to 8 inches, light-gray (10YR 7/2) fine sandy loam, light brownish gray (10YR 6/2) moist; massive but porous, crushes to single grained; hard, friable; medium acid; abrupt, wavy boundary.

B21t—8 to 16 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; common, medium, yellowish-brown (10YR 5/6) mottles; moderate, fine to medium, blocky structure; extremely hard, very firm; plant roots mainly between peds; distinct clay films on peds; vertical cracks partially filled with brown soil; strongly acid; clear, wavy boundary.

B22t—16 to 27 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; common, medium, yellowish-red (5YR 5/6) mottles and few, brownish-yellow (10YR 6/6) mottles; moderate, medium and coarse, blocky structure; extremely hard, very firm; clay films on peds; few shiny pressure faces; cracks extend from horizon above; few, fine, soft, black masses; medium acid; gradual, wavy boundary.

B23t—27 to 36 inches, pale-brown (10YR 6/3) clay, same color

moist; moderate, medium and coarse, blocky structure; extremely hard, very firm; clay films on peds; few shiny pressure faces; cracks extend from horizon above; few, fine, soft, black masses and few, small, black sploches; medium acid; gradual, wavy boundary.

B3—36 to 54 inches, pale-brown (10YR 6/3) clay, same color moist; moderate, medium and coarse, blocky structure; extremely hard, very firm; clay films on peds; few shiny pressure faces; cracks extend from horizon above; few, fine, soft, black masses; few, fine, soft masses of calcium carbonate; neutral; abrupt, smooth boundary.

C1—54 to 72 inches, mottled yellowish-red (5YR 4/6), pale-brown (10YR 6/3), and brownish-yellow (10YR 6/6) clay; massive; very hard, firm; neutral; abrupt, smooth boundary.

C2ca—72 to 78 inches, pale-brown (10YR 6/3) clay; 40 to 60 percent, by volume, powdery calcium carbonate.

The solum ranges from 40 to 70 inches in thickness. The A horizon ranges from 7 to 10 inches in thickness. The Ap horizon is dark grayish brown, grayish brown, brown, pale brown, or light brownish gray. The A2 horizon is light gray, light brownish gray, or pale brown. The Bt horizon is yellowish red, light brownish gray, reddish brown, pale brown, and yellowish brown. This horizon has few to many mottles in shades of red, brown, yellow, gray, and olive.

**Axtell fine sandy loam, 1 to 3 percent slopes** (AxB).—This gently sloping soil is on old terraces that are higher in elevation than other terraces in the county. Areas are irregular in shape and are 5 to 95 acres in size.

Included with this soil in mapping are small areas of Wilson soils, which are in the low positions.

This soil is better suited to use as pasture than to most other uses. Most areas were cultivated at one time, but they are now mainly in unimproved pasture. Some small areas are cultivated to crops for grazing use, and a few areas are in native vegetation. The hazard of erosion is moderate. Capability unit IIIe-1; pasture and hay group 8A; Claypan Savanna range site.

## Bastrop Series

The Bastrop series consists of deep, nearly level to gently sloping, loamy soils on stream terraces. These noncalcareous soils formed in loamy material.

In a representative profile the surface layer is fine sandy loam about 16 inches thick. It is dark brown in the upper 6 inches and reddish brown in the lower 10 inches. The next layer is sandy clay loam that extends to a depth of 72 inches. It is red in the upper 20 inches and yellowish red in the lower 36 inches.

Bastrop soils are well drained. Permeability is moderate, and the available water capacity is high. Runoff is medium.

Most areas of these soils are cultivated. Some areas have been planted to improved pasture. The soils are well suited to cultivated crops and improved pasture.

Representative profile of Bastrop fine sandy loam, 0 to 2 percent slopes, 0.5 mile east of Leon River bridge on Texas Highway 817, then 10 feet north of road, in a pasture:

Ap—0 to 6 inches, dark-brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; soft, very friable; weak crust on surface after rain; slightly acid; abrupt, smooth boundary.

A1—6 to 16 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; slightly hard, friable; slightly acid; clear, smooth boundary.

B21t—16 to 36 inches, red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate, fine, subangular blocky structure; hard, friable; few fine pores; slightly acid; gradual, smooth boundary.

B22t—36 to 72 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, fine, subangular blocky structure; hard, friable; few fine pores; neutral.

The solum ranges from 66 to 90 inches in thickness and is slightly acid or neutral. The A horizon ranges from 12 to 20 inches in thickness and is dark brown, brown, reddish brown, or light brownish gray. The Bt horizon ranges from 26 to 56 inches or more in thickness and is reddish brown, yellowish red, and red.

**Bastrop fine sandy loam, 0 to 2 percent slopes** (BaA).—This nearly level to gently sloping soil is on stream terraces. Areas are long and narrow and are 5 to 184 acres in size. Most areas of this soil receive extra water and soil material from slopes above.

Included with this soil in mapping are narrow areas of Axtell and Payne soils. These included areas make up less than 10 percent of any mapped area.

Most areas of this soil are cultivated. The acreage that is in improved pasture has increased in recent years. The hazard of erosion is slight. Capability unit IIe-3; pasture and hay group 8C; Sandy Loam range site.

## Bosque Series

The Bosque series consists of deep, nearly level, calcareous loamy soils on the flood plains of the larger streams. These soils formed in loamy alluvium. Areas are in high bands parallel to the stream channel.

In a representative profile the surface layer is clay loam about 45 inches thick. It is grayish brown in the upper 5 inches and dark grayish brown in the lower 40 inches. The next layer is brown clay loam that reaches to a depth of 60 inches. The underlying material is light brownish-gray silty clay that extends to a depth of 80 inches.

Bosque soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow to medium.

The soils in higher, less frequently flooded areas are used mostly for crops; the soils in lower, more frequently flooded areas are used mostly as pasture and for pecan trees.

Representative profile of Bosque clay loam, 0.83 mile south on Texas Highway 95, from its intersection with Farm Road 436 in Academy, then 300 feet east of the highway, in a field:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, very fine, subangular blocky structure; slightly hard, friable, sticky; calcareous; moderately alkaline; abrupt, smooth boundary.

A12—5 to 16 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure parting to subangular blocky; slightly hard, friable, sticky; many worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

A13—16 to 45 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure parting to subangular blocky; hard, firm, sticky; calcareous; moderately alkaline; gradual, smooth boundary.

B2—45 to 60 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; weak, medium, subangular blocky structure; hard, firm, sticky; few threads of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—60 to 80 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; weak, medium, subangular blocky structure; porous; hard, friable, sticky. This material extends many feet downward and becomes lighter in color as depth increases.

The solum ranges from 50 to 80 inches in thickness. The A horizon ranges from 29 to 60 inches in thickness. It is grayish brown, dark grayish brown, or very dark grayish brown. This horizon has few to common threads and films of calcium carbonate. Between depths of 10 and 40 inches, the clay content is 25 to 35 percent. The B horizon is dark brown, brown, or very pale brown. The C horizon ranges from clay loam to silty clay. In some places this horizon has thin lenses of coarser material.

**Bosque clay loam** (Be).—This nearly level soil is on the higher part of bands along the major rivers. Areas are 10 to 224 acres in size, and slopes are 0 to 1 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Frio soils that make up less than 12 percent of any mapped area.

This soil is suited to crops, and most areas are cultivated. It is flooded about once every 4 to 12 years in the Lampasas River bottom upstream from Stillhouse Hollow Lake. Floods along the Little River, except for those that occur at 25- to 50-year intervals as a result of high-intensity, long-duration rains, are controlled by dams that form the Belton and Stillhouse Hollow Lakes. The two potential flood seasons each year are early in spring and in September when hurricanes cause disturbances in the Gulf of Mexico. The hazard of erosion is slight. Capability unit I-1; pasture and hay group 1C; Loamy Bottomland range site.

**Bosque clay loam, frequently flooded** (Bf).—This deep, nearly level soil is on bottom lands. Areas are parallel to stream channels and are 10 to 200 acres in size. Slopes are 0 to 1 percent.

The surface layer is dark grayish-brown clay loam that extends to a depth of 45 inches. The next layer is brown clay loam that reaches to a depth of 60 inches. Below this is light brownish-gray silty clay that extends to a depth of 80 inches.

Included with this soil in mapping are small areas of Bosque soils in higher parts of areas, small areas of Bosque soils that have slopes of 1 to 2 percent, and some areas of Frio soils. Included areas make up less than 10 percent of any mapped area.

This soil is too frequently flooded for successful crop production. It is flooded at least once every 2 years and is sometimes flooded twice in 1 year. Most areas are in pasture and pecan trees. The hazard of erosion is slight. Capability unit Vw-1; pasture and hay group 1C; Loamy Bottomland range site.

## Brackett Series

The Brackett series consists of gently sloping to strongly sloping and rolling, calcareous, loamy soils. These shallow soils formed in loamy material underlain by soft limestone. They are in narrow bands, mainly along limestone escarpments, and on ridgetops, where they are underlain by soft chalk.

In a representative profile the surface layer, about 6 inches thick, is light brownish-gray, calcareous loam and a small amount of limestone fragments. The next layer is pale-yellow loam and a small amount of limestone fragments and extends to a depth of 16 inches. The underlying material is interbedded, weakly cemented and strongly cemented limestone and pale-yellow clay loam.

Brackett soils are well drained. Permeability is moderately slow, and available water capacity is very low. Runoff is rapid.

These soils are better suited to range than to most other uses. Most areas are in native grass range, but some of the smoother areas are cultivated.

Representative profile of Brackett loam in an area of Brackett association, rolling, 5.3 miles west on U.S. Highway 190 from its intersection with Interstate Highway 35 in Belton, then 5 miles southwest on Farm Road 2410, then 2.0 miles southeast on a county road and 125 feet north of the road, in an area of range:

A1—0 to 6 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; moderate, fine and very fine, subangular blocky and granular structure; hard, firm; many grass roots; many worm casts of lighter-colored material from horizon below; about 3 percent limestone fragments, mostly 5 to 15 millimeters in diameter and mostly on the surface as pavement; about 55 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear, wavy boundary.

B2—6 to 16 inches, pale-yellow (2.5Y 8/4) loam, pale yellow (2.5Y 7/4) moist; moderate, very fine, subangular blocky structure; hard, friable; many roots; about 5 percent, by volume, subrounded, weakly cemented and strongly cemented limestone fragments, mostly 2 to 15 millimeters in diameter; common tongues of darker soil from layer above in old root channels or cracks; a few soft masses of calcium carbonate; about 65 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear, wavy boundary.

C—16 to 50 inches, thinly interbedded, weakly cemented and strongly cemented, platy limestone and pale-yellow calcareous clay loam; cleavage planes of rock structure evident in both the limestone and the clay loam; few roots in the upper part in vertical crevices and between the horizontal plates of the limestone.

The solum ranges from 10 to 20 inches in thickness. Limestone and oystershell gravel fragments are on the surface and make up 3 to 35 percent of the A horizon. The A horizon is 3 to 8 inches thick and is brown, grayish brown, pale brown, or light brownish gray. It ranges from loam or gravelly loam to clay loam. The B2 horizon ranges from 5 to 13 inches in thickness and from loam to clay loam in texture. It is 5 to 35 percent limestone and oystershell gravel fragments. It is pale brown, light gray, or pale yellow. The C horizon is light brownish-gray, very pale brown, or pale-yellow clay loam interbedded with limestone and marl or oystershell that is more than 50 percent calcium carbonate.

**Brackett clay loam, 1 to 3 percent slopes** (BkB).—This gently sloping soil is in areas irregular in shape and 10 to 50 acres in size.

The surface layer is brown clay loam 6 inches thick. The next layer is pale-brown clay loam that extends to a depth of 14 inches. Below this is pale-yellow, soft platy limestone.

Included with this soil in mapping are small areas

of Altoga and Eddy soils. These areas make up 15 percent or less of any mapped area.

Most areas of this soil are cultivated. A few small areas are in improved pasture and a few are in range. The hazard of erosion is moderate. Capability unit IVs-1; pasture and hay group 13A; Adobe range site.

**Brackett-Urban land complex, 3 to 12 percent slopes** (BnE).—This complex is made up of gently sloping to strongly sloping soils. Areas are irregular in shape and are 5 to 30 acres in size. Brackett soils make up about 65 percent of the complex, Urban land about 30 percent, and rock outcrop and other soils about 5 percent. The soils and Urban land cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

These Brackett soils have a surface layer of light brownish-gray clay loam about 8 inches thick. The next layer is pale-yellow clay loam about 13 inches thick. Below this is chalky nodular limestone and calcareous material. These soils are as much as 35 percent, by volume, limestone gravel, cobblestones, and stones.

Urban land areas are mainly used for single-unit dwellings and attendant streets, driveways, sidewalks, and patios. A few areas are used for small shopping centers, service stations, churches, and paved parking lots. Most structures are on narrow ridges in the less sloping areas. In this complex, the percentage of Urban land covered by buildings, streets, and similar features ranges from 25 to 75 percent.

In urban developments, soils and slopes are altered to prepare building sites, to build trafficways, or to create a better environment for growing lawn grasses and plants used for landscaping. In some places cuts as deep as 8 to 12 feet are made, and the soils are spread over the downslope or hauled away. In other places split-level construction is used to offset the effect of steep slopes on foundations. Larger stones are removed, and most yards are topdressed with 2 to 6 or more inches of imported topsoil. About a fourth of the soil areas not covered with works and structures are modified. The majority of trafficways are constructed on the contour. Trenching for utilities and shaping the underlying interbedded limestone and marl for site leveling or street construction are the main concerns for urban development. Not placed in interpretive groups.

**Brackett association, rolling** (BRE).—This association is made up of soils that are mostly on the lower two-thirds of the sides of hills. Mapped areas are irregular in shape and are 200 to 1,000 acres or more in size. Slopes are convex and 8 to 12 percent. This association generally is made up of about 70 percent Brackett soils and 30 percent other soils, but in areas the percentage of the Brackett soils ranges from 60 to 100. Brackett soils are in all the areas of this mapping unit, but the soils associated with them are not. On the soil map, areas of this mapping unit are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils.

A Brackett soil in this association has the profile described as representative of the series.

Included with these soils in mapping are areas of Altoga, Purves, and Real soils. Also included in mapping are areas of soils that are similar to Brackett soils but have more stone fragments, are underlain by bedrock, or have a darker color in the surface layer. The included areas make up less than 15 percent of any mapped area.

The soils in this association are better suited to range than to most other uses. Grass is sparse, however, because most areas have been continuously overgrazed. The hazard of erosion is severe. Capability unit VIIs-2; Adobe range site.

## Branyon Series

The Branyon series consists of nearly level to gently sloping, calcareous, clayey soils on broad ancient terraces. These deep soils formed in clayey alluvial material.

In a representative profile the surface layer is dark-gray, calcareous clay about 45 inches thick. Below this is gray calcareous clay that reaches to a depth of 65 inches. The underlying material is light-gray, calcareous clay and has many very pale brown mottles (fig. 2).

Branyon soils are moderately well drained. They crack and take in water readily when dry, but permeability is very slow when they are wet. Available water capacity is high, and runoff is slow to medium.

Nearly all areas of these soils are cultivated.

Representative profile of Branyon clay, 0 to 1 percent slopes, 2,400 feet east on Farm Road 436 from its intersection with a county road in Little River to the point where a high pressure gasline crosses, then 5,120 feet north along gasline, in a field:

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay; very dark gray (10YR 3/1) moist; weak, fine, granular structure; very hard, firm, sticky and plastic; many fine roots; few snail shell fragments; calcareous; moderately alkaline; abrupt, smooth boundary.

A11—6 to 20 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, medium, angular blocky structure that forms parallelepipeds; extremely hard, firm, sticky and plastic; many fine roots; few snail shell fragments; shiny faces on peds; calcareous; moderately alkaline; gradual, wavy boundary.

A12—20 to 45 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, medium, angular blocky structure that forms parallelepipeds; extremely hard, very firm, sticky and plastic; few fine roots; few snail shell fragments; coarse-grooved intersecting slickensides that form parallelepipeds; shiny faces on peds; few fine ferromanganese concretions; calcareous; moderately alkaline; gradual, wavy boundary.

AC—45 to 65 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; few distinct mottles of light brownish gray (10YR 6/2); moderate, medium, angular blocky structure that forms parallelepipeds; extremely hard, very firm, sticky and plastic; shiny faces on peds; few fine ferromanganese concretions; few, fine and medium, strongly and weakly cemented concretions and a few soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

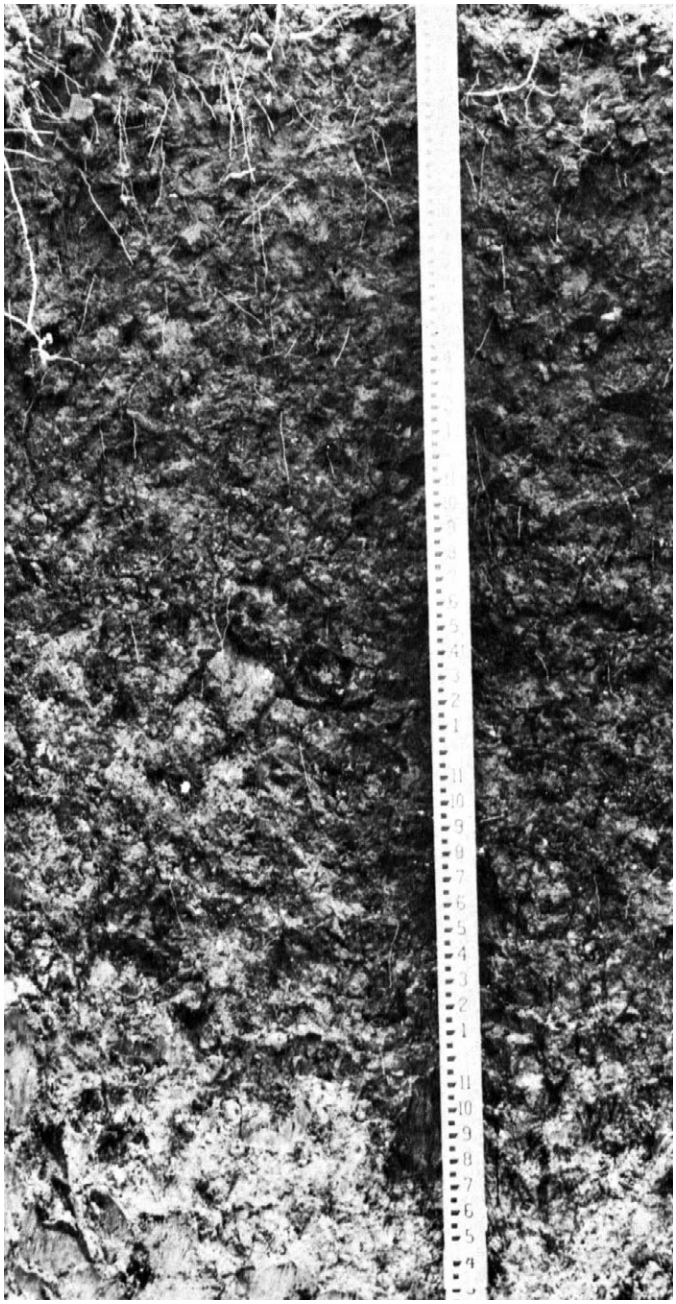

*Figure 2.*—**Profile of Branyon clay that shows thick, dark-colored layers.**

C—65 to 70 inches, light-gray (10YR 7/1) clay, moist; many, medium to coarse, very pale brown (10YR 8/3) mottles, moist; extremely hard, very firm, sticky and plastic; calcareous; moderately alkaline.

When the soil is dry, cracks 1 inch to 3 inches wide extend from the surface to a depth of 36 to 60 inches or more. In undisturbed areas gilgai microrelief consists of knolls 3 to 15 inches higher than depressions. The distance between the center of the knolls and the center of the depressions ranges from 6 to 12 feet. Intersecting slickensides begin at a depth ranging from 20 to 26 inches.

The A horizon ranges from 16 to 70 inches in thickness. It is very dark gray and dark gray. The AC horizon is gray and light brownish gray. The C horizon is light gray, light brownish gray, and very pale brown. A IIC horizon is in many profiles below a depth of 60 inches.

**Branyon clay, 0 to 1 percent slopes** (ByA).—This nearly level soil is in areas irregular in shape and 8 acres to more than 1,300 acres in size. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Burleson and Krum soils. The included areas make up less than 5 percent of the mapped area.

This soil is well suited to crops, and nearly all areas are cultivated. The hazard of erosion is slight, and runoff is slow. Capability unit IIw-1; pasture and hay group 7A; Blackland range site.

**Branyon clay, 1 to 3 percent slopes** (ByB).—This gently sloping soil is mostly around and on the edges of larger areas of nearly level soils as well as at the head of drainageways. Most areas are long and narrow and are 10 acres to more than 1,000 acres in size.

The surface layer is dark-gray clay 42 inches thick. The next layer is gray clay that reaches to a depth of 66 inches. Below this is light-gray clay that has many very pale brown mottles and that extends to a depth of 80 inches.

Included with this soil in mapping are small areas of Houston Black and Lewisville soils that make up less than 10 percent of any mapped area.

Nearly all areas of this soil are cultivated. Some small areas are in improved pasture. The hazard of erosion is moderate, and runoff is medium. Capability unit IIe-1; pasture and hay group 7A; Blackland range site.

## Burleson Series

The Burleson series consist of deep, nearly level to gently sloping, clayey soils on the higher alluvial terraces. These noncalcareous soils formed in alkaline clayey material.

In a representative profile the surface layer is dark-gray slightly acid clay about 38 inches thick. The next layer is 22 inches of gray, mildly alkaline clay. The underlying material is olive-gray, calcareous clay that extends to a depth of 93 inches.

Burleson soils are moderately well drained. They crack and take in water readily when dry, but permeability is very slow when they are wet. Available water capacity is high, and runoff is slow.

These soils are well suited to crops. Most of the acreage is cultivated; the rest is used for improved pasture and hay.

Representative profile of Burleson clay, 0 to 1 percent slopes, 1.25 miles south of Holland on Texas Highway 95 and 100 feet east of the highway, in a field:

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, fine, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; light gray (10YR 5/1) crust about 1/8 inch thick on surface; slightly acid; abrupt, smooth boundary.

A11—6 to 22 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, medium, blocky structure; extremely hard, very firm, very sticky and very plastic; shiny pressure faces on peds; slightly acid; diffuse, wavy boundary.

A12—22 to 38 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; intersecting slickensides border parallelepipeds that have the long axis tilted 30 to 60 degrees from the horizontal parting to moderate, fine and medium, blocky structure; extremely hard, very firm, very sticky and very plastic; shiny

pressure faces on peds; few, very dark brown, strongly cemented ferromanganese concretions 1 to 3 millimeters in diameter; slightly acid; diffuse, wavy boundary.

AC—38 to 60 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; common olive-gray (5Y 4/2) and few very dark gray (10YR 3/1) streaks; distinct intersecting slickensides border parallelepipeds that have the long axis tilted 30 to 60 degrees from the horizontal; extremely hard, very firm; shiny pressure faces on peds; few ferromanganese concretions; few, fine to medium, strongly cemented concretions of calcium carbonate; mildly alkaline; diffuse, wavy boundary.

C—60 to 93 inches, olive-gray (5Y 5/2) clay, light olive gray (5Y 6/2) moist; few slickensides and parallelepipeds; extremely hard, very firm; few ferromanganese concretions; calcareous; moderately alkaline.

The solum ranges from 60 to 80 inches in thickness. When this soil is dry, it has a hard, gray or light-gray sandy loam crust on the surface that ranges from 1/16 to ½ inch in thickness. When it is dry, this soil has cracks that are ½ inch to 2 inches wide at a depth of 20 inches. In undisturbed areas gilgai microrelief consists of knolls 3 to 10 inches higher than depressions. The distance between the center of the knolls and the center of the depressions range from 6 to 12 feet.

The A horizon ranges from 15 to 50 inches in thickness. It is dark gray or very dark gray clay. The AC horizon is dark gray or gray and has few to common, faint to distinct mottles of gray, brown, olive, and yellow. This horizon is mildly alkaline or moderately alkaline. The C horizon ranges from dark gray or gray to olive gray and light olive gray and has mottles of olive, brown, and yellow. This horizon is mildly alkaline or moderately alkaline.

**Burleson clay, 0 to 1 percent slopes** (BzA).—This nearly level soil is mostly in oval areas 20 to 2,500 acres in size. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Branyon and Wilson soils. The included areas make up 10 percent or less of any mapped area.

This soil is used mostly for crops. A few areas are in improved pasture. The hazard of erosion is slight. Capability unit IIw-1; pasture and hay group 7A; Blackland range site.

**Burleson clay, 1 to 3 percent slopes** (BzB).—This gently sloping soil is mostly adjacent to areas of nearly level Burleson soils and at the head of drainageways. Areas are irregular in shape and are 10 acres to more than 400 acres in size.

The surface layer is very dark gray clay 35 inches thick. The next layer is dark-gray clay that reaches to a depth of 60 inches. Below this is mottled, light olive-gray clay that extends to a depth of 80 inches.

Included with this soil in mapping are areas of Branyon and Wilson soils that make up less than 8 percent of any mapped area.

This soil is suited to crops, and most areas are cultivated. A few small areas are in improved pasture. The hazard of erosion is moderate. Capability unit IIe-1; pasture and hay group 7A; Blackland range site.

## Chigley Series

The Chigley series consists of deep, gently sloping, loamy soils on ancient high terraces. These noncalcareous soils formed in material weathered from marl and limestone. Slopes are convex.

In a representative profile the surface layer is 8 inches of dark grayish-brown gravelly fine sandy loam. The subsurface layer is reddish-brown very gravelly fine sandy loam about 7 inches thick. The next layer reaches to a depth of 46 inches. It is reddish-brown and light reddish-brown gravelly clay in the upper 21 inches and brownish-yellow clay in the lower 10 inches. The underlying material is yellow, soft, chalky, marly clay that extends to a depth of 50 inches.

Chigley soils are moderately well drained. Permeability is moderately slow, and available water capacity is medium. Runoff is medium.

These soils are used mostly as native pasture. A few areas that extend into fields of other soils are cultivated. Some areas are mined for gravel.

Representative profile of Chigley gravelly fine sandy loam, 1 to 3 percent slopes, 8 miles northwest of Temple on Texas Highway 36, then 5.5 miles north on Farm Road 2409, then 2.4 miles west on a county road, then 40 feet north of fence line, in post oak trees and pasture:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) gravelly fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; very hard, friable; 15 percent, by volume, gravel; slightly acid; clear, smooth boundary.

A2—8 to 15 inches, reddish-brown (5YR 5/3) very gravelly fine sandy loam, dark reddish brown (5YR 3/3) moist; massive but porous; very hard, friable; 80 percent, by volume, chert gravel; few cobblestones; slightly acid; clear, wavy boundary.

B21t—15 to 24 inches, reddish-brown (5YR 5/4) gravelly clay, reddish brown (5YR 4/4) moist; many, medium, distinct, yellowish-red (5YR 4/6) and brownish-yellow (10YR 6/6) mottles; weak, fine, angular blocky structure; very hard, very firm; 15 percent, by volume, chert gravel; medium acid; clear, smooth boundary.

B22t—24 to 36 inches, light reddish-brown (5YR 6/3) gravelly clay, reddish brown (5YR 5/3) moist; common and medium, olive (5Y 5/3) and brownish-yellow (10YR 6/6) mottles; moderate, fine, angular blocky structure; very hard, very firm; clay films on faces of peds; 15 percent, by volume, chert gravel; medium acid; clear, smooth boundary.

B3t—36 to 46 inches, brownish-yellow (10YR 6/6) clay, yellowish brown (10YR 5/6) moist; weak, coarse, angular blocky structure; extremely hard, very firm; few, small, ferromanganese concretions; slightly acid; abrupt, smooth boundary.

IICca—46 to 50 inches, yellow (2.5Y 7/6), soft, chalky, marly clay and nodular limestone; calcareous; moderately alkaline.

The solum ranges from 40 to 70 inches in thickness. The A1 horizon ranges from 6 to 8 inches in thickness. It is dark grayish brown or brown and ranges from 15 to 25 percent gravel. The A2 horizon ranges from 1 to 9 inches in thickness. This horizon is pale brown, brown, and reddish brown and ranges from 20 to 80 percent gravel. The B horizon ranges from 10 to 30 percent, by volume, gravel fragments and is medium acid or slightly acid. The B21t horizon is reddish brown, reddish yellow, or brown, or it is mottled in shades of red or brown. The B22t and B3t horizons are light reddish brown, brownish yellow, pale brown, or reddish brown. The B3t horizon is clay or clay loam. The IIC horizon is yellow or brownish yellow.

**Chigley gravelly fine sandy loam, 1 to 3 percent slopes** (ChB).—This gently sloping soil is on the top of small hills and on ridges of the highest old stream terraces in the county. Areas are mostly rounded and are 13 to 227 acres in size.

Included with this soil in mapping are a few small areas of Axtell soils.

This soil is used mostly as native range. The

hazard of erosion is moderate. Capability unit IIIe-1; pasture and hay group 8A; Claypan Savanna range site.

## Crawford Series

The Crawford series consists of moderately deep, nearly level to gently sloping, clayey soils on smooth uplands. These noncalcareous soils formed in clayey sediment underlain by limestone.

In a representative profile the surface layer is clay about 36 inches thick. It is dark brown in the upper 16 inches and dark reddish brown and calcareous in the lower 20 inches. Below this is honeycombed limestone bedrock.

Crawford soils are well drained. They crack and take in water readily when dry, but permeability is very slow when they are wet. Available water capacity is medium, and runoff is slow to medium.

These soils are well suited to crops, and most areas are cultivated. A few areas are in improved pasture.

Representative profile of Crawford clay, 0 to 1 percent slopes, 0.2 mile north on Interstate Highway 35 from its Salado Creek crossing in Salado, then 1 mile west on a county road, then 0.25 mile north on the same road and 15 feet east of the road, in a pasture:

Ap—0 to 5 inches, dark-brown (7.5YR 3/2) clay, dark brown (7.5YR 3/2) moist; weak to moderate, very fine, angular blocky structure; hard, firm, sticky; few, fine, quartz pebbles; few, fine, limestone fragments; neutral; abrupt, smooth boundary.

A11—5 to 16 inches, dark-brown (7.5YR 3/2) clay, dark brown (7.5YR 3/2) moist; moderate, medium, angular blocky structure parting to very fine, blocky; extremely hard, very firm, sticky; shiny faces on peds; neutral; gradual, smooth boundary.

A12—16 to 34 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/2) moist; moderate to coarse, angular blocky structure parting to fine, blocky; extremely hard, very firm, sticky; few parallelepipeds and slickensides that have the axis tilted more than 10 degrees from the horizontal; shiny pressure faces; neutral; clear, smooth boundary.

A13—34 to 36 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/2) moist; same structure and consistence as horizon above; few very small particles of limestone; calcareous; moderately alkaline; abrupt, irregular boundary.

R—36 to 70 inches, honeycombed limestone bedrock.

The solum is 20 to 40 inches thick. The Ap and A11 horizons range from 9 to 20 inches in thickness. They are very dark grayish brown, dark brown, brown, or dark reddish brown and slightly acid or neutral. The A12 and the A13 horizons are 11 to 27 inches thick and are dark brown, brown, or dark reddish brown. The A12 horizon is slightly acid or neutral, and the A13 horizon is neutral to moderately alkaline. Several times each year, cracks as wide as 1½ inches open as the soil dries and close as it is wetted.

**Crawford clay, 0 to 1 percent slopes** (CrA).—This nearly level soil is on uplands in smooth, irregularly shaped areas 9 to 150 acres in size. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of gently sloping Crawford, Denton, and Speck soils. Included areas make up less than 8 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. Some areas are in improved pasture. Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-1; pasture and hay group 7A; Deep Redland range site.

**Crawford clay, 1 to 3 percent slopes** (CrB).—This gently sloping soil is at the head of drainageways near the nearly level areas of Crawford clay. Areas are long, are irregular in shape, and are 8 to 350 acres in size.

The surface layer is brown clay 20 inches thick. The next layer is dark reddish-brown clay 11 inches thick. Below this is hard fractured limestone that reaches to a depth of 60 inches.

Included with this soil in mapping are small areas of nearly level Crawford soil and gently sloping Speck soils. Included areas make up less than 8 percent of the mapped acreage.

This soil is used mostly for cultivated crops. A few areas are in improved pasture. The hazard of erosion is moderate, and runoff is medium. Capability unit IIIe-5; pasture and hay group 7A; Deep Redland range site.

## Denton Series

The Denton series consists of moderately deep, nearly level to gently sloping and undulating, clayey soils on uplands. These calcareous soils formed in clayey material underlain by limestone and interbedded marl.

In a representative profile the surface layer is calcareous silty clay about 21 inches thick. It is dark grayish brown in the upper 6 inches and dark brown in the lower 15 inches. The next layer is dark-brown calcareous silty clay that reaches to a depth of 40 inches. Below this is fractured hard limestone.

Denton soils are well drained. Permeability is slow, and available water capacity is high. Runoff is medium to rapid.

These soils are suited to crops, and most areas are cultivated. Some areas are in native range.

Representative profile of Denton silty clay, 1 to 3 percent slopes, 0.3 mile south of Prairie Dell on a county road to a county road junction, then 7,200 feet west to another county road junction, then 100 feet north and 50 feet west of the road, in a field just off the north side of the fence line:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine to medium, subangular blocky and granular structure; hard, firm, sticky and plastic; few, fine limestone chips; calcareous; moderately alkaline; abrupt, smooth boundary.

A12—6 to 13 inches, dark-brown (7.5YR 3/2) silty clay, dark brown (7.5YR 3/2) moist; moderate, fine to medium, subangular blocky structure; very hard, firm, sticky and plastic; common very fine pores; few streaks or old cracks filled with material from horizon above; calcareous; moderately alkaline; gradual, wavy boundary.

A13—13 to 21 inches, dark-brown (7.5YR 3/2) silty clay, dark brown (7.5YR 3/2) moist; moderate, fine to medium, angular and subangular blocky structure; very hard, firm, sticky and plastic; common very fine pores; common shiny pressure faces; calcareous; moderately alkaline; gradual, wavy boundary.

B21—21 to 35 inches, dark-brown (7.5YR 4/4) silty clay, dark brown (7.5YR 3/4) moist; moderate, medium and fine, angular and subangular blocky structure; hard, firm, sticky and plastic; few dark streaks

of soil from horizon above; few fine limestone fragments; calcareous; moderately alkaline; gradual, wavy boundary.

B22ca—35 to 40 inches, dark-brown (7.5YR 4/4) silty clay, same color moist; same structure as horizon above; common, fine to medium, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; abrupt, irregular boundary.

R—40 to 60 inches, fractured hard limestone that cannot be cut with a spade

The solum ranges from 22 to 40 inches in thickness. The A horizon ranges from 16 to 30 inches in thickness. It is dark brown, dark grayish brown, or very dark grayish brown. The B2 horizon ranges from 10 to 19 inches in thickness and from brown to dark brown. The B horizon has stone lines in some profiles. The C horizon, where present, is clayey material over weakly cemented to indurated limestone and interbedded marl.

**Denton silty clay, 0 to 1 percent slopes** (DeA).—This nearly level soil generally is on broad flats or very gently rounded ridges. In some places it is in higher areas. Areas are small, are irregular in shape, and are mainly less than 45 acres in size.

The surface layer is dark grayish-brown silty clay 8 inches thick. The next layer is dark-brown silty clay that extends to a depth of 38 inches. The underlying material is fractured limestone.

Included with this soil in mapping are small areas of gently sloping Denton and San Saba soils.

Most areas of this soil are cultivated. A few areas are in pasture. The hazard of erosion is slight, and runoff is medium. Capability unit IIs-1; pasture and hay group 7C; Clay Loam range site.

**Denton silty clay, 1 to 3 percent slopes** (DeB).—This gently sloping soil is on low ridges. Areas mainly are irregular in shape and are less than 75 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of nearly level Denton, Purves, and San Saba soils. The included areas make up 10 percent or less of any mapped area.

This soil is suited to most crops commonly grown in the county. Most areas have been cultivated. Some areas are in native range, and other small areas are in improved pasture. The hazard of erosion is moderate, and runoff is medium. Capability unit IIe-2; pasture and hay group 7C; Clay Loam range site.

**Denton-Urban land complex, 1 to 3 percent slopes** (DnB).—This complex is made up of gently sloping soils on ridges and side slopes. Most areas are irregular in shape and are 5 to 50 acres in size. Denton soils make up about 66 percent of this mapping unit, Urban land about 25 percent, and Lewisville, Purves, and other soils about 9 percent. The soils and Urban land cannot be show separately at the scale mapped, because they are too intermingled or the areas are too small.

The Denton soils have a surface layer of dark grayish-brown, calcareous silty clay 8 inches thick. The next layer is dark-brown silty clay that reaches to a depth of 26 inches. The underlying material is fractured limestone.

Urban land areas are covered with works and structures. In Fort Hood these works and structures are barracks, streets, and motor pools. In Belton and Killeen they are mostly single-unit dwellings and attendant streets, driveways, sidewalks, patios, and cemeteries. Because the topography is smooth, much of the soil has not been disturbed during construction. Shallow ditches along roads and streets account for most of the soil movement.

Features of the soils in this complex that affect urban development are shrink-swell potential, which can cause cracking and shifting of structures; corrosivity, which causes deterioration of pipelines and steel in the ground; and silty clay texture, which becomes sticky and plastic when wet. Nearly all new dwellings are built on a floating reinforced concrete slab so that the effects of the shrink-swell behavior of these soils are reduced. Not placed in interpretive groups.

**Denton association, undulating** (DPB).—This association is mostly on the Fort Hood Military Reservation. Soil areas are mainly in saddles between hills and on foot slopes. Slopes are 1 to 8 percent. Mapped areas are irregular in shape and are 200 acres to more than 1,000 acres in size. A mapped area generally is about 50 percent Denton soils and about 50 percent other soils. The percentage of Denton soils ranges from 20 to 70. Denton soils and closely similar, deep or moderately deep soils are dominant in all mapped areas. The soils could be separated in mapping but are not because their use and management are similar. Areas of this association are much larger and composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils.

The Denton soils are mostly in wide valleys. They have a surface layer of dark grayish-brown silty clay about 18 inches thick. The next layer is dark-brown silty clay that reaches to a depth of 36 inches. The underlying material is fractured limestone.

Included with these soils in mapping are Brackett, Krum, and Purves soils. Brackett and Purves soils are mainly in areas above Denton soils, and Krum soils are in small, irregularly shaped areas mostly below Denton soils.

The soils in this association are mostly in native vegetation. They are used for army maneuvers as well as range. Runoff is medium to rapid, and the hazard of erosion is moderate. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

## Eddy Series

The Eddy series consists of nearly level to sloping, calcareous, loamy soils on uplands (fig. 3). These shallow to very shallow soils formed in material weathered from strongly cemented chalky limestone.

In a representative profile the surface layer is about 5 inches of light brownish-gray gravelly clay loam that is 35 to 40 percent chalk fragments. The next layer is 3 inches of light brownish-gray very gravelly clay loam that is 85 to 90 percent chalk fragments. The underlying material is white chalky limestone.

*Figure 3.*—**Profile of an Eddy gravelly loam that shows platy chalk fragments.**

Eddy soils are well drained. Permeability is moderately slow, and available water capacity is very low. Runoff is medium to rapid.

These soils are used mostly as pasture. A few small areas are cultivated, and some areas are sites of rock quarries. The chalky limestone in the substratum is a source of material for road surfaces and subgrades.

Representative profile of Eddy gravelly clay loam, in an area of Eddy-Stephen complex, 0 to 3 percent slopes, 1.5 miles west on a county road from its intersection with Interstate Highway 35 in Troy to a crossroad, then 0.9 mile south on another county road and 50 feet east of the road, in a field:

A—0 to 5 inches, light brownish-gray (10YR 6/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate, very fine, granular and subangular blocky structure; hard, friable, sticky; 35 to 40 percent chalk fragments that are less than 3 inches in diameter; calcareous; moderately alkaline; abrupt, irregular boundary.

A&C—5 to 8 inches, light brownish-gray (10YR 6/2) very gravelly clay loam, dark grayish brown (10YR 4/2) moist; 85 to 90 percent chalk fragments that are less than 3 inches in diameter; soil material in cracks between limestone particles; plant roots in soil-filled interstices; calcareous; moderately alkaline; clear, wavy boundary.

C—8 to 60 inches, white, marine, chalky limestone that has a hardness of less than 3 on the Mohs scale.

The solum ranges from 5 to 12 inches in thickness. The A horizon ranges from 3 to 6 inches in thickness and is 35 percent to more than 50 percent, by volume, chalk fragments that are less than 3 inches across the long axis. This horizon is light brownish gray, very dark grayish brown, dark grayish brown, grayish brown, and pale brown. In places where the soil is very dark grayish brown, the A horizon is less than 4 inches thick. The A&C horizon ranges from 2 to 5 inches in thickness and is 60 to 95 percent, by volume, chalk fragments. This horizon is light brownish gray, very dark grayish brown, dark grayish brown, grayish brown, and pale brown. In the C horizon the chalky limestone ranges in hardness from about 1 to slightly less than 3 on the Mohs scale.

**Eddy-Stephen complex, 0 to 3 percent slopes** (EsB).—This complex is made up of nearly level to gently sloping soils on the tops of ridges and the sides of slopes. Most areas are oval in shape and are 7 to 50 acres in size. This complex is about 50 percent Eddy soils, 47 percent Stephen soils, and 3 percent other soils. The included soils cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

An Eddy soil in this complex has the profile described as representative of the series.

This Stephen soil has a surface layer of dark grayish-brown silty clay about 10 inches thick. The next layer is dark grayish-brown silty clay about 4 inches thick. It is about 35 percent soft chalk fragments. Below this is light-gray, soft platy chalk.

Included with these soils in mapping are small areas of Austin soils that make up less than 8 percent of any mapped area.

The soils in this complex are better suited to improved pasture than to most other uses. They are not suited to crops. Most areas are used as pasture. The hazard of erosion is moderate, and runoff is medium. Capability unit IVs-1; pasture and hay group 14A; Chalky Ridge range site.

**Eddy-Stephen complex, 3 to 8 percent slopes** (EsD).—This complex is made up of gently sloping to sloping soils on the sides of slopes and the tops of ridges. Areas are mostly long and narrow and are 7 to 40 acres in size. This complex is about 56 percent Eddy soils, 42 percent Stephen soils, and 2 percent other soils. The soils cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

This Eddy soil has a surface layer, about 5 inches thick, of light brownish-gray very gravelly clay loam that is about 35 percent, by volume, chalk fragments. Below this is 3 inches of light brownish-gray very gravelly clay loam that is 85 percent chalk fragments. The underlying material is white chalky limestone.

This Stephen soil has a surface layer of dark grayish-brown silty clay 10 inches thick. Below this is 4 inches of dark grayish-brown silty clay that is about 35 percent soft chalk fragments. Below a depth of 14 inches is light-gray, soft platy chalk.

Included with these soils in mapping are areas of Austin soils and two large areas, about 3 and 4 miles south of Temple, that have slopes of 6 to 30 percent or more. Hartrick's Bluff along the Leon River is one of these areas.

The soils in this complex are suited to improved pasture, and most areas are used as pasture. They are not suited to crops. The hazard of erosion is severe, and runoff is rapid. Capability unit VIe-3; pasture and hay group 14A; Chalky Ridge range site.

## Ferris Series

The Ferris series consists of sloping to strongly sloping, calcareous, clayey soils on uplands. These deep soils formed in shaly clay and marl.

In a representative profile the surface layer is olive calcareous clay about 8 inches thick. The next layer is about 28 inches of pale-olive calcareous clay that has brownish-yellow mottles. The underlying material is mottled, pale-olive and yellow marly and shaly clay that extends to a depth of 80 inches.

Ferris soils are well drained. Permeability is very slow, and available water capacity is high. Runoff is rapid.

These soils are better suited to improved pasture than to most other uses. A few areas are in improved pasture, but most areas are formerly cultivated fields where stands of grass are thin.

Representative profile of Ferris clay in an area of Ferris-Heiden complex, 5 to 12 percent slopes, eroded, 3.2 miles northwest on Texas Highway 36 from its intersection with Farm Road 437 in Rogers, then 1 mile south on a county road, then 30 feet west of the fence line, in a pasture:

Ap—0 to 8 inches, olive (5Y 5/3) clay, olive (5Y 4/3) moist; weak, fine, angular to subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few, fine, pale-olive (5Y 6/3 moist) streaks (apparently material brought up by earthworms from below); calcareous; moderately alkaline; gradual, smooth boundary.

AC—8 to 36 inches, pale-olive (5Y 6/3) clay, olive (5Y 5/3) moist; faint brownish-yellow (10YR 6/8) mottles; compound, fine to medium subangular blocky and fine angular blocky structure; extremely hard, very firm, very sticky and very plastic; common, coarse, intersecting slickensides; parallelepipeds that have the long axis tilted as much as 45 degrees from the horizontal; shiny pressure faces when moist; vertical cracks ½ inch to 2 inches wide and about 2 feet apart extend to a depth of 36 inches; calcareous; moderately alkaline; diffuse, wavy boundary.

C1—36 to 56 inches, mottled, pale-olive (5Y 6/3) and yellow (10YR 7/8) marly clay, mottles are prominent and coarse; massive; shiny faces on blocks when moist; few, fine, soft masses of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

C2—56 to 80 inches, mottled, pale-olive (5Y 6/3) and yellow (10YR 7/8) shaly clay; mottles are coarse; small, soft, black splotches; calcareous; moderately alkaline.

The solum ranges from 35 to 65 inches in thickness. The A horizon ranges from 4 inches to about 10 inches in thickness and is olive, light olive brown, or olive gray. The AC horizon ranges from 18 to 38 inches in thickness and is pale olive, olive, or olive yellow.

**Ferris-Heiden complex, 5 to 12 percent slopes, eroded** (FeE2).—This complex is made up of sloping to strongly sloping clayey soils in areas 8 acres to more than 700 acres in size. All areas are cut by many natural drainageways and gullies. This complex is about 51 percent Ferris soils, 20 percent Heiden clay, and 29 percent areas that have gullies and small areas of Altoga, Houston Black, and other soils. The included soils cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

This Ferris soil is in the more sloping and eroded areas that lead to natural drainageways. It has the profile described as representative of the series.

The Heiden soil in this complex is on the tops of ridges and in other less sloping areas. It has a surface layer of dark grayish-brown clay 18 inches thick. The next layer is olive-gray clay that reaches to a depth of 48 inches. Below this is mottled, olive and yellow shaly clay that extends to a depth of 70 inches.

The soils in this complex are not suited to crops. They are better suited to improved pasture than to most other uses. Most areas are abandoned fields that have a thin plant cover. The hazard of erosion is severe (fig. 4). Capability unit VIe-2; pasture and hay group 7B; Eroded Blackland range site.

## Frio Series

The Frio series consists of deep, nearly level, clayey soils on flood plains of major streams. These calcareous soils formed in alluvial material.

In a representative profile the surface layer is calcareous silty clay about 78 inches thick. It is dark grayish brown in the upper 36 inches and brown in the lower 42 inches. Below this is brown calcareous silty clay that extends to a depth of 88 inches.

Frio soils are well drained. Permeability is moderately slow, and available water capacity is high. Runoff is slow.

These soils in occasionally flooded areas are mostly in crops and have a potential for irrigation. These soils in frequently flooded areas are in pasture and pecan trees.

Representative profile of Frio silty clay, 2.2 miles north on Texas Highway 95 from its intersection with Farm Road 2268 in Holland, then 4 miles east on a county road to the bridge over Little River, then 0.7 mile north to a turn in road, then 30 feet northwest, in a field:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky and granular structure; hard, firm, sticky and plastic; few small snail shell fragments; calcareous; moderately alkaline; abrupt, smooth boundary.

A11—6 to 36 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, firm, sticky and plastic; calcareous; moderately alkaline; diffuse, smooth boundary.

A12—36 to 78 inches, brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate, medium, granular structure; hard, firm; calcareous; moderately alkaline; diffuse, smooth boundary.

C—78 to 88 inches, brown (10YR 5/3) silty clay, brown (10YR 4/3) moist; massive but porous; hard, firm; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 72 to 96 inches in thickness. The A horizon ranges from 22 to 80 inches in thickness and is brown, dark grayish brown, or very dark grayish brown. A buried horizon that is similar to the A horizon is common below a depth of 40 inches. The C horizon is brown, light gray, or dark grayish brown. It ranges from clay loam to silty clay. This horizon has a few films and threads of calcium carbonate and a few thin strata of sand or sand and fine gravel.

**Frio silty clay** (Fr).—This nearly level soil is in higher areas of flood plains of streams that drain mostly limestone soils. It has the profile described as representative of the series. Slopes range from 0 to 1 percent. Areas are long and irregular to oval

*Figure 4.*—Area of Ferris-Heiden complex, 5 to 12 percent slopes, eroded. Mesquite trees are invading this gullied area.

and are 10 acres to several hundred acres in size. The largest areas of this soil are protected from flooding by Belton and Stillhouse Hollow Dams. Areas above these dams are flooded once every 4 to 10 years.

Included with this soil in mapping are small areas of Bosque soils, Frio soils, frequently flooded, and Trinity soils. The included areas make up less than 10 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. Flooding does not limit the use of this soil for crops, because most flooding occurs early in spring before crops are planted. This soil receives extra water as runoff and has potential for irrigated crops. A few areas are in improved pasture. The hazard of erosion is slight. Capability unit I-1; pasture and hay group 1C; Loamy Bottomland range site.

**Frio silty clay, frequently flooded** (Fs).—This soil is on flood plains in lower areas that are long and narrow and are 10 to 100 acres in size. It is flooded as often as once or twice a year. Mapped areas include sloughs and slopes leading down to the sloughs. Slopes range from 0 to 1 percent.

The surface layer is dark grayish-brown silty clay that reaches to a depth of 36 inches. The next layer is brown silty clay that extends to a depth of 80 inches.

Included with this soil in mapping are small areas of Frio silty clay, of Frio soils that have slopes of 1 to 3 percent, and of Trinity clay, frequently flooded. Included areas make up less than 10 percent of any mapped area.

This soil is mainly in improved pasture and pecan trees. It is not suited to cultivation. The hazard of erosion is slight. Capability unit Vw-1; pasture and hay group 1C; Loamy Bottomland range site.

## Heiden Series

The Heiden series consists of gently sloping to sloping, calcareous, clayey soils on uplands. These deep soils formed in clayey material.

In a representative profile the surface layer is dark grayish-brown clay about 36 inches thick. The next layer is olive-gray clay about 22 inches thick. The underlying material is mottled, olive and yellow shaly clay that extends to a depth of 70 inches.

Heiden soils are well drained. Permeability is very slow, and available water capacity is high. Runoff is rapid. When these soils are dry, cracks form in the surface that are as much as 2 inches wide and that extend to a depth of 40 to 60 inches. Water rapidly enters the cracks when they are open, but after the soil is wet, the cracks close and water intake is very slow.

These soils are suited to crops, and most areas are cultivated. Some areas are in improved pasture.

Representative profile of Heiden clay, 1 to 3 percent slopes, 0.57 mile southeast on Texas Highway 36 from its intersection with Farm Road 436 in Heidenheimer, then 15 feet southwest of the highway, in a field, in an old microdepression:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; weak, angular blocky structure; very hard, very firm, very sticky and very plastic; many grass roots; few worm casts; few snail shell fragments; calcareous; moderately alkaline; abrupt, clear boundary.

A11—6 to 18 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, angular blocky structure; extremely hard, very firm, and very plastic; few grass roots; few parallelepipeds in lower part; shiny faces on peds; calcareous; moderately alkaline; diffuse, wavy boundary.

A12—18 to 36 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, medium and coarse, angular blocky structure; extremely hard, very firm, very sticky and very plastic; parallelepipeds about 1 to 3 inches long that have the axis tilted 10 to 60 degrees from the horizontal; intersecting slickensides; common white concretions of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

AC—36 to 58 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; few, fine, faint, olive mottles and streaks; weak, coarse, angular blocky structure; extremely hard, very firm, very sticky and very plastic; parallelepipeds about 1 to 3 inches long that have the axis tilted 10 to 60 degrees from the horizontal; intersecting slickensides; common white concretions of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

C—58 to 70 inches, mottled, olive (5Y 5/3) and yellow (5Y 7/6) moist shaly clay; mottles are fine and coarse, prominent; massive; extremely hard, very firm, and very plastic; few slickensides in upper part; calcareous; moderately alkaline.

The combined A and AC horizons range from about 40 to 65 inches in thickness. In undisturbed areas there are microknolls about 6 to 12 inches higher than the microdepressions. The A horizon ranges from 12 inches in thickness at the center of the microknolls to 36 inches in thickness at the center of the microdepressions. The average thickness of the A horizon is more than 12 inches. The A horizon is very dark grayish brown, dark grayish brown, or olive gray. In places this horizon has small fragments of snail shell. The AC horizon ranges from 20 to 40 inches in thickness. It is yellowish brown, olive gray, or olive. In some profiles this horizon has a few calcium carbonate concretions and a few soft masses of calcium carbonate. The C horizon ranges from strongly weathered shaly clay to slightly weathered calcareous shale and shale that has limestone flagstones in places.

**Heiden clay, 1 to 3 percent slopes** (HeB).—This soil is in oblong areas on divides and foot slopes. Most areas are about 60 acres in size but range from 10 acres to more than 500 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Heiden clay, 3 to 5 percent slopes, and Houston Black soils. The included areas make up less than 10 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. A few areas are in improved pasture. The hazard of erosion is moderate. Capability unit IIe-1; pasture and hay group 7A; Blackland range site.

**Heiden clay, 3 to 5 percent slopes** (HeC).—This soil is in oblong areas that lead to natural drainageways. Areas average about 40 acres in size.

This soil is dark grayish-brown clay in the upper 16 inches, yellowish-brown clay in the next 36 inches, and mottled, olive and yellow shaly clay in the lower 18 inches.

Included with this soil in mapping are small areas of gently sloping Heiden clay, small areas of Heiden-Ferris complex, 3 to 8 percent slopes, eroded, and small areas of a soil that has gullies. Included areas make up less than 10 percent of any mapped area.

This soil is cultivated in places where it is joined by large areas of a gently sloping Heiden clay. It is well suited to improved pasture, and many areas are planted to improved pasture. The hazard of erosion is severe. A few gullies have formed, but they are easily crossed by farm machinery. Capability unit IIIe-2; pasture and hay group 7A; Blackland range site.

**Heiden stony clay, 3 to 8 percent slopes** (HfD).—This soil is on the sides of hills. On the top of the hills are outcrops of limestone that form the cap of an escarpment. The limestone cap ranges from less than 1 foot to about 4 feet in thickness. Scattered down the sides of the hill are stones that have broken off from the limestone cap as a result of erosion. Areas of this soil are irregular in shape and are 10 to 50 acres in size.

This soil is dark grayish-brown calcareous clay in the upper 16 inches, olive clay in the next 15 inches, and mottled, olive and yellow marly clay in the lower 14 inches. Large and small, hard limestone stones are scattered on the surface and in the upper part of this soil. These stones are 10 inches to 5 feet in diameter and cover 5 to 10 percent of the surface.

Included with this soil in mapping are small areas of Ferris soils and small areas of soils that are eroded and gullied.

This soil is suitable for pasture, and most areas are used as pasture. The hazard of erosion is severe. Capability unit VIe-2; Blackland range site.

**Heiden-Ferris complex, 3 to 8 percent slopes, eroded** (HgD2).—This complex is made up of clayey soils on the sides of hills and in drainageways. Most areas are oblong or irregular in shape and are 10 to 800 acres in size. Heiden clay, 3 to 8 percent slopes, eroded, makes up about 72 percent of the complex; Ferris clay, 3 to 8 percent slopes, eroded, makes up 26 percent; and Houston Black and other soils make up 2 percent. In many places erosion has removed much of the surface layer and exposed the subsoil. These soils cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

This Heiden soil is dark grayish-brown clay in the upper 16 inches, yellowish-brown clay in the next 36 inches, and mottled olive and yellow clay in the lower 18 inches.

This Ferris soil is olive clay in the upper 8 inches. The next 28 inches is pale-olive clay that has faint, brownish-yellow mottles. The underlying material is mottled, pale-olive and yellow marly and shaly clay that extends to a depth of 80 inches.

Included with these soils in mapping are small

areas of Ferris and Heiden soils that have slopes of less than 3 percent. Included areas are 2 to 8 acres in size and make up less than 10 percent of any mapped area.

The soils in this complex are suited to pasture. Most areas have been cultivated in the past but are being planted to improved pasture and to hay. Runoff is rapid, and the hazard of erosion is severe. A few gullies are in this mapping unit, and most of the deeper ones cannot be crossed by farm machinery. Capability unit IVe-1; pasture and hay group 7B; Blackland range site.

## Houston Black Series

The Houston Black series consists of nearly level to gently sloping, calcareous, clayey soils on uplands. These deep soils formed in clay and marl.

In a representative profile the surface layer is clay about 46 inches thick. It is very dark gray in the upper 24 inches and dark gray in the lower 22 inches. The next layer is gray clay that reaches to a depth of 68 inches. The underlying material is coarsely mottled, light-gray and yellow clay that extends to a depth of 110 inches (fig. 5).

Houston Black soils are moderately well drained. Runoff is slow to rapid. Permeability is very slow, and available water capacity is high. When these soils are dry, cracks form on the surface and extend to a depth of more than 40 inches. Water rapidly enters the cracks when they are open, but after the soil is wet, the cracks close and water moves very slowly through the soil.

Most areas of these soils are cultivated, but some areas are used for pasture and hay.

Representative profile of Houston Black clay, 1 to 3 percent slopes, 12.3 miles east of the Municipal Building in downtown Temple on Texas Highway 53 to junction with Farm Road 485, then 250 feet north of the edge of Farm Road 485 and 225 feet east of the edge of Texas Highway 53, in a native meadow:

A11—0 to 8 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, fine, subangular blocky structure parting to very fine, angular blocky; very hard, very firm, very sticky and plastic; many grass roots; few worm casts; few snail shell fragments; shiny faces on peds; calcareous; moderately alkaline; gradual, wavy boundary.

A12—8 to 24 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, fine and very fine, angular blocky structure; extremely hard, very firm, very sticky and plastic; many grass roots; few worm casts; few snail shell fragments; shiny faces on peds; few, fine, weakly cemented concretions of ferromanganese; calcareous; moderately alkaline; gradual, wavy boundary.

A13—24 to 46 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; intersecting slickensides border parallelepipeds that have the long axis tilted 40 to 60 degrees from the horizontal parting to moderate, coarse, blocky structure; extremely hard, very firm, very sticky and plastic; common grass roots; few, fine, black masses of ferromanganese; few, fine, strongly cemented concretions of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

AC—46 to 68 inches, gray (10YR 6/1) clay, gray (10YR 5/1) moist; few, fine, distinct, olive-brown (2.5Y 4/4) mottles; weak, very coarse, blocky structure; extremely hard, very firm, very sticky and plastic; few fine roots; common strongly cemented concretions and few soft masses of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

C—68 to 110 inches, mottled, light-gray (10YR 7/1) and yellow (2.5Y 7/6) clay; common, coarse, distinct, olive and brown mottles; massive; very hard; firm, very sticky and plastic; few strongly cemented concretions and few soft masses of calcium carbonate; calcareous; moderately alkaline.

*Figure 5.*—**A coarse-grooved slickenside in a profile of a Houston Black clay.**

The A and AC horizons combined range from about 60 to more than 100 inches in thickness. In undisturbed areas the gilgai microrelief consists of knolls that are 3 to 15 inches higher than depressions. The distance between the center of the knolls and the center of the depressions ranges from about 6 to 12 feet. At a depth of 20 to 24 inches are intersecting slickensides. The A horizon ranges from 6 inches in thickness on the microknolls to as much as 66 inches in thickness in the microdepressions. It is gray, dark gray, very dark gray, or black. The AC horizon is gray, grayish brown, dark grayish brown, or dark gray and has few to common mottles of olive brown, olive, and yellow. The C horizon is yellow, light brownish gray, or light gray.

**Houston Black clay, 0 to 1 percent slopes** (HoA).—This nearly level soil is on ridgetops and on upland divides. Areas are irregular in shape and are 5 to 100 acres in size. On the surface is a mulch of fine, discrete, very hard aggregates.

The surface layer is very dark gray clay about 25 inches thick. Below this is dark-gray clay that reaches to a depth of 48 inches. The next layer is gray clay that extends to a depth 70 inches. The underlying material is coarsely mottled, light-gray and yellow clay that extends to a depth of 100 inches.

Included with this soil in mapping are small areas of gently sloping Heiden and Houston Black soils. The included areas make up less than 8 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. A few areas are in improved pasture. The hazard of erosion is slight. Capability unit IIw-1; pasture and hay group 7A; Blackland range site.

**Houston Black clay, 1 to 3 percent slopes** (HoB).—This gently sloping soil is in areas irregular in shape and 5 acres to more than 1,000 acres in size. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Heiden and Houston Black soils that have slopes of 0 to 1 percent and areas that have slopes of 3 to 5 percent. Also included are small areas of a soil that is similar to Houston Black soils but is underlain by chalky limestone at a depth of 24 to 40 inches. Included areas make up less than 8 percent of any mapped area.

This soil is well suited to crops, and nearly all areas are cultivated. A few areas are used for improved pasture and hay. The hazard of erosion is moderate. Capability unit IIe-1; pasture and hay group 7A; Blackland range site.

**Houston Black clay, 3 to 5 percent slopes** (HoC).—This gently sloping soil is in irregularly shaped areas 5 to 100 acres in size.

The surface layer is black clay about 20 inches thick. Below this is very dark gray clay that reaches to a depth of 31 inches. The next layer is dark-gray clay that extends to a depth of 43 inches. The underlying material is mottled yellow, light-gray, and light brownish-gray clay that extends to a depth of 66 inches.

Included with this soil in mapping are some areas of Heiden soils and small areas of Houston Black soils that have slopes of 1 to 3 percent. Included areas make up less than 10 percent of any mapped area.

This soil is suited to crops, and many areas are cultivated. A few areas are used for improved pasture and hay. The hazard of erosion is severe. Capability unit IIIe-2; pasture and hay group 7A; Blackland range site.

**Houston Black-Urban land complex, 1 to 5 percent slopes** (HuC).—This complex is made up of gently sloping soils on divides and along drainageways, mainly in Killeen and Temple. Slopes are mostly less than 3 percent. Mapped areas are irregular in shape and are 10 to 150 acres in size. Houston Black soils make up 70 percent of this complex, Urban land 27 percent, and other soils 3 percent. The soils and Urban land cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

These Houston Black soils have a surface layer of very dark gray clay about 25 inches thick. Below this is dark-gray clay that reaches to a depth of 48 inches. The underlying material is gray clay that extends to a depth of 70 inches.

Urban land areas are mostly occupied by single-unit dwellings and such works and structures as streets, sidewalks, buildings, driveways, paved parking lots, and patios. Schools and school grounds and small one-story factories are in some areas.

The shrink-swell potential of the soils in this complex is very high. The soils have cracks as much as 2 inches wide when they are dry. The cracks can cause a concrete sidewalk, concrete floor, or brick wall to crack; therefore, such precaution as reinforcing foundation material with steel rods is needed to prevent damage to structures. In addition, these soils are sticky and plastic when they are wet, their infiltration rate is very slow, and they have a high pH value, which limits the kinds of ornamental shrubs, trees, and flowers that can be grown. Corrosivity causes deterioration of pipelines and steel in the soil. An extra-thick crushed rock and gravel base is needed under all road and street surfaces. Not placed in interpretive groups.

## Krum Series

The Krum series consists of nearly level to gently sloping and undulating, calcareous soils. These deep, clayey soils are mainly on alluvial stream terraces along the larger streams in the county, but small areas are on foot slopes and in narrow valleys. These soils formed in unconsolidated, clayey sediment.

In a representative profile the surface layer is silty clay about 36 inches thick. It is dark grayish brown in the upper 16 inches and very dark grayish brown in the lower 20 inches. The next layer is dark-brown or brown silty clay that reaches to a depth of 66 inches. The underlying material is very pale brown silty clay that extends to a depth of 82 inches.

Krum soils are well drained. Permeability is moderately slow, and available water capacity is high. Runoff is slow to rapid.

These soils are well suited to crops. Most areas are cultivated, but the areas in the Fort Hood Military Reservation are mainly used as range for livestock. Some areas are in improved pasture.

Representative profile of Krum silty clay, 0 to 1 percent slopes, 3.2 miles south on Farm Road 1741 from its intersection with Loop 363 in the southern part of Temple to Taylors Valley Church, then 0.75 mile west on the road and 30 feet north of the road, in a field:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; hard, firm but crumbly, sticky and plastic; calcareous; moderately alkaline; abrupt, smooth boundary.

A12—5 to 16 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moder-

ate, fine, subangular blocky structure; hard, firm but crumbly, sticky and plastic; common roots; calcareous; moderately alkaline; gradual, wavy boundary.

A13—16 to 36 inches, very dark grayish brown (10YR 3/2) silty clay, very dark grayish brown moist; strong, medium, subangular blocky structure; hard, very firm, sticky and plastic; few, fine, angular blocky peds; shiny pressure faces on a few peds; cracks filled with dark soil material from above; calcareous; moderately alkaline; gradual, wavy boundary.

B21—36 to 58 inches, dark-brown (10YR 3/3) silty clay, dark brown (10YR 3/3) moist; moderate, medium to coarse, subangular blocky structure; very hard, very firm, sticky and plastic; shiny pressure faces on peds; vertical streaks of darker soil from above; few weakly and strongly cemented concretions of calcium carbonate in lower part; calcareous; moderately alkaline; gradual, irregular boundary.

B22—58 to 66 inches, brown (10YR 4/3) silty clay; brown (10YR 4/3) moist; strong, medium, subangular blocky structure; hard, firm, sticky; 2 percent, by volume, visible soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; diffuse, irregular boundary.

C1ca—66 to 82 inches, very pale brown (10YR 7/3) silty clay, pale brown (10YR 6/3) moist; massive; common, scattered, soft masses and few concretions of calcium carbonate.

The solum ranges from about 40 inches to more than 60 inches in thickness. The A horizon ranges from 22 inches to about 44 inches in thickness. This horizon ranges from dark gray, dark grayish brown, or very dark grayish brown to dark brown. The B2 horizon is 18 to 44 inches thick and is dark brown or brown. The C horizon ranges from brown, light olive brown, or very pale brown to reddish yellow. This horizon is about 2 to 20 percent, by volume, concretions and powdery masses of visible calcium carbonate.

**Krum silty clay, 0 to 1 percent slopes** (KrA).—This nearly level soil is on alluvial stream terraces along the larger streams in the county. Areas are long and narrow and are 5 acres to about 150 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Branyon and Burleson soils. The included areas do not make up more than 8 percent of any mapped area.

This soil is well suited to crops, and nearly all areas are cultivated. A few areas are used for improved pasture and hay. The hazard of erosion is slight. Capability unit IIs-1; pasture and hay group 7C; Clay Loam range site.

**Krum silty clay, 1 to 3 percent slopes** (KrB).—This gently sloping soil is in curved bands on terraces along major streams as well as at the head of drainageways. Most areas border areas of nearly level Krum soils and are 5 to about 150 acres in size.

The surface layer is very dark grayish brown silty clay 6 inches thick. Below this is dark-gray silty clay that reaches to a depth of 29 inches. The next layer is brown silty clay that reaches to a depth of 54 inches. Below this is light olive-brown silty clay that extends to a depth of 70 inches.

Included with this soil in mapping are small areas of nearly level Krum and gently sloping Lewisville soils. Included areas are less than 5 acres in size and make up less than 5 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. A few areas are in improved pasture, and a few areas are in range. The hazard of erosion is moderate. Capability unit IIe-2; pasture and hay group 7C; Clay Loam range site.

**Krum-Urban land complex, 0 to 3 percent slopes** (KuB).—This complex is made up of nearly level to gently sloping soils. The soils are mainly in Belton, but some areas are in Fort Hood and Killeen. About two-thirds of the acreage has slopes of 0 to 1 percent. Mapped areas are 5 to 50 acres in size. Krum silty clay makes up about 68 percent of this mapping unit, Urban land about 26 percent, and Lewisville and other soils about 6 percent. The soils and Urban land cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

This Krum soil has a surface layer of very dark grayish-brown silty clay about 6 inches thick. Below this is dark-gray silty clay that reaches to a depth of 30 inches. The next layer is brown silty clay that reaches to a depth of 54 inches. Below this is light olive-brown silty clay that extends to a depth of 70 inches.

Urban land areas are occupied by such works and structures as single-unit dwellings, army barracks, streets, driveways, sidewalks, patios, schools and school grounds, and paved parking lots. Because the topography is smooth, little soil has been disturbed during construction.

Features of the soils in this complex that affect urban development are shrink-swell potential, which can cause cracking and shifting of structures; corrosivity, which results in the deterioration of pipelines and steel in the soil; high pH value, which limits the kinds of ornamental shrubs, trees, and flowers that can be grown; and clay texture, which becomes sticky and plastic when wet. Nearly all new dwellings are built on a floating reinforced concrete slab so that the effects of the shrink-swell behavior of these soils are reduced. Not placed in interpretive groups.

**Krum-Lewisville association, undulating** (KVB).—This association is mostly on the foot slopes of the higher limestone hills and in narrow valleys that are drainageways from the hill country. Areas are irregular in shape and are 100 acres to more than 1,000 acres in size. Most areas are on the Fort Hood Military Reservation. Krum soils make up about 53 percent of the mapping unit, Lewisville soils 37 percent, and Frio and Purves soils 10 percent. Krum and Lewisville soils are in all delineations and are about equal in extent in the average area, but the percentage of either soil ranges from 25 to 65. Areas of this association are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils. The soils could have been mapped separately, but their projected long-term uses, such as maneuver areas for Fort Hood troops and as range for livestock, made separation in mapping impractical.

The Krum soils have a surface layer of very dark grayish-brown silty clay about 8 inches thick. Below this is dark-gray silty clay that reaches to a depth of 29 inches. The next layer is brown silty clay that

extends to a depth of 54 inches. Below this is olive-brown silty clay that reaches to a depth of 70 inches.

The Lewisville soils have a surface layer of dark-brown silty clay about 18 inches thick. Below this is brown silty clay that extends to a depth of 34 inches. The next layer is strong-brown silty clay that extends to a depth of 44 inches. Below this is reddish-yellow silty clay that reaches to a depth of 70 inches.

The soils in this association are used mostly for army maneuvers and as range for livestock. They are well suited to range. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

## Lewisville Series

The Lewisville series consists of deep, gently sloping and undulating clayey soils on stream terraces and foot slopes below limestone hills. These calcareous soils formed in alluvium.

In a representative profile the surface layer is dark-brown silty clay about 18 inches thick. The next layer is brown to strong-brown silty clay that reaches to a depth of 44 inches. The underlying material is reddish-yellow silty clay that extends to a depth of 70 inches.

Lewisville soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is medium.

These soils are suited to crops, and most areas in the eastern part of the county are cultivated. Most areas in the western part are in native range. A few areas are in improved pasture.

Representative profile of Lewisville silty clay, 1 to 3 percent slopes, 3.2 miles south on Farm Road 1741 from its intersection with Loop 363 in the southern part of Temple, then 0.5 mile south and 0.55 mile west of Taylors Valley Church, and 50 feet north of the road, in a field:

Ap—0 to 4 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; weak, very fine, subangular blocky structure; hard, friable, sticky; few worm casts on surface; few fine calcium carbonate concretions throughout; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—4 to 18 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate, fine, granular and subangular blocky structure; hard, friable, sticky; few worm casts, some the color of the underlying material; few fine calcium carbonate concretions; calcareous; moderately alkaline; clear, wavy boundary.

B21—18 to 34 inches, brown (7.5YR 4/4) silty clay, brown (7.5YR 4/4) moist; moderate, fine, subangular blocky structure; hard, friable, sticky; few fine calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.

B22—34 to 44 inches, strong-brown (7.5YR 5/6) silty clay, strong brown (7.5YR 5/6) moist; moderate, fine, subangular blocky structure; hard, friable; few fine calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.

Cca—44 to 70 inches, reddish-yellow (7.5YR 7/6) silty clay, reddish yellow (7.5YR 6/6) moist; weak, subangular blocky structure; hard, friable; numerous soft masses of segregated calcium carbonate and a few, small, strongly cemented concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 30 to about 60 inches in thickness. The A horizon ranges from 12 to 20 inches in thickness and is very dark grayish brown, dark brown, and dark grayish brown. The B2 horizon is 12 to 40 inches thick. It is dark brown, brown, strong brown, yellowish brown, and grayish brown. The C horizon ranges from pale brown, light yellowish brown, or very pale brown to reddish yellow. This horizon has few to common threads and films of calcium carbonate.

**Lewisville silty clay, 1 to 3 percent slopes** (LeB).—This gently sloping soil is in curved bands along major streams. Areas are as much as 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Krum and Venus soils that make up less than 10 percent of any mapped area.

This soil is suited to crops, and most areas are cultivated. A few areas are in improved pasture. The hazard of erosion is moderate. Capability unit IIe-2; pasture and hay group 7C; Clay Loam range site.

**Lewisville silty clay, 3 to 5 percent slopes** (LeC).—This gently sloping soil is on foot slopes and in convex bands along major streams. Most areas are 7 acres to about 25 acres in size.

The surface layer is dark grayish-brown silty clay about 16 inches thick. The next layer is brown silty clay that extends to a depth of 38 inches. The underlying material is very pale brown silty clay that reaches to a depth of 60 inches.

Included with this soil in mapping are small areas of Altoga and Venus soils and of Lewisville silty clay, 1 to 3 percent slopes.

This soil is suited to crops, and more than half of the acreage is cultivated. A few areas are in improved pasture, and a few areas are in range. The hazard of erosion is severe. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

**Lewisville-Altoga complex, 2 to 5 percent slopes** (LgC).—This complex is made up of gently sloping soils in irregularly shaped areas 10 to 50 acres in size. Slopes are convex. This complex is about 50 percent Lewisville silty clay and about 50 percent Altoga silty clay. The soils cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

The Lewisville soil has a surface layer of very dark grayish-brown silty clay about 18 inches thick. Below this is dark-brown silty clay that reaches to a depth of 24 inches. The next layer is strong-brown silty clay that reaches to a depth of 30 inches. The underlying material is light yellowish-brown silty clay that extends to a depth of 60 inches.

The Altoga soil has a surface layer of light brownish-gray silty clay about 6 inches thick. Below this is silty clay that reaches to a depth of 58 inches. It is very pale brown in the upper 20 inches and light gray in the lower 32 inches. The underlying material is light-gray chalky marl that reaches to a depth of 62 inches.

The soils in this complex are suited to improved pasture. Most areas have been cultivated, but most are now in unimproved pasture. The hazard of erosion is moderate to severe. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

**Lewisville-Urban land complex, 1 to 5 percent slopes** (LuC).—This complex is made up of gently sloping soils, mainly in Belton and Killeen. Slopes are convex, and soil areas are in bands 10 to 50

acres in size. This complex is about 66 percent Lewisville soils, 25 percent Urban land, and 9 percent other soils. The soils and Urban land cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

This Lewisville soil has a surface layer of dark grayish-brown silty clay about 16 inches thick. The next layer is brown silty clay that reaches to a depth of 38 inches. The underlying material is very pale brown silty clay that extends to a depth of 60 inches.

The Urban land areas are occupied by such works and structures as single-unit dwellings, mobile home parks, schools and school grounds, streets, driveways, sidewalks, and patios.

Features of the soils in this mapping unit that affect urban development are shrink-swell potential, corrosivity, percolation, and alkalinity. The more sloping areas are cut and shaped for building sites and lot leveling. Cuts and fills range in depth from a few inches to 1 or 2 feet, depending on the slope. A few yards have a thin layer of imported soil on the surface. Not placed in interpretive groups.

## Lindy Variant

The Lindy variant consists of moderately deep to deep, nearly level to gently sloping, loamy soils. These noncalcareous soils formed in loamy and clayey material on uplands.

In a representative profile the surface layer is very dark grayish-brown, slightly acid clay loam about 6 inches thick. The next layer is 11 inches of dark reddish-brown clay, 5 inches of dark-brown clay, 11 inches of reddish-brown clay, and 10 inches of yellowish-red silty clay. Below this is reddish-yellow silty clay loam that extends to a depth of 56 inches.

Lindy variant soils are well drained. Permeability is slow, and available water capacity is high. Runoff is slow to medium.

These soils are well suited to range, and most areas are used as range.

Representative profile of Lindy clay loam, dark subsoil variant, 0 to 2 percent slopes, 2.25 miles east on North Nolan Road from its intersection with East Range Road on the Fort Hood Military Reservation, then 1.2 miles north on a tank road, then 50 feet west of the road, in an area of range:

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure parting to granular; hard, firm, sticky and plastic; common fine roots; estimated 15 percent chert gravel fragments in the soil and on the surface; slightly acid; clear, smooth boundary.

B21t—6 to 17 inches, dark reddish-brown (2.5YR 3/4 moist) clay; moderate, fine, angular blocky structure; extremely hard, very firm, sticky and plastic; shiny pressure faces; dark vertical streaks in old cracks; few small chert fragments; medium acid, clear, smooth boundary.

B22t—17 to 22 inches, dark-brown (7.5YR 3/2 moist) clay; moderate, medium, angular and subangular blocky structure; extremely hard, very firm, sticky and plastic; continuous clay films; vertical dark streaks in old cracks ¼ inch wide; few small chert fragments; neutral; clear, smooth boundary.

B23t—22 to 33 inches, reddish-brown (5YR 5/4 moist) clay; moderate, medium, angular and subangular blocky structure; extremely hard, very firm, sticky and plastic; few films and threads of calcium carbonate; few small chert fragments; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—33 to 43 inches, yellowish-red (5YR 5/6 moist) silty clay; moderate, medium, subangular blocky structure; hard, friable, sticky; few to many small concretions of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

C—43 to 56 inches, reddish-yellow (5YR 6/6 moist) silty clay loam; massive but porous; slightly hard, friable; about 50 percent lime-coated chert and limestone fragments that are estimated to be more than 50 percent calcium carbonate equivalent; calcareous; moderately alkaline.

The solum ranges from 25 inches to more than 60 inches in thickness. The A horizon ranges from 4 to 10 inches in thickness, from clay loam to silty clay in texture, and from moderately alkaline to strongly acid in reaction. This horizon ranges from a few to 20 percent, by volume, chert, gravel, and cobblestones. It is very dark grayish brown, dark brown, and brown. The Bt horizon ranges from moderately alkaline to strongly acid. The B2t horizon ranges from 17 to 40 inches in thickness. It is dark reddish brown, reddish brown, dark brown, strong brown, yellowish red, and brown. The B3ca horizon has a calcium carbonate content that ranges from very thin coatings on the limestone to 10 percent, by volume.

These soils have a dark-brown, hard-setting surface layer underlain by a dark reddish-brown, clayey, B21t horizon. They are variants of the Lindy series because the Bt horizon in these soils is too dark in color for the Lindy series. Also, the solum in most of these soils is slightly more than 40 inches in thickness and is underlain by a bed of cherty fractured limestone. In some places these soils are underlain by limestone at a depth of 40 inches.

**Lindy clay loam, dark subsoil variant, 0 to 2 percent slopes** (LyB).—This nearly level to gently sloping soil is on some of the highest plateaus on the Fort Hood Military Reservation. Areas are irregular in shape and are 24 to 658 acres in size.

Included with this soil in mapping are small areas of Speck and Tarrant soils that make up less than 15 percent of any mapped area.

All areas of this soil are in range for livestock and are also used as maneuver areas for Fort Hood troops. This soil is well suited to range. The hazard of erosion is slight. Capability unit IIe-2; pasture and hay group 7C; Deep Redland range site.

## Menard Series

The Menard series consists of deep, sloping, loamy soils in irregularly shaped areas. These noncalcareous soils are in long narrow bands along major rivers. They formed in loamy sediment.

In a representative profile the surface layer is reddish-brown fine sandy loam about 10 inches thick. The next layer is yellowish-red sandy clay loam about 18 inches thick. The underlying material is reddish-yellow sandy clay loam that extends to a depth of 50 inches.

Menard soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is medium.

These soils are suited to pasture. Most areas have been cultivated but are now in pasture.

Representative profile of Menard fine sandy loam in an area of Menard soils, 5 to 8 percent slopes, eroded, 2.2 miles east on Farm Road 1741 from its

junction with Interstate Highway 35 in southeast Belton, then 0.8 mile south on a county road, then 50 yards east on another county road and 50 feet north of the road, in a field:

Ap—0 to 5 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, very fine, subangular blocky and granular structure; hard, friable; slightly acid; abrupt, smooth boundary.

A12—5 to 10 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, fine, subangular blocky structure; hard, friable; slightly acid; clear, smooth boundary.

B21t—10 to 28 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, medium, subangular blocky structure; very hard, firm; slightly acid; gradual, wavy boundary.

Cca—28 to 50 inches, reddish-yellow (7.5YR 7/6) sandy clay loam; reddish yellow (7.5YR 6/6) moist; massive; very hard, firm; few to common threads and soft masses of calcium carbonate; calcareous; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. The A horizon ranges from 6 to 10 inches in thickness and is reddish brown or yellowish red. It ranges from fine sandy loam to sandy clay loam and is slightly acid or neutral. The Bt horizon ranges from 15 to 48 inches in thickness and is yellowish red, red, or reddish brown. This horizon is slightly acid or neutral. The Cca horizon is reddish yellow, pink, or pinkish white.

**Menard soils, 5 to 8 percent slopes, eroded** (MeD2).—These soils are in the breaks between alluvial terraces and the bottom land of rivers. Areas are 17 to 50 acres in size and are marked by shallow gullies 50 to 150 feet apart. The gullies are in various stages of formation. In some areas the original surface layer has been removed by sheet and gully erosion. Generally, the textures of the surface layer are fine sandy loam and sandy clay loam, but the soils are not in a uniform pattern, and both surface textures are not in all the mapped areas.

Included with these soils in mapping are small areas of Bastrop soils that make up less than 8 percent of any mapped area.

These soils are suited to pasture, and most areas are abandoned fields and are used for pasture. The hazard of erosion is severe. Capability unit IVe-5; pasture and hay group 8C; Sandy Loam range site.

## Patrick Series

The Patrick series consists of shallow to moderately deep, gently sloping to sloping, clayey soils. These calcareous soils formed in clayey material underlain by gravelly sediment. They are on ancient high terraces, many of which are not associated with the present major drainageways.

In a representative profile the surface layer is about 9 inches of very dark grayish-brown silty clay that contains a few, small, rounded, limestone and chert pebbles. The next layer is about 9 inches of dark yellowish-brown silty clay that contains a few, small, rounded, limestone and chert pebbles. The underlying material, to a depth of 70 inches, is rounded, chert and limestone gravel.

Patrick soils are well drained. Permeability is moderate in the solum and very rapid in the substratum. Available water capacity is low, and runoff is medium.

These soils are suited to pasture. Most areas were once used as pasture, but many areas are now mined for gravel. A few small areas are cultivated.

Representative profile of Patrick silty clay in an area of Patrick soils, 1 to 8 percent slopes, 1 mile south on Interstate Highway 35 from its intersection with U.S. Highway 190 in Belton, then 1 mile east on a county road to a junction, then 3.4 miles south on a county road, then 100 feet east of the road on the north side of a gravel pit, in a pasture:

A—0 to 9 inches, very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; hard, friable; many roots; few, small, rounded, chert and limestone pebbles; calcareous; moderately alkaline; clear, smooth boundary.

B—9 to 18 inches, dark yellowish-brown (10YR 4/4) silty clay, dark yellowish brown (10YR 3/4) moist; weak, fine, subangular blocky and granular structure; hard, friable; few roots; few, small, rounded, chert and limestone pebbles; calcareous; moderately alkaline; abrupt, wavy boundary.

IIC—18 to 70 inches, rounded, chert and limestone gravel, about 60 percent; spots of clay (probably old root channels) and lenses of coarse sand; calcareous; moderately alkaline.

The solum ranges from 18 to 30 inches in thickness. In places on the surface and throughout the soil are 5 to 20 percent, by volume, large and small, rounded, chert gravel. The A horizon ranges from 8 to 12 inches in thickness and is very dark grayish brown, dark grayish brown, and dark brown. It is clay, silty clay, or clay loam. The B horizon ranges from 6 to 16 inches in thickness and is very dark grayish brown, dark brown, and dark yellowish brown. It is clay, silty clay, or clay loam. The IIC horizon is 55 to 75 percent coarse fragments.

**Patrick soils, 1 to 8 percent slopes** (PaD).—This undifferentiated group is made up of gently sloping to sloping soils. These soils are mainly on ridgetops. Mapped areas are irregular in shape and are 5 to 80 acres in size. Slopes are mostly 1 to 5 percent. This mapping unit is made up of about 57 percent Patrick soils, 35 percent a soil that is similar to Patrick soils but thinner to the gravelly layer, and 8 percent other soils. Soil patterns are not uniform, and the soil similar to the Patrick soils is not in all mapped areas. About 10 percent of the areas mapped as Patrick soils have a hard layer that is high in calcium at a depth of 15 to 24 inches.

Included with these soils in mapping are small areas of Lewisville and Payne soils. Also included are a few areas of soils that have more than 75 percent gravel in the underlying layers. No included areas make up more than 15 percent of any mapped area.

The soils in this mapping unit are suited to improved pasture. Most areas are used as pasture, but a few small areas are cultivated. The hazard of erosion is slight to severe. Capability unit IVe-3; pasture and hay group 7C; Chalky Ridge range site.

## Payne Series

The Payne series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils. These soils are in smooth areas on ancient high terraces that are not associated with the present major drainageways. They are on the highest part of the landscape. They formed in old alluvium.

In a representative profile the surface layer is brown loam about 7 inches thick. The next layer is clay that extends to a depth of 50 inches. It is dark reddish brown in the upper 8 inches and reddish brown in the lower 35 inches. Below this is reddish-yellow silty clay that has many soft masses and concretions of calcium carbonate.

Payne soils are well drained. Permeability is very slow, and available water capacity is high. Runoff is slow to medium.

These soils are suited to crops and to improved pasture. Most areas are cultivated, but a few areas are used as pasture.

Representative profile of Payne loam, 0 to 1 percent slopes, 2 miles west on Farm Road 436 from its crossing with the Missouri-Kansas-Texas railroad in Little River, then 0.25 mile west on a county road from where the farm road curves northwest, then 1,700 feet south on a county road, then 800 feet west on another county road and 560 feet north of the road, in a field:

Ap—0 to 7 inches, brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, firm; hard, pale-brown (10YR 6/3), sandy clay loam crust ⅛ to ¼ inch thick on the surface following rain; slightly acid; abrupt, wavy boundary.

B21t—7 to 15 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 3/3) moist; moderate, fine, blocky structure; very hard, very firm; few fine pores; nearly continuous clay films; shiny surfaces on peds; slightly acid; gradual, wavy boundary.

B22t—15 to 29 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate, fine, blocky structure; very hard, very firm; calcareous; moderately alkaline; gradual, smooth boundary.

B23tca—29 to 50 inches, reddish-brown (5YR 4/4) clay, reddish brown (5YR 4/4) moist; few, fine and medium, distinct mottles of yellowish red (5YR 5/6); weak, coarse, blocky structure; very hard, very firm; few calcium carbonate concretions 2 to 5 millimeters in diameter; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—50 to 80 inches, reddish-yellow (5YR 6/8) silty clay, yellowish red (5YR 5/8) moist; weak, coarse, blocky structure; hard, firm; many soft masses and concretions of calcium carbonate.

The solum ranges from 60 to 80 inches in thickness. The A horizon ranges from 6 to 10 inches in thickness. It is dark grayish brown, brown, or dark brown and is slightly acid or neutral. The B2t horizon ranges from 24 to 54 inches in thickness. It is dark reddish brown, reddish brown, dark brown, or brown and ranges from slightly acid to moderately alkaline. Below a depth of 28 inches are few to many soft masses and concretions of calcium carbonate.

**Payne loam, 0 to 1 percent slopes** (PcA).—This deep, nearly level, loamy soil is in irregularly shaped areas. The areas are mainly 12 to 40 acres in size, but a few areas are more than 160 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Burleson and Wilson soils. Included areas are less than 7 acres in size and make up less than 10 percent of any mapped area.

This soil is suited to crops and improved pasture. Most areas are cultivated, but a few small areas are in pasture. The hazard of erosion is slight. Capability unit IIIs-2; pasture and hay group 7H; Claypan Prairie range site.

**Payne loam, 1 to 3 percent slopes** (PcB).—This deep, gently sloping, loamy soil is in irregularly shaped areas that are mainly 10 to 30 acres in size.

The surface layer is dark-brown loam about 8 inches thick. The next layer is dark reddish-brown clay that reaches to a depth of 48 inches. Below this is reddish-yellow silty clay that extends to a depth of 75 inches.

Included with this soil in mapping are small areas of nearly level Payne loam and small areas of Wilson soils.

This soil is suited to crops and improved pasture. Most areas are cultivated, but a few small areas are in pasture. The hazard of erosion is moderate. Capability unit IIIe-4; pasture and hay group 7H; Claypan Prairie range site.

## Pedernales Series

The Pedernales series consists of gently sloping, noncalcareous, loamy soils on ancient high terraces that are not associated with the present major drainageways. These deep soils formed in loamy and clayey material.

In a representative profile the surface layer is brown fine sandy loam about 14 inches thick. The next layer is sandy clay that reaches to a depth of 52 inches. It is dark red in the upper 26 inches and red in the lower 12 inches. The underlying material is gravel and sand. The gravel is mainly chert, and some pebbles have coatings of calcium carbonate.

Pedernales soils are well drained. Permeability is moderately slow, and available water capacity is high. Runoff is medium.

These soils are suited to improved pasture. Most areas are in unimproved wooded pasture, and a few small areas are cultivated.

Representative profile of Pedernales fine sandy loam, 1 to 3 percent slopes, 4.3 miles south on Texas Highway 95 from the point where the Little River crosses this highway, then about 45 feet east of the highway on the south bank of a small gravel pit, in a pasture:

Ap—0 to 5 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak, fine, granular structure; slightly hard, very friable; many fine roots; neutral; clear, smooth boundary.

A1—5 to 14 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak, fine, subangular blocky structure; hard, friable; many fine roots; neutral; clear, smooth boundary.

B21t—14 to 40 inches, dark-red (2.5YR 3/6) sandy clay, dark red (2.5YR 3/6) moist; moderate, fine to medium, blocky structure; very hard, firm; clay films on peds; few, small, chert pebbles scattered throughout; neutral; gradual, wavy boundary.

B3—40 to 52 inches, red (2.5YR 4/6) sandy clay, red (2.5YR 4/6) moist; weak, fine to medium, blocky structure; very hard, firm; clay films on peds; common, small, chert pebbles scattered throughout; neutral; abrupt, wavy boundary.

IICca—52 to 90 inches, gravel and sand mixture; mainly fine to coarse, rounded, chert gravel; calcium carbonate coating on some pebbles.

The solum ranges from 35 to 60 inches in thickness. The A horizon ranges from 10 to 15 inches in thickness and is brown, pale brown, and reddish brown. The Bt and B3 horizons are red, dark red, and reddish brown. The B2t horizon ranges from 20 to 35 inches in thickness. It is slightly acid or neutral in the upper part and slightly acid to mildly alkaline in the lower part. The IICca horizon consists of

pockets of sand, sand and gravel, and sandy clay. It is mildly alkaline or moderately alkaline.

**Pedernales fine sandy loam, 1 to 3 percent slopes** (PdB).—This gently sloping soil is on parts of ridgetops on ancient high terraces. Areas are irregular in shape and are 20 to 40 acres in size.

Included with this soil in mapping are small areas of Axtell and Riesel soils.

This soil is used mostly as unimproved pasture. A few areas are used for crops, and a few areas have been planted to improved pasture. The hazard of erosion is moderate. Capability unit IIe-3; pasture and hay group 8A; Sandy Loam range site.

## Purves Series

The Purves series consists of gently sloping to sloping and undulating, clayey soils on uplands. These very shallow to shallow, calcareous soils are underlain by limestone. They formed in material weathered from interbedded hard limestone and calcareous marl.

In a representative profile the surface layer is dark-brown silty clay about 11 inches thick. The next layer is 3 inches of dark-brown silty clay that is about 75 percent, by volume, small limestone fragments. Below this is nodular, hard, limestone bedrock.

Purves soils are well drained. Permeability is moderately slow, and available water capacity is low. Runoff is slow to medium.

These soils are suited to range, and most areas are used as range. Some areas are cultivated, and a few areas are in improved pasture.

Representative profile of Purves silty clay, 1 to 4 percent slopes, 0.25 mile north of the Leon River crossing on Texas Highway 317 north of Belton, then 1.5 miles east on a county road to a junction, then 0.5 mile north on another county road and 20 feet east of the road, in a field:

Ap—0 to 4 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

A12—4 to 11 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; strong, medium, subangular blocky and granular structure; hard, firm; calcareous; moderately alkaline; clear, smooth boundary.

A13—11 to 14 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; strong, fine, granular structure; hard, firm; about 75 percent, by volume, small limestone fragments that have secondary carbonate coatings ⅛ to ¼ inch thick; calcareous; moderately alkaline; abrupt, smooth boundary.

R—14 to 24 inches, nodular, hard, limestone bedrock.

The solum ranges from 8 to 20 inches in thickness and from clay loam to silty clay in texture. It is a few to 35 percent, by volume, limestone fragments. The limestone fragments range from small gravel to rocks more than 10 inches across the long axis. The A horizon is very dark grayish brown, dark grayish brown, and dark brown.

**Purves silty clay, 1 to 4 percent slopes** (PrB).—This gently sloping soil is underlain by hard limestone. Areas are irregular in shape and are mainly 8 to 35 acres in size, but a few areas are more than 125 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Brackett and Denton soils that make up less than 12 percent of any mapped area.

This soil is suited to crops, and most areas have been cultivated. Some areas are in native range, and a few small areas are in improved pasture. The hazard of erosion is moderate. Capability unit IVe-3; pasture and hay group 13A; Shallow range site.

**Purves-Urban land complex, 1 to 8 percent slopes** (PuD).—This complex is made up of gently sloping and sloping soils. Most areas of this complex are in Belton, Fort Hood, and Killeen and are 10 to 50 acres in size. Purves silty clay makes up about 44 percent of this complex, Urban land 25 percent, and other soils 31 percent. The soils and Urban land cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

The Purves soil has a surface layer of brown silty clay 12 inches thick. Below this, and reaching to a depth of 16 inches, is brown silty clay that is about 75 percent limestone fragments. The underlying material is limestone bedrock.

The Urban land areas are occupied by such works and structures as streets, sidewalks, buildings, driveways, and patios. The structures are mostly single-unit dwellings.

Included with these soils in mapping are areas of Speck and Tarrant soils that have cobblestones and stones on the steepest slopes.

Features of the soils in this complex that affect urban developments are shallow depth to limestone, shrink-swell potential, corrosivity, percolation, alkalinity, and clay texture. The more sloping areas are cut and shaped for building sites and lot leveling. Not placed in interpretive groups.

**Purves association, undulating** (PVD).—This association is made up of shallow, stony, and gravelly soils. Slopes are mainly 1 to 8 percent, but some areas of soils that have short slopes of 8 to 15 percent are also included. Mapped areas are oblong and are as much as 300 acres in size. Purves soils make up about 70 percent of this association. Such similar soils as Tarrant make up about 25 percent, and Brackett and Lindy soils make up 5 percent. Soil areas are as much as 35 percent, by volume, stones, gravel, and cobblestones. Where the soil is less than 10 inches in depth, it is less than 25 percent coarse fragments. Areas of this association are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils. The soils could have been mapped separately, but their similar use and management made separation impractical.

The Purves soils have a surface layer of dark-brown silty clay that is about 8 inches thick and is 5 percent coarse limestone fragments. Below this, and reaching to a depth of 14 inches, is dark-brown silty clay that is about 70 percent limestone fragments. The underlying material is hard limestone.

The soils in this association are suited to range, and most areas are used as range. The hazard of erosion is slight. Capability unit VIs-1; Shallow range site.

## Real Series

The Real series consists of very shallow to shallow, calcareous, loamy soils in hilly areas. These gravelly soils formed in material weathered from limestone.

In a representative profile the surface layer is about 15 inches thick. It is very dark grayish-brown gravelly loam in the upper 11 inches and dark grayish-brown very gravelly loam in the lower 4 inches. It rests abruptly on nodular limestone.

Real soils are well drained. Permeability is moderate, and available water capacity is very low. Runoff is rapid.

These soils are used as native grass range.

Representative profile of Real gravelly loam in an area of Real association, hilly, 1 mile north of Salado on Interstate Highway 35, then 5 miles west on Farm Road 2786 to Union Grove crossroads, then 1.7 miles west on a county road to the junction of a county road going north to Cedar Knob church, then 500 feet south along fence line and 10 feet west, in area of native range:

A11—0 to 11 inches, very dark grayish-brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure parting to weak, medium, subangular blocky; hard, friable; many fine roots; an estimated 35 percent, by volume, weakly cemented limestone fragments as much as 2 inches in diameter; few cobblestones and stones; calcareous; moderately alkaline; clear, smooth boundary.

A12—11 to 15 inches, dark grayish-brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure parting to moderate, fine, granular; hard, friable; many fine roots; an estimated 75 percent, by volume, weakly cemented limestone fragments as much as 3 inches in diameter; few cobblestones; calcareous; moderately alkaline; abrupt, wavy boundary.

R—15 to 40 inches, weakly cemented, nodular, white (10YR 8/2) limestone.

The solum ranges from 8 to 20 inches in thickness and is 35 to 75 percent, by volume, coarse fragments of soft limestone gravel. A few cobblestones and stones are scattered on the surface. The A horizon is dark grayish-brown, dark-brown, or very dark grayish-brown loam or clay loam.

**Real association, hilly** (REF).—This association is mainly long, narrow strips along canyon walls. Slopes range from 10 to 30 percent but are mainly 12 to 25 percent. Mapped areas are 50 to 800 acres in size. Real soils make up about 85 percent of this association, and limestone bedrock outcrop and other soils make up about 15 percent. Areas of this association are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils. The soils could have been mapped separately, but their similar use and management made separation impractical.

Included with this association in mapping are areas of Brackett and Purves soils, which make up less than 20 percent of any mapped area. Also included are a few areas of soils that have slopes of as much as 50 percent.

The soils in this association are well suited to range, and most areas are used as range. The hazard of erosion is severe. Capability unit VIIs-1; Steep Rocky range site.

## Riesel Series

The Riesel series consists of deep, gently sloping, loamy soils on ancient high terraces that are not associated with the present major streams. These noncalcareous soils formed in old, gravelly and clayey alluvial sediment.

In a representative profile the surface layer is 16 inches thick. It is dark grayish-brown gravelly fine sandy loam in the upper 5 inches and brown very gravelly fine sandy loam in the lower 11 inches. The next layer extends to a depth of 56 inches. It is red gravelly clay in the upper part and red clay in the lower part. The underlying material is reddish-yellow very gravelly loamy sand and has soft masses of calcium carbonate in the upper part.

Riesel soils are well drained. Permeability is slow, and available water capacity is low. Internal drainage is slow, and runoff is medium.

These soils are used mostly as pasture.

Representative profile of Riesel gravelly fine sandy loam in an area of Riesel gravelly soils, 1 to 3 percent slopes, about 4 miles south of Academy on Texas Highway 95, then 1.8 miles west on a county road to a junction, then 0.5 mile south on another county road, then 10 feet east of a fence, in a wooded pasture:

A11—0 to 5 inches, dark grayish-brown (10YR 4/2) gravelly fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, friable; many fine roots; 15 percent, by volume, siliceous pebbles 2 to 15 millimeters in diameter; neutral; abrupt, smooth boundary.

A12—5 to 16 inches, brown (7.5YR 4/4) very gravelly fine sandy loam, dark brown (7.5YR 3/4) moist; weak, fine, granular structure; hard, friable; many fine roots; about 80 percent, by volume, rounded siliceous pebbles 2 to 50 millimeters in diameter; neutral; clear, smooth boundary.

B21t—16 to 40 inches, red (2.5YR 4/6) gravelly clay, dark red (2.5YR 3/6) moist; weak, fine, blocky structure; extremely hard, firm; few fine roots; evident clay films on peds and pebbles; 40 percent, by volume, rounded siliceous pebbles mostly 2 to 50 millimeters in diameter; neutral; gradual, wavy boundary.

B22t—40 to 56 inches, red (2.5YR 4/6) clay, red (2.5YR 4/6) moist, common, medium, distinct, strong-brown (7.5YR 5/6) and yellowish-red (5YR 4/6) mottles; weak, medium, blocky structure; extremely hard, firm; evident clay films on faces of peds; about 10 percent, by volume, rounded siliceous pebbles 2 to 50 millimeters in diameter; neutral; abrupt, smooth boundary.

IIC—56 to 62 inches, reddish-yellow (7.5YR 6/6) very gravelly loamy sand, strong brown (7.5YR 5/6) moist; massive; about 65 percent gravel; few soft masses of calcium carbonate in the upper 6 inches; mildly alkaline.

The solum ranges from 40 to 65 inches in thickness. The A horizon ranges from fine sandy loam to very gravelly fine sandy loam and is neutral or slightly acid. The A11 horizon is very dark grayish brown, dark grayish brown, grayish brown, or brown and ranges from 10 to 30 percent siliceous gravel. The A12 horizon is brown, grayish brown, or yellowish brown and ranges from 15 to 90 percent siliceous gravel. The B21t horizon is dusky red, dark red, or red and is gravelly clay to very gravelly clay. It ranges from 35 to 80 percent, by volume, gravel. The B22t horizon is dark red, red, weak red, or reddish brown and ranges from clay to very gravelly clay. It is 10 to 80 percent, by volume, gravel. In

most profiles, this horizon has few to common mottles of yellowish red and strong brown. The IIC horizon is sandy and is 55 to 90 percent coarse gravel and a few cobbles.

**Riesel gravelly soils, 1 to 3 percent slopes** (RgB).—These gently sloping, loamy soils are on ancient high stream terraces. Areas are irregular in shape and 10 to 70 acres in size.

The surface layer is variable in texture. Texture ranges from fine sandy loam to very gravelly sandy loam. The soil patterns are not uniform, and all textures are not in all mapped areas.

Included with these soils in mapping are small areas of Pedernales soils that make up less than 12 percent of any mapped area.

These soils are suited to improved pasture, but most areas are in wooded pasture. Trees have been removed in some small areas. The hazard of erosion is slight. Capability unit VIe-1; pasture and hay group 8A; Gravelly range site.

## San Saba Series

The San Saba series consists of nearly level to gently sloping, calcareous, clayey soils in low areas on limestone uplands. These moderately deep soils formed in clayey material underlain by limestone.

In a representative profile the surface layer is clay about 19 inches thick. It is dark gray in the upper part and very dark gray in the lower part. The next layer is dark-gray clay that extends to a depth of 35 inches. Below this is hard gray limestone.

San Saba soils are moderately well drained. Permeability is very slow when the soil is saturated and rapid when it is dry and cracked. Available water capacity is medium, and runoff is slow to medium.

These soils are well suited to crops, and most areas are cultivated. A few areas are in improved pasture, and a few areas are in range.

Representative profile of San Saba clay, 0 to 1 percent slopes, 6 miles northwest of Temple on Texas Highway 36, then 1.1 miles north on Texas Highway 317, then 1,600 feet west of the junction of a private road and the highway, in a field:

Ap—0 to 4 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, fine and medium, granular structure; extremely hard, very firm; few roots; calcareous; mildly alkaline; clear, smooth boundary.

A1—4 to 19 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, medium, angular blocky structure; extremely hard, very firm; few roots; dark-gray streaks of old filled cracks; shiny faces on peds; few, fine, dark concretions; calcareous; mildly alkaline; gradual, wavy boundary.

AC—19 to 35 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; intersecting slickensides border parallelepipeds that are tilted 30 to 45 degrees from the horizontal parting to moderate, fine, angular blocky structure; extremely hard, very firm; few calcium carbonate concretions; few, fine, dark concretions; calcareous; moderately alkaline; abrupt, smooth boundary.

R—35 to 38 inches, gray indurated limestone; fractured; hardness of about 3 on the Mohs scale.

The solum ranges from 24 to 40 inches in thickness. It is commonly mildly alkaline or moderately alkaline and calcareous, but some profiles are noncalcareous to a depth of 18 inches. Some profiles are 5 to 8 percent, by volume, limestone fragments that are ½ inch to 2 inches in diameter. The A horizon ranges from 12 to 32 inches in thickness and is very dark gray or dark gray. Slickensides are common in the lower part of this horizon and extend into the AC horizon. The AC horizon ranges from 12 to 20 inches in thickness and from gray or dark gray to grayish brown or dark grayish brown.

**San Saba clay, 0 to 1 percent slopes** (SaA).—This nearly level soil is in smooth, shallow valleys. Areas are long, narrow, and irregular in shape and are 10 to 100 acres in size. This soil has the profile described as representative of the series. In some areas the soil has seepy spots after heavy rains.

Included with this soil in mapping are small areas of nearly level Denton and Trinity soils and small areas of gently sloping Purves and San Saba soils. Included areas make up less than 6 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. A few areas are in improved pasture. The hazard of erosion is slight. Capability unit IIIs-1; pasture and hay group 7A; Blackland range site.

**San Saba clay, 1 to 3 percent slopes** (SaB).—This soil is in contour bands on the gentle slopes of smooth valleys and at the heads of drainageways. Areas are irregular in shape and are 50 to 200 acres in size.

The surface layer is dark-gray clay about 4 inches thick. Below this is very dark gray clay that extends to a depth of 18 inches. The next layer is dark-gray clay that extends to a depth of 36 inches. The underlying material is hard, gray limestone. In some areas the stone lines beneath the AC horizon are thin and can be cut easily with most digging equipment. In areas where this soil is underlain by hard limestone, it has a hardness of about 3 on the Mohs scale and the limestone is honeycombed.

Included with this soil in mapping are small areas of nearly level San Saba clay and small areas of Denton and Purves soils.

This soil is well suited to crops, and most areas have been cultivated. The hazard of erosion is moderate. Capability unit IIIe-5; pasture and hay group 7A; Blackland range site.

**San Saba-Urban land complex, 0 to 3 percent slopes** (SnB).—This complex is made up of nearly level to gently sloping soils in irregularly shaped areas 5 to 50 acres in size. Mapped areas are mostly in Belton, Fort Hood, and Killeen. San Saba soils make up 54 percent of this mapping unit, Urban land 25 percent, and Crawford and other soils 21 percent. The soils and Urban land cannot be shown separately at the scaled mapped, because they are too intermingled or the areas are too small.

The San Saba soils have a surface layer of dark-gray clay about 4 inches thick. The next layer is very dark gray clay that reaches to a depth of 19 inches. Below this is dark-gray clay that reaches to a depth of 35 inches. The underlying material is hard gray limestone.

Areas of Urban land are covered with such works and structures as streets, sidewalks, buildings, driveways, and patios. The structures are mostly single-unit dwellings. Because the topography in this complex is smooth, much of the soil has not

been disturbed during construction. Most structures have been built on 6 to 12 inches of fill dirt to keep foundations high and to reduce the hazard of wetness.

Features of the soils in this complex that affect urban development are shrink-swell potential, corrosivity, very slow permeability, and clay texture. Not placed in interpretive groups.

## Speck Series

The Speck series consists of gently sloping and undulating, noncalcareous, clayey soils on uplands. These shallow soils formed in noncalcareous, loamy and clayey material underlain by limestone.

In a representative profile the surface layer is very dark grayish brown gravelly clay loam about 8 inches thick. The next layer is clay that reaches to a depth of 19 inches. It is reddish brown in the upper part and dark reddish brown in the lower part. Below this is indurated limestone bedrock.

Speck soils are well drained. Permeability is slow, and available water capacity is low. Runoff is medium.

These soils are suited to range, and most areas are used as native grass range. A small area is cultivated. A large area on the Fort Hood Military Reservation is used both for army maneuvers and as range for livestock.

Representative profile of Speck gravelly clay loam, in an area of Speck association, undulating, 6.5 miles east on North Nolan Road from its intersection with East Range Road on the Fort Hood Military Reservation, then 1.75 miles south on another road, then 0.5 mile east on a second road and 50 feet south of the road, in an area of native range:

A—0 to 8 inches, very dark grayish-brown (10YR 3/2) gravelly clay loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure; hard, firm; about 40 percent chert gravel fragments in lower 3 inches; slightly acid; abrupt, smooth boundary.

B21t—8 to 16 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; weak, fine, angular blocky structure; very hard and very firm; few pores; clay films on faces of peds; neutral; clear, smooth boundary.

B22t—16 to 19 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/2) moist; weak, fine, subangular blocky structure parting to angular blocky; hard and firm; neutral; abrupt, smooth boundary.

R—19 to 21 inches, indurated limestone bedrock.

The solum ranges from 14 to 20 inches in thickness. Coarse fragments on the surface range from a few to 25 percent. The A horizon ranges from 7 to 9 inches in thickness and is very dark grayish brown or very dark brown. In some soils the lower half of the A horizon is 1 to 50 percent chert pebbles. The Bt horizon ranges from 8 to 12 inches in thickness and is dark reddish brown or reddish brown. The underlying indurated limestone bedrock is very hard in all profiles. The cobbles and stones in this soil are mostly limestone, and the pebbles are mostly angular chert.

**Speck association, undulating** (SPD).—This association is made up of stony and gravelly soils that are 1 to 35 percent, by volume, stone and gravel. Mapped areas are irregular in shape and are 50 to 1,000 acres in size. Slopes are 1 to 8 percent. This association is about 73 percent Speck soils, about 18 percent a soil that is similar to Speck soils except that it is thicker, and about 9 percent a soil that is similar to Speck soils except that it is thinner. The soils could have been mapped separately, but their similar use and management made separation impractical. Areas of this association are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils.

A Speck soil in this mapping unit has the profile described as representative of the series.

The soils in this association are better suited to range than to most other uses. Most areas are used as range. A few small fields have been cleared of stones and cultivated. Areas on the Fort Hood Military Reservation are used as range for livestock as well as for army maneuvers. The hazard of erosion is slight. Capability unit VIs-1; Redland range site.

**Speck soils, 1 to 3 percent slopes** (SsB).—This undifferentiated group is made up of gently sloping soils in irregularly shaped areas 10 to 80 acres in size. Speck soils make up about 76 percent of the mapping unit. Soils that are similar to Speck soils except that they are thicker make up about 18 percent, and soils that are similar to Speck soils except that they are thinner make up about 6 percent. Speck soils are in all mapped areas, but the soils that are similar to Speck soils are not.

The Speck soils have a surface layer of very dark brown clay loam 7 inches thick. The next layer is reddish-brown clay that extends to a depth of 20 inches. Below this is hard limestone bedrock.

These soils are suited to crops, and most areas are cultivated. A few small areas are in improved pasture. The hazard of erosion is slight. Capability unit IIIe-6; pasture and hay group 13A; Redland range site.

## Stephen Series

The Stephen series consists of very shallow to shallow, gently sloping to sloping, calcareous, clayey soils on uplands. These soils are underlain by chalky limestone. They formed in material weathered from interbedded chalk, marl, or soft limestone rubble.

In a representative profile the surface layer is dark grayish-brown silty clay about 10 inches thick. The next layer, reaching to a depth of 14 inches, is dark grayish-brown silty clay and 80 to 90 percent small, soft, chalk fragments. Below this is light-gray, soft platy chalk (fig. 6).

Stephen soils are well drained. Permeability is moderately slow, and available water capacity is very low. Internal drainage is medium, and runoff is medium to rapid.

Nearly all areas of these soils have been cultivated. Many formerly cultivated fields are used as pasture. Some areas are in improved pasture.

Representative profile of Stephen silty clay, 1 to 3 percent slopes, 2 miles north on Interstate Highway 35 from its intersection with Texas Highway 36 in Temple, then 1.5 miles west on a county road and 100 feet southwest, in a field:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak,

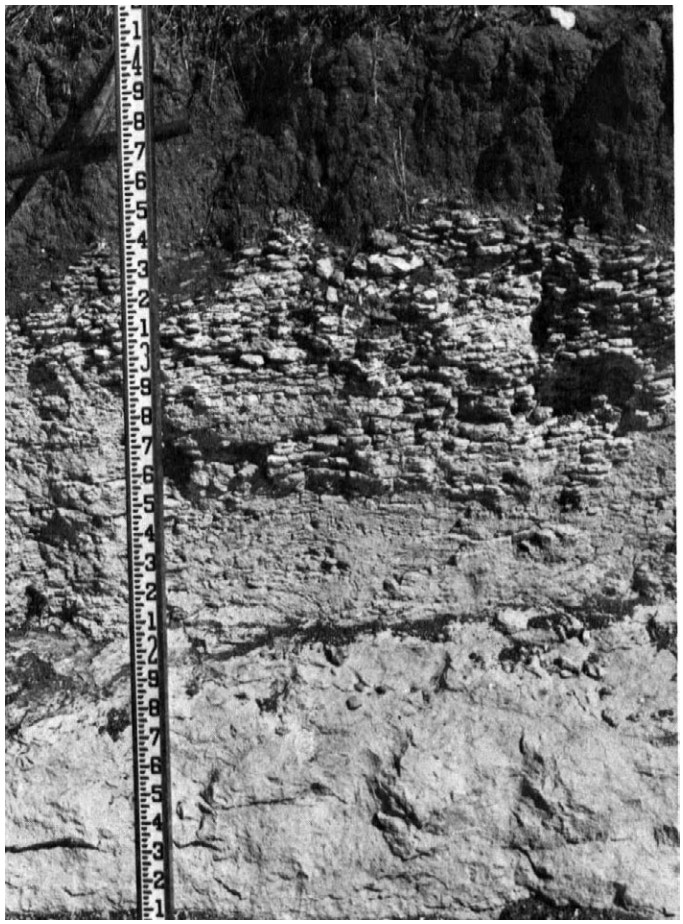

*Figure 6.*—Profile of a Stephen silty clay that shows platy chalk.

very fine, subangular blocky structure; hard, firm, sticky and plastic; many roots; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—5 to 10 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky and granular structure; hard, firm, sticky and plastic; many roots; calcareous; moderately alkaline; clear, irregular boundary.

A&C—10 to 14 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; 10 to 20 percent silty clay, the rest is small, soft, chalk fragments; many roots; calcareous; moderately alkaline; clear, smooth boundary.

C1—14 to 26 inches, light-gray (5Y 7/2), soft, platy chalk; few root hairs along interstices.

C2—26 to 36 inches, white (5Y 8/2) hard chalk; hardness less than 3 on the Mohs scale.

The solum ranges from 8 to 20 inches in thickness. The A horizon ranges from 7 to 15 inches in thickness and is very dark grayish brown, dark grayish brown, dark brown, and brown. It ranges from a few to 35 percent, by volume, chalk fragments. In some profiles the C layer is interbedded chalk and limy material or soft limestone and limy material.

**Stephen silty clay, 1 to 3 percent slopes** (StB).—This gently sloping soil is underlain by chalky limestone. Areas are irregular in shape and are 5 to 25 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Austin soils, small areas of Eddy soils, and small areas of a soil that is similar to Stephen soils except that it has pale-brown silty clay above the chalky limestone. Included areas make up less than 12 percent of any mapped area.

This soil is used mostly for cultivation. Some areas are in native range, and some areas are abandoned fields that are now used for grazing. A few small areas are in improved pasture. The hazard of erosion is moderate. Capability unit IIIe-6; pasture and hay group 13A; Chalky Ridge range site.

**Stephen silty clay, 3 to 5 percent slopes** (StC).—This gently sloping soil is on ridgetops and in areas that slope into natural drainageways. Areas are irregular in shape and are 7 to 50 acres in size.

The surface layer is dark grayish-brown silty clay about 8 inches thick. The next layer, reaching to a depth of 12 inches, is dark grayish-brown silty clay and is 80 to 90 percent small, soft, chalk fragments. Below this is gray, soft, platy chalk.

Included with this soil in mapping are areas of Brackett and Eddy soils. Included areas are less than 5 acres in size and make up less than 15 percent of any mapped area.

Most areas of this soil are abandoned fields. Shallow gullies are in many areas. The hazard of erosion is severe. Capability unit IVe-3; pasture and hay group 13A; Chalky Ridge range site.

**Stephen-Urban land complex, 1 to 6 percent slopes** (SuC).—This complex is made up of gently sloping to sloping soils. Most areas are in Temple. Mapped areas are irregular in shape and are 10 to 50 acres in size. Stephen soils make up 52 percent of this mapping unit, Urban land 30 percent, and Eddy and other soils 18 percent. The soils cannot be shown separately at the scale mapped, because they are too intermingled or the areas are too small.

The Stephen soils have a surface layer of dark grayish-brown silty clay about 10 inches thick. The next layer, which reaches to a depth of 12 inches, is dark grayish-brown silty clay and is 80 to 90 percent small, soft, chalk fragments. The underlying material is soft platy chalk that is harder in some places than in others but is mainly less than 3 on the Mohs scale.

Urban land areas are occupied by single-unit dwellings and attendant streets, driveways, sidewalks, parking lots, and patios as well as schools and school grounds and small, one-story factories. Most structures are in the less sloping areas of this complex.

Features of the soils in this complex that affect urban developments are shallow soil depth; high pH value; corrosivity, which causes deterioration of pipelines and steel in the ground; high calcium carbonate content, which limits the kinds of shrubs and flowers that can be grown; and silty clay texture, which becomes sticky and plastic when wet. Soil has been added to many yards to increase soil depth for landscaping and better plant growth. Not placed in interpretive groups.

## Tarrant Series

The Tarrant series consists of very shallow to shallow, undulating to rolling, clayey soils on uplands. These noncalcareous soils formed in interbed-

ded chalk, marl, and marly material weathered mainly from limestone.

In a representative profile the surface layer is dark grayish-brown silty clay about 16 inches thick. Large and small limestone rocks and gravel are on the surface and throughout the horizon and make up about 40 percent, by volume, of the upper part of this horizon. The lower part is about 80 percent, by volume, large and small flagstones of limestone. The underlying material is hard limestone bedrock.

Tarrant soils are well drained. Permeability is moderately slow, and available water capacity is low. Runoff is rapid.

These soils are suited to range, and most areas are in native range.

Representative profile of Tarrant silty clay in an area of Tarrant association, undulating, about 6 miles north of Belton on Texas Highway 317, then 1.5 miles west on Farm road 2483, then 0.7 mile northwest on a county road, then 150 feet east on a second road and 10 feet north of the road, in wooded range:

A11—0 to 8 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, very fine, subangular blocky structure; hard, firm; common roots; about 40 percent, by volume, large and small limestone rocks and limestone gravel on the surface and throughout the horizon; neutral; clear, smooth boundary.

A12—8 to 16 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; very hard, firm; many roots in the soil in the interstices of the limestone; about 80 percent, by volume, large and small flagstones of limestone; calcareous; moderately alkaline; abrupt, wavy boundary.

R—16 to 20 inches, hard limestone bedrock, some secondary lime on underside of stones.

The solum ranges from 6 to 20 inches in thickness and from 35 to 65 percent coarse limestone fragments. The A11 horizon ranges from 4 to 10 inches in thickness and is 10 to 60 percent coarse limestone fragments. It is very dark grayish brown, dark grayish brown, and dark brown and is neutral to moderately alkaline. The A12 horizon ranges from 2 to 10 inches in thickness and is 70 to 90 percent coarse limestone fragments. It is very dark grayish brown, dark grayish brown, and dark brown.

**Tarrant association, undulating** (TAD).—This association is made up of soils that are on the top of limestone hills. Slopes range from 1 to 8 percent. Mapped areas are irregular in shape and are 200 to 1,000 acres or more in size. They are generally about 83 percent Tarrant soils and 17 percent Purves and other soils and Rock outcrop. The percentage of Tarrant soils in areas ranges from 60 to 100. Areas of this association are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils. The soils could have been mapped separately, but their similar use and management made separation impractical.

A Tarrant silty clay in this mapping unit has the profile described as representative of the series. Limestone fragments as much as 2 feet in diameter make up 40 to 60 percent, by volume, of the surface and extend into the soil.

The soils in this mapping unit are well suited to range and wildlife habitat, and most areas are used as range and wildlife habitat. The hazard of erosion is slight. Capability unit VIIs-3; Low Stony Hill range site.

**Tarrant-Purves association, rolling** (TPF).—This association is made up of soils on low, rolling hills. Areas are 200 acres to more than 1,000 acres in size. The association generally is about 53 percent Tarrant soils, 23 percent Purves soils, and 24 percent Brackett and other soils and Rock outcrop. The percentage of Tarrant soils in areas ranges from 48 to 72, and that of Purves soils from 9 to 37. Areas of this association are much larger and their composition is more variable than those of most other mapping units in the county. Mapping has been controlled well enough, however, for the anticipated use of the soils. The soils could have been mapped separately, but their similar use and management made separation impractical.

The sides of the hills are eroded into alternating flat areas and steeper areas upgrade, which gives them the appearance of graded terraces. Slopes range from 5 to 16 percent. The flat areas have a slope of less than 8 percent and are 25 to 125 feet wide. The areas upgrade have a slope of 5 to 16 percent and are 5 to 20 feet wide. Purves soils are in the flat areas, and Tarrant soils are mostly in the areas upgrade. Stones and limestone gravel are on the surface and in the surface layer. The Rock outcrop is in narrow bands and is on the contour. The deepest soil is found at the base of this hard limestone rock, and seeps occur in some places. Mid and tall grasses as well as shrubs grow in these areas.

The Tarrant soils have large and small limestone rocks on the surface. The surface layer is dark grayish-brown silty clay about 8 inches thick. It is about 40 percent, by volume, large and small limestone rocks and gravel. The next layer is dark grayish-brown silty clay about 8 inches thick. It is about 80 percent, by volume, large and small flagstones of limestone. The underlying material is hard limestone bedrock.

The Purves soils have a surface layer of dark-brown silty clay 11 inches thick. The next layer is dark-brown silty clay, is about 35 percent, by volume, small limestone fragments, and reaches to a depth of 14 inches. Below this is hard nodular limestone bedrock.

The soils in this association are well suited to range and wildlife habitat, and most areas are used for these purposes. The hazard of erosion is slight. Capability unit VIIs-1; Low Stony Hill range site.

## Trinity Series

The Trinity series consists of nearly level, calcareous, clayey soils on flood plains. These deep soils formed in clayey alluvium.

In a representative profile the surface layer is clay about 42 inches thick. It is very dark gray in the upper 20 inches and black in the lower 22 inches. The underlying material is dark-gray clay that extends to a depth of 72 inches.

Trinity soils are moderately well drained or somewhat poorly drained. Permeability is very slow, and

available water capacity is high. Runoff is very slow.

Large areas of these soils that were once frequently flooded are now protected by the Belton and Stillhouse Hollow Dams. Soils in the higher areas on bottom lands are cultivated. Lower, more frequently flooded areas are used for pasture and hay.

Representative profile of Trinity clay, frequently flooded, 1.9 miles north on Farm Road 437 from its intersection with Texas Highway 36 in Rogers, then 120 feet west of the road, in a pasture:

Ap—0 to 6 inches, very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak, very fine, subangular blocky structure; very hard, firm, sticky and very plastic; many fine pores; calcareous; moderately alkaline; abrupt, smooth boundary.

A11—6 to 20 inches, very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak, medium, subangular and angular blocky structure; very hard, firm, very sticky and very plastic; many fine pores; shiny pressure faces on peds; calcareous; moderately alkaline; diffuse, smooth boundary.

A12—20 to 42 inches, black (10YR 2/1) clay, black (10YR 2/1) dry; weak, coarse, angular blocky structure parting to fine, angular blocky; very hard, very firm, very sticky and very plastic; shiny pressure faces on peds; few slickensides that do not intersect; calcareous; moderately alkaline; diffuse, smooth boundary.

C—42 to 72 inches, dark-gray (5Y 4/1) clay, dark gray (5Y 4/1) dry; massive; very hard, very firm; few slickensides that do not intersect; calcareous; moderately alkaline.

The A horizon ranges from 40 to 80 inches in thickness and is dark gray, very dark gray, or black. The C horizon is gray, olive gray, or dark gray. In some places the underlying layer is grayish brown and has some thin strata.

**Trinity clay** (Tr).—This nearly level soil is mostly in backwater areas. Slopes range from 0 to 1 percent. Areas are long and narrow and are 10 acres to more than 400 acres in size.

The surface layer is very dark gray clay about 48 inches thick. The next layer is dark-gray clay about 20 inches thick. Below this is gray clay about 12 inches thick.

Included with this soil in mapping are small fringe areas of Frio soils that make up less than 10 percent of any mapped area.

This soil is well suited to crops and to improved pasture. Most areas are cultivated, and a few areas are in pasture. This soil is flooded once every 5 to 15 years, and drainage ditches have been installed in most cultivated areas. A few small areas are in native range. The hazard of erosion is slight. Capability unit IIw-1; pasture and hay group 1A; Clayey Bottomland range site.

**Trinity clay, frequently flooded** (Ty).—This soil is on flood plains parallel to stream channels in the lowest bottom land areas. Areas are long and narrow and are 10 to 800 acres in size. This soil has the profile described as representative of the series.

This soil is flooded as frequently as twice each year or as infrequently as once every 5 years. The surface drainage and the subsurface drainage are so slow that much of the soil is saturated for long periods. Stream channels through this bottom land are 4 to 12 feet deep and adequately carry all runoff, except that of major storms.

This soil is well suited to improved pasture, and most areas are in improved pasture. The hazard of erosion is slight. Capability unit Vw-1; pasture and hay group 1A; Clayey Bottomland range site.

## Urban Land

Urban land (Ub) is in parts of Belton, Killeen, and Temple. Areas are 10 to 100 acres in size. About 75 to 95 percent of Urban land is covered with such works and structures as office buildings, hotels, railroad yards, multiple-unit dwellings, churches, schools, streets, wide sidewalks, and paved parking lots. About 10 to 15 percent of the Urban land consists of areas of single-unit dwellings and their attendant structures. In areas of single-unit dwellings 40 to 50 percent of the land surface is covered.

The installation of works and structures has so altered and obscured soil features that the original soils cannot be identified. The soil materials are from soils that formed over limestone, chalk, marl, and alluvium. Not placed in interpretive groups.

## Venus Series

The Venus series consists of nearly level to gently sloping, calcareous, loamy soils on stream terraces. These deep soils formed in loamy sediment.

In a representative profile the surface layer is dark grayish-brown clay loam about 12 inches thick. The next layer is clay loam that extends to a depth of about 46 inches. It is brown in the upper 6 inches and pale brown in the lower 28 inches. The underlying material is pink clay loam that extends to a depth of 72 inches.

Venus soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow to medium.

These soils are suited to crops and to improved pasture. The smoother areas are mostly cultivated, and the more sloping areas are in pasture.

Representative profile of Venus clay loam, 3 to 5 percent slopes, 3.2 miles south on Farm Road 1741 from its intersection with Loop 363 in the southern part of Temple, then 100 yards west of Taylors Valley Church on this road, then 0.5 mile south and 0.6 mile west on a county road and 20 yards south of the road, in an abandoned field:

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky and granular structure; hard, firm; abundant worm casts in the horizon and on the surface; few snail shell fragments; fine calcium carbonate concretions and fine gravel; calcareous; moderately alkaline; abrupt, clear boundary.

A1—4 to 12 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure; hard, firm but crumbly; abundant worm casts; about 5 percent calcium carbonate concretions and snail shell fragments; calcareous; moderately alkaline; gradual, smooth boundary.

B21—12 to 18 inches, brown (10YR 5/3) clay loam; dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, firm but crumbly; common worm casts; common fine calcium carbonate concretions and snail shells; few quartz pebbles; calcareous; moderately alkaline; gradual, smooth boundary.

B22—18 to 46 inches, pale-brown (10YR 6/3) clay loam, dark

brown (10YR 4/3) moist; moderate, medium, subangular and angular blocky structure; hard, firm but crumbly; few soft masses and hard concretions of calcium carbonate; few ferromanganese concretions; calcareous; moderately alkaline; clear, smooth boundary.

C—46 to 72 inches, pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; massive; hard, firm but very crumbly; calcareous; moderately alkaline.

The solum ranges from 40 to 70 inches in thickness. The A horizon ranges from 10 to 19 inches in thickness and is very dark grayish brown, dark grayish brown, or grayish brown. It is subangular blocky to granular in structure. The B2 horizon is 20 to 50 inches thick and is clay loam or loam. It ranges from grayish brown, brown, pale brown, or yellowish brown to dark brown and has common to many threads and films of calcium carbonate. The C horizon is pale brown, light brown, or pink. It contains many threads and films of calcium carbonate, some sand and fine gravel, and a few fine concretions of calcium carbonate.

**Venus clay loam, 0 to 1 percent slopes** (VeA).—This nearly level soil is on low terraces of flood plains that are high on the landscape and do not flood. Areas are long and oval and are 10 to 200 acres in size.

The surface layer is dark grayish-brown clay loam 6 inches thick. The next layer is clay loam that extends to a depth of 45 inches. It is very dark grayish brown in the upper 13 inches, brown in the next 14 inches, and pale brown in the lower 12 inches. Below this is very pale brown clay loam that extends to a depth of 70 inches.

Included with this soil in mapping are a few small areas of soils that are similar to this Venus soil, except that the surface layer is slightly thicker or the lower layers are redder. Included areas make up less than 10 percent of any mapped area.

This soil is well suited to crops, and most areas are cultivated. A few small areas are in improved pasture. The hazard of erosion is slight. Capability unit I-1; pasture and hay group 7C; Clay Loam range site.

**Venus clay loam, 1 to 3 percent slopes** (VeB).—This gently sloping soil is on terraces in long, narrow bands parallel to drainageways. Areas are 15 to 250 acres in size.

The surface layer is dark grayish-brown clay loam 6 inches thick. The next layer is very dark grayish-brown clay loam that reaches to a depth of 13 inches. The next 14 inches is brown clay loam. Below this is a layer of light-brown clay loam 30 inches thick.

Included with this soil in mapping are small areas of Lewisville soils that make up less than 10 percent of any mapped area.

This soil is suited to crops. Most areas are cultivated, but some areas are in pasture. The hazard of erosion is slight. Capability unit IIe-2; pasture and hay group 7C; Clay Loam range site.

**Venus clay loam, 3 to 5 percent slopes** (VeC).—This gently sloping soil is in long, narrow, convex areas that conform to the contour of the landscape. Areas are 15 to 200 acres in size. Some areas have a few gullies. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Altoga and Lewisville soils. Also included are small areas of a soil that is similar to this Venus soil, except that the surface layer is less than 10 inches thick. Included areas make up as much as 20 percent of some mapped areas.

This soil has been cultivated, but it is now used mostly as pasture. The hazard of erosion is moderate. Capability unit IIIe-3; pasture and hay group 7C; Clay Loam range site.

## Wilson Series

The Wilson series consists of nearly level to gently sloping, loamy soils on uplands. These deep soils formed in clayey alluvium.

In a representative profile the surface layer is dark grayish-brown clay loam about 7 inches thick. The next layer is dark-gray clay to a depth of 42 inches and gray clay between the depths of 42 and 54 inches. The underlying material is light olive-gray clay that extends to a depth of 72 inches.

Wilson soils are somewhat poorly drained. Internal drainage is very slow, and runoff is very slow to medium. Permeability is very slow, and available water capacity is high. When these soils are dry, cracks more than 1 centimeter wide form on the surface and extend to a depth of more than 30 inches. Water readily enters these cracks, but after the soil is wet, the cracks close and water intake is very slow.

These soils are used mostly for crops, but some areas are used for pasture and hay.

Representative profile of Wilson clay loam, 0 to 1 percent slopes, 0.4 mile north on a county road from its intersection with Farm Road 436 in Little River, then 40 feet east from the edge of the pavement, in a field:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure when moist, but massive when dry; very hard, firm; slightly acid; abrupt, smooth boundary.

A1—5 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, friable; slightly acid; abrupt, wavy boundary.

B21tg—7 to 15 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, medium, blocky structure; extremely hard, very firm; continuous thin clay films on peds; vertical cracks filled with material from the above layer; slightly acid; gradual, wavy boundary.

B22tg—15 to 42 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, coarse, blocky structure; extremely hard, very firm; few fine pores; vertical cracks filled with material from the above layer; continuous thin clay films on peds; slightly acid, diffuse, wavy boundary.

B3tg—42 to 54 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, coarse, blocky structure; extremely hard, very firm; common, fine, soft masses of calcium carbonate; mildly alkaline; diffuse, wavy boundary.

C—54 to 72 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) moist; massive; mildly alkaline.

The solum ranges from 40 to 75 inches in thickness. The A horizon ranges from 6 to 10 inches in thickness and from very dark gray and dark gray to dark grayish brown in color. The B2t horizon ranges from 20 to 48 inches in thickness and from very dark gray, dark gray, and gray to grayish brown in color. In some places the lower part of this horizon is mottled with yellowish brown. The C horizon is gray, light olive-gray, yellowish-red, or brown silty clay or clay. Gravel

or sand and gravel is at a depth of more than 8 feet on stream terraces.

**Wilson clay loam, 0 to 1 percent slopes** (WcA).—This nearly level soil is in large, oval areas that range from 8 acres to more than 300 acres in size but are mainly about 35 acres. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Branyon, Burleson, and Payne soils that make up less than 10 percent of any mapped area.

This soil is suited to crops, and most areas are cultivated. Some areas are used for pasture or hay. The hazard of erosion is slight. Capability unit IIIw-1; pasture and hay group 7H; Claypan Prairie range site.

**Wilson clay loam, 1 to 3 percent slopes** (WcB).—This gently sloping soil is in long, oval or half-moon shaped areas around areas of nearly level soils. Areas range from 6 acres to more than 300 acres in size but are mainly about 30 acres.

The surface layer is dark grayish-brown clay loam 8 inches thick. The next layer is dark-gray clay that extends to a depth of about 40 inches. The next 12 inches is gray clay. Below this is light olive-gray clay that reaches to a depth of 72 inches.

Included with this soil in mapping are areas of Branyon, Burleson, and Payne soils that make up less than 12 percent of any mapped area.

This soil is suited to improved pasture. About half of the acreage is cultivated, and the rest is used as pasture. The hazard of erosion is moderate. Capability unit IIIe-4; pasture and hay group 7H; Claypan Prairie range site.

**Wilson clay loam, 3 to 5 percent slopes** (WcC).—This gently sloping soil is on slopes parallel to drainageways. Areas are irregular in shape and are about 20 acres in size. This soil receives extra water as runoff and has a few gullies. The gullies are shallow and can be crossed by farm machinery.

The surface layer is dark grayish-brown clay loam 6 inches thick. The next layer is dark-gray clay that extends to a depth of about 36 inches. The next 12 inches is gray clay. Below this is light olive-gray clay that reaches to a depth of 72 inches.

Included with this soil in mapping are small areas of Wilson clay loam, 1 to 3 percent slopes, and small areas of Heiden and Payne soils.

This soil is suited to improved pasture. Most areas have been cultivated. Only a small acreage is now used for crops; most of the acreage is used as pasture. The hazard of erosion is moderate. Capability unit IVe-4; pasture and hay group 7H; Claypan Prairie range site.

# *Use and Management of the Soils*

The use and management of the soils of Bell County for crops and for pasture and hay are discussed in this section. The predicted yields of principal crops and pasture are given. The availability of irrigation water and the use of the soils for range, wildlife, and recreation are explained. The use of the soils for engineering is also described.

## Use of the Soils for Crops

In this section the system of capability classification used by the Soil Conservation Service is explained, and the soils of the county are placed in capability units. In the descriptions of the capability units, the suitability of the soils in each unit for various uses and for crops is discussed, and the problems in the management of the soils in each unit are described. In addition, management practices that are specifically applicable to the soils in each unit and that are necessary to achieve high levels of productivity are given.

### *Capability grouping*

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

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

Class I soils have few limitations that restrict their use.

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

Class III soils have severe limitations that reduce the choice of plants, require special conservation practies, or both.

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

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

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

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

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or to esthetic purposes. (No class VIII soils are in Bell 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 habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Bell County are described and suggestions for the use and management of the soils are given. The capability unit designations for all the soils in the county can be found in the "Guide to Mapping Units" at the back of this survey. The capability units are not numbered consecutively in Bell County because not all of the capability units used in Texas are in this county.

### CAPABILITY UNIT I-1

This unit consists of deep, nearly level soils in valleys and on bottom lands. These soils have a surface layer of silty clay and clay loam. They have lower layers that are moderately permeable or moderately slowly permeable. Available water capacity is high.

Most areas of these soils are cultivated. Cotton, grain sorghum, and corn are the main crops. These soils are well suited to pecans.

A cropping system that helps to conserve moisture and maintain tilth is needed.

### CAPABILITY UNIT IIe-1

This unit consists of deep, gently sloping, clayey soils. These soils have lower layers of very slowly permeable clay that hinder the movement of water and air and restrict the growth of plant roots. When these soils are dry, cracks form on the surface, and water readily enters. After the soil is wet, the cracks close, and water enters very slowly. Available water capacity is high, and the hazard of erosion is moderate. These soils are difficult to keep in good tilth, because of the narrow range of moisture content within which they can be cultivated.

Most areas of these soils are cultivated. Grain sorghum and cotton are the main crops. A small acreage is planted to corn.

A cropping system that helps to control erosion, conserve moisture, and maintain tilth is needed. Terraces, grassed waterways, and contour tillage are needed in areas where row crops are planted (fig. 7).

### CAPABILITY UNIT IIe-2

This unit consists of moderately deep to deep, nearly level to gently sloping soils. These soils have a surface layer of silty clay or clay loam. They have lower layers that are moderately permeable to slowly permeable. Available water capacity is high, and the hazard of erosion is slight to moderate.

Most areas of these soils are cultivated. Grain sorghum, cotton, and small grain are the main crops. The soils are well suited to cool-season crops, such as small grain and sweetclover.

A cropping system that helps to control erosion and conserve moisture is needed. Terraces, grassed waterways, and contour tillage are needed in areas where row crops are planted. If a close-spaced or drilled crop, such as small grain, is planted every year and crop residue is left on the surface, terraces may not be needed.

### CAPABILITY UNIT IIe-3

This unit consists of deep, nearly level to gently sloping soils on uplands. These soils have a surface layer of fine sandy loam and lower layers that are moderately permeable or moderately slowly permeable. Available water capacity is high, and the hazard of erosion is slight to moderate.

Many areas of these soils are cultivated. Small grain and grain sorghum are the main crops. These soils are well suited to orchards and to cool-season legumes, such as vetch. Some areas are used as improved pasture. Suited grasses are improved bermudagrass, weeping lovegrass, johnsongrass, Kleingrass-75, and introduced bluestem. Some areas are in native wooded pasture of post oak and elm and a sparse cover of annual grasses.

A cropping system that helps to control erosion, maintain tilth, and conserve moisture is needed. Terraces, grassed waterways, and contour tillage are needed in areas where row crops are planted.

### CAPABILITY UNIT IIs-1

This unit consists of moderately deep to deep, nearly level soils on uplands. These soils have a surface layer of silty clay and lower layers that are moderately slowly permeable or slowly permeable. Available water capacity is high, and the hazard of erosion is slight.

Nearly all areas of these soils are cultivated. Cotton and grain sorghum are the main crops.

*Figure 7.*—Parallel terraces and contour farming used to control loss of soil and water on Houston Black clay, 1 to 3 percent slopes.

These soils are well suited to small grain, corn, and sweetclover.

A cropping system that helps to maintain tilth is needed. The layer immediately below the plow layer may become compacted by tillage if row crops are grown continuously. A rotation of clean-tilled row crops following small grain, sweetclover, or other close-growing crops and shredding crop residue and leaving it on the surface help to maintain tilth and to conserve moisture.

CAPABILITY UNIT IIw-1

This unit consists of deep, nearly level, clayey soils. These soils have lower layers of very slowly permeable clay that hinder the movement of water and air and restrict the growth of plant roots. Runoff is slow to very slow, and the hazard of erosion is slight. Available water capacity is high. These soils are difficult to keep in good tilth because of the narrow range of moisture content within which they can be cultivated.

Nearly all areas of these soils are cultivated. Cotton and grain sorghum are the main crops, but a few areas are in corn, sweetclover, and small grain.

A cropping system that helps to conserve moisture and maintain tilth is needed. Crop residue left on or near the surface helps to maintain tilth (fig. 8).

CAPABILITY UNIT IIIe-1

This unit consists of deep, gently sloping soils. These soils have a surface layer of fine sandy loam and gravelly fine sandy loam. They have lower layers of dense, moderately slowly permeable to very slowly permeable clay that hinder the movement of water and air and restrict the growth of plant roots. These soils are difficult to keep in good tilth because a hard crust forms on the surface after rain. Available water capacity is medium, and the hazard of erosion is moderate in cultivated areas.

Most areas of these soils are used as pasture. A few areas are cultivated to small grain. These soils are well suited to cool-season crops, such as small grain and legumes.

A cropping system that helps to conserve moisture, control erosion, and maintain tilth is needed. Close-growing crops and crops that produce a large amount of residue, if residue is kept on or near the soil surface, help to maintain tilth and conserve moisture. Terracing, farming on the contour, and using grassed waterways help to control erosion. Fertilizer is needed for good plant growth.

CAPABILITY UNIT IIIe-2

This unit consists of deep, gently sloping, clayey soils on uplands. These soils have dense lower layers

*Figure 8.*—Management of crop residue on Burleson clay, 0 to 1 percent slopes, helps to maintain tilth.

that hinder the movement of water and air and restrict the growth of plant roots. When these soils are dry, cracks form on the surface and extend to a depth of more than 30 inches, and water rapidly enters. After the soil is wet, the cracks close and water enters very slowly. Available water capacity is high, and the hazard of erosion is severe.

Most areas of these soils are cultivated, but some areas are used as pasture. Grain sorghum is the main crop, but cotton, corn, small grain, and sweetclover are also grown.

A cropping system that helps to maintain tilth, control erosion, and conserve moisture is needed. Close-growing crops and crops that produce a large amount of residue are very suitable. Keeping crop residue on or near the surface helps to protect the soil from damaging rains. Terracing and farming on the contour help to control erosion in cultivated fields. Fertilizer is needed for good plant growth.

CAPABILITY UNIT IIIe-3

This unit consists of moderately deep to deep, gently sloping to sloping soils. These soils have a surface layer of clay loam to silty clay. They have lower layers that are moderately permeable to slowly permeable. Available water capacity is high.

These soils are better suited to cool-season crops than to most other crops. Grain sorghum and small grain are the main crops.

A cropping system that helps to conserve moisture, control erosion, and maintain tilth is needed. Terraces, contour tillage, and grassed waterways are needed in areas where row crops are planted.

CAPABILITY UNIT IIIe-4

This unit consists of deep, gently sloping clay loams and loams on uplands. These soils have dense lower layers that hinder the movement of water and air and restrict the growth of plant roots. They are difficult to keep in good tilth, because a hard crust forms on the surface after rain. When these soils are dry, cracks form on the surface and extend to a depth of 20 to 30 inches, and water rapidly enters. After the soil is wet, the cracks close and water enters very slowly. Available water capacity is high, and the hazard of erosion is moderate.

Most areas of these soils are cultivated. Grain sorghum and small grain are the main crops.

A cropping system that helps to maintain tilth and control erosion is needed. Grain sorghum or other crops that produce a large amount of residue are very suitable. Keeping the residue on or near the soil surface helps to prevent surface crusting. Farming on the contour and terracing help to con-

trol erosion. Fertilizer is needed for good plant growth.

CAPABILITY UNIT IIIe-5

This unit consists of moderately deep, gently sloping, clayey soils. These soils have lower layers of very slowly permeable clay that hinder the movement of water and air and restrict the growth of plant roots. When these soils are dry, cracks form on the surface and water readily enters, but after they are wet, the cracks close and water enters very slowly. Available water capacity is medium, and the hazard of erosion is moderate. These soils are difficult to keep in good tilth because of the narrow range of moisture content within which they can be cultivated.

Most areas of these soils are cultivated. Grain sorghum and small grain are the main crops.

A cropping system that helps to control erosion, conserve moisture, and maintain good tilth is needed. If these soils are planted to row crops, terraces, grassed waterways, and contour tillage are needed. Keeping crop residue on the soil surface helps to control erosion and maintain tilth. Terracing and farming on the contour also help to control erosion and conserve moisture.

CAPABILITY UNIT IIIe-6

This unit consists of very shallow to shallow, gently sloping soils on uplands. These soils have a surface layer of gravelly clay loam to silty clay. Available water capacity is low to very low, and the hazard of erosion is slight to moderate. Permeability is moderately slow or slow.

Many areas of these soils are cultivated. Small grain is the main crop. These soils are suited to shallow-rooted, cool-season crops.

A cropping system that helps to conserve moisture, control erosion, and improve tilth is needed. Close-growing crops and crops that produce a large amount of residue are well suited. Keeping the residue on or near the soil surface helps to improve tilth and conserve moisture. Terraces, grassed waterways, and contour tillage are needed in areas where row crops are planted. Fertilizer is needed for good plant growth.

CAPABILITY UNIT IIIs-1

This unit consists of moderately deep, nearly level, clayey soils. These soils have lower layers of very slowly permeable clay that hinder the movement of water and air and restrict the growth of plant roots. When these soils are dry, cracks form on the surface, and water readily enters. After the soil is wet, the cracks close and water enters very slowly. Available water capacity is medium, and the hazard of erosion is slight.

Most areas of these soils are cultivated. Grain sorghum, cotton, and small grain are the main crops.

A cropping system that helps to conserve moisture and maintain tilth is needed.

CAPABILITY UNIT IIIs-2

Payne loam, 0 to 1 percent slopes, is the only soil in this unit. This soil is difficult to keep in good tilth, because a crust forms on the surface after rain. It has very slowly permeable lower layers that hinder the movement of water and air and restrict the growth of plant roots. Available water capacity is high, and the hazard of erosion is slight.

Cotton, grain sorghum, and small grain are the main crops. Some corn is also grown.

A cropping system that helps to maintain tilth is needed. Planting crops that produce a large amount of residue and keeping the residue on or near the soil surface help to maintain tilth.

CAPABILITY UNIT IIIw-1

Wilson clay loam, 0 to 1 percent slopes, is the only soil in this unit. This soil is difficult to keep in good tilth, because a crust forms on the surface after rain. It has very slowly permeable lower layers that hinder the movement of water and air and restrict the growth of plant roots. Runoff is very slow. Available water capacity is high, and the hazard of erosion is slight.

Grain sorghum and small grain are the main crops. A cropping system that helps to maintain tilth is needed. Planting crops that produce a large amount of residue and keeping the residue on or near the soil surface help to maintain tilth.

CAPABILITY UNIT IVe-1

Only Heiden-Ferris complex, 3 to 8 percent slopes, eroded, is in this unit. These soils have a clay surface layer and very slowly permeable lower layers. When these soils are dry, cracks form on the surface and water readily enters. After the soil is wet, the cracks close and water enters very slowly. The hazard of erosion is severe, and small gullies and thin spots are common. Available water capacity is high, and runoff is rapid.

These soils are better suited to cool-season crops, such as small grain and sweetclover, than to most other crops. A cropping system that helps to control erosion and improve tilth is needed. Terracing and farming on the contour help to control erosion. Keeping crop residue on or near the soil surface helps to improve tilth and control erosion.

CAPABILITY UNIT IVe-2

Austin silty clay, 3 to 5 percent slopes, is the only soil in this unit. Permeability is moderately slow. Available water capacity is high, and the hazard of erosion is severe.

This soil is better suited to small grain and sweetclover than to most other crops. A cropping system that helps to control erosion and maintain tilth is needed. Terracing and farming on the contour help to control erosion. On fields that are not terraced, close-growing crops help to prevent erosion. Keeping crop residue on or near the soil surface helps to control erosion and maintain tilth.

CAPABILITY UNIT IVe-3

This unit consists of very shallow to moderately deep, gently sloping to sloping soils on uplands. These soils have a surface layer of clay, clay loam, or silty clay. Permeability is moderate or moderately slow. Available water capacity is low to very low, and the hazard of erosion is slight to severe.

These soils are droughty and are better suited to cool-season drilled crops, such as small grain, than to most other crops. They are well suited to sweetclover, but they are not suited to row crops.

A cropping system that provides a permanent cover of vegetation or produces a large amount of residue is needed. Keeping the residue on or near the surface helps to conserve moisture and control erosion. Contour tillage and terraces are needed where row crops are planted.

CAPABILITY UNIT IVe-4

Wilson clay loam, 3 to 5 percent slopes, is the only soil in this unit. This deep soil has dense lower layers that hinder the movement of water and air and restrict the growth of plant roots. A crust forms on the surface after rain. Permeability is very slow. Available water capacity is high, and the hazard of erosion is moderate.

A small acreage of this soil is cultivated, and the rest is in pasture. Small grain and sudangrass are the main cultivated crops, and they are used mostly for grazing.

A cropping system that produces a large amount of residue is needed to improve tilth. Terraces and contour tillage are needed in areas where row crops are planted.

CAPABILITY UNIT IVe-5

Menard soils, 5 to 8 percent slopes, eroded, are the only soils in this unit. These deep soils are moderately permeable. Available water capacity is high, and the hazard of erosion is severe.

Oats, grain sorghum, and sudangrass are the main crops. A cropping system that helps to control erosion, conserve moisture, and maintain tilth is needed. Keeping crop residue on or near the surface helps to control erosion and maintain tilth. Terracing and farming on the contour help to control erosion and conserve moisture.

CAPABILITY UNIT IVs-1

This unit consists of shallow to very shallow, nearly level to gently sloping soils on uplands. These soils have a surface layer of silty clay, clay loam, and gravelly clay loam. Permeability is moderately slow. Available water capacity is very low, and the hazard of erosion is moderate.

These soils are used mainly for cultivated crops and pasture and hay. They are not well suited to row crops. These soils are well suited to cool-season crops, such as small grain, which are used mostly for grazing.

A cropping system that provides a permanent cover of vegetation or produces a large amount of residue is needed. Keeping the residue on or near the soil surface helps to control erosion, conserve moisture, and maintain tilth.

CAPABILITY UNIT Vw-1

This unit consists of deep, nearly level clays, silty clays, and clay loams. These soils are along the major streams and their tributaries, and they are frequently flooded. When these soils are flooded, they are subject to washing and deposition of new soil material. They also receive runoff from soils in surrounding higher areas. Permeability is moderately slow to very slow. Available water capacity is high, and the hazard of erosion is slight.

These soils are used mainly for pasture and hay or for some kind of permanent vegetation. They are not suitable for cultivated crops.

CAPABILITY UNIT VIe-1

Riesel gravelly soils, 1 to 3 percent slopes, are the only soils in this unit. These deep soils have a surface layer of fine sandy loam to very gravelly fine sandy loam. Permeability is slow. Available water capacity is low, and the hazard of erosion is slight.

These soils are used mainly as pasture. They are not suitable for cultivation, and only a very small acreage is cultivated. The cultivated acreage is mostly in areas 1 to 5 acres in size that extend into cultivated fields of other soils.

CAPABILITY UNIT VIe-2

This unit consists of deep, gently sloping to strongly sloping, eroded and stony soils. These soils have a surface layer of silty clay to clay and lower layers that are moderately permeable to very slowly permeable. Available water capacity is high, and the hazard of erosion is severe.

Most areas of these soils are in pasture. Most areas, except the stony ones, were cultivated at one time, but cultivation was stopped as erosion became severe. These soils are better suited to grass than to most other crops. Permanent plant cover is needed to control erosion. Grazing should be controlled to maintain grass at a sufficient height to keep plants vigorous.

CAPABILITY UNIT VIe-3

Only Eddy-Stephen complex, 3 to 8 percent slopes, is in this unit. These shallow to very shallow soils have a surface layer of very gravelly clay loam to silty clay. Permeability is moderately slow, and available water capacity is very low. The hazard of erosion is severe, and shallow gullies are common.

These soils are used mainly for pasture and hay. They are not suitable for cultivation.

A cropping system that provides plant cover to control erosion is needed. Grazing should be controlled to maintain grass at a sufficient height to keep plants vigorous.

CAPABILITY UNIT VIs-1

This unit consists of very shallow to shallow, undulating soils on uplands. These soils have a surface layer of gravelly clay loam to silty clay. They have lower layers that are moderately slowly permeable or slowly permeable. Available water capacity is low, and the hazard of erosion is slight.

These soils are used as range. They are not suitable for cultivation.

Grazing should be controlled to maintain grass at a sufficient height to keep plants vigorous.

CAPABILITY UNIT VIIs-1

This unit consists of shallow to very shallow, undulating to hilly soils on uplands. These soils have a surface layer of gravelly loam to silty clay.

They have lower layers that are moderately permeable or moderately slowly permeable. Available water capacity is low to very low. The hazard of erosion is severe.

These soils are used only as native range. They are not suitable for cultivation, because soil areas are too steep and stony. Native grasses and browse afford a moderate amount of forage. Grazing should be controlled to maintain grass at a sufficient height to keep plants vigorous.

CAPABILITY UNIT VIIs-2

Only Brackett association, rolling, is in this unit. These shallow soils have a loam surface layer and moderately slowly permeable lower layers. Available water capacity is very low, and the hazard of erosion is severe.

These soils are used only as range. A grass cover to control runoff and erosion is needed. Grazing should be controlled to maintain grass at a sufficient height to keep plants vigorous.

CAPABILITY UNIT VIIs-3

Only Tarrant association, undulating, is in this unit. These very shallow to shallow soils have a surface layer of stony silty clay. They have lower layers that are moderately slowly permeable. Available water capacity is low, and the hazard of erosion is slight.

These soils are used as range. Grazing should be controlled to maintain grass at a sufficient height to keep plants vigorous.

## Use of the Soils for Pasture and Hay

During the long period that the soils in Bell County have been used for crops and forage, two principles of soil management have evolved: (1) protect the soil from water erosion and (2) maintain and improve tilth. The amount and distribution of rainfall, periods of drought, and high winds affect farming and are concerns of soil management in the county.

Sound practices of grazing management are needed to achieve sustained high production of grasses in areas of pasture. Grasses should be given a period of recovery after they have been grazed. During the growing season, a sufficient amount of leaf surface must be left on a plant to permit the plant to rapidly manufacture food in its leaves. Leaving a good supply of plant material on the surface helps to control erosion and improve tilth and helps to protect the plant from extremes in temperature.

Other management practices, such as fertilization, weed control, and rotational grazing, are important. Fertilizer should be applied in the amount indicated by a soil test and the needs of the plants. The combination of grass and legumes in pastures can be regulated, in part, by the time of fertilization. The application of fertilizer in fall generally favors legumes, and the application of fertilizer in spring favors grass. Weed control is less of a concern on well-managed, properly grazed pasture than poorly managed, overgrazed pasture. A good ground cover restricts the growth of undesirable plants. Plants in improved pasture can be adversely affected if weeds are not controlled early.

Many of the soils in the county, because they have steeper slopes, less depth, and a higher hazard of erosion, are better suited to pasture or hay than to cultivated crops. Many areas in the county that are suitable for cultivation are used for hay or pasture, and areas that were once cultivated are being converted to improved pasture and hay. An improved pasture or meadow is one in which grasses are introduced into the plant community to obtain high production of forage.

The most important grasses in the area for pasture and hay are Coastal bermudagrass and common bermudagrasses. These grasses grow better on such deep soils as Austin, Branyon, Burleson, Houston Black, and Trinity than on most other soils. Other grasses generally planted for hay and pasture are johnsongrass, King Ranch bluestem, Kleberg bluestem, and Kleingrass. Several native grasses, such as indiangrass and switchgrass, respond to intensive management and are suitable for pasture and hay.

### *Pasture and hay groups*

The soils in Bell County have been placed in 11 pasture and hay groups according to their suitability for the production of forage. The soils in each group are suited to the same grasses, have similar limitations, are subject to similar hazards, require similar management practices, have similar rates of productivity, and respond similarly to management.

The pasture and hay group is a convenient grouping of soils for making many statements about management. These groups are identified by a numeral and an upper case letter, for example, 1A. The numerals generally are assigned locally, but the system of grouping is statewide. Not all groups in the system are represented by the soils of Bell County; therefore, the numerals do not run consecutively.

Yields of pasture under a high level of management are given in table 2, see page 42. The names of the soils in a pasture and hay group can be found in the "Guide to Mapping Units" at the back of this survey.

PASTURE AND HAY GROUP 1A

This group consists of clayey soils on bottom lands. If these soils are not protected, they are subject to flooding. They crack and take in water rapidly when dry, and they expand and absorb water very slowly when wet. Available water capacity is high.

These soils are seasonally wet and seasonally droughty. If they are grazed when wet, they become puddled. They are better suited to warm-season grazing because they are subject to flooding and wetness during the winter.

Seedbed preparation is difficult because the soils are clayey. Nitrogen and phosphorus are usually needed to maintain satisfactory forage production. The potential of these soils to produce such grasses

as improved bermudagrass, johnsongrass, and Kleingrass-75 is high.

PASTURE AND HAY GROUP 1C

This group consists of nearly level clayey to loamy soils on bottom lands. Some areas of these soils are subject to flooding if they are not protected. Permeability is moderate or moderately slow, and available water capacity is high.

These soils are best suited to warm-season forage production and to forage production in periods when they are not subject to flooding and seasonal wetness. Nitrogen and phosphorus are needed to maintain satisfactory forage production. The potential of these soils to produce such grasses as improved bermudagrass, Kleingrass-75, and johnsongrass is high.

PASTURE AND HAY GROUP 7A

This group consists of nearly level to gently sloping clayey soils on uplands. These soils crack and take in water rapidly when dry, but they are very slowly permeable when wet. Available water capacity is medium or high.

These soils become puddled if they are grazed when wet. Seedbed preparation is difficult because the soils are clayey. Nitrogen and phosphorus are needed to maintain satisfactory forage production.

These soils are better suited to warm-season forage production. The potential of these soils to produce such grasses as improved bermudagrass and Kleingrass-75 is high. The potential to produce grasses such as King Ranch bluestem and Kleberg bluestem is medium.

PASTURE AND HAY GROUP 7B

This group consists of gently sloping to strongly sloping clayey soils on uplands. Permeability is very slow, and available water capacity is high.

These soils are suited to cool-season grazing. If they are grazed when wet, the soil becomes compacted and the surface is sealed so that water infiltration is restricted. Seedbed preparation is difficult. Nitrogen and phosphorus are needed to maintain satisfactory forage production. The potential of these soils to produce such grasses as improved bermudagrass, johnsongrass, indiangrass, King Ranch bluestem, and Kleberg bluestem is medium.

PASTURE AND HAY GROUP 7C

This group consists of nearly level to sloping clayey to loamy soils on uplands. Permeability is moderate to slow, and available water capacity is high to low.

Nitrogen and phosphorous are needed to maintain satisfactory forage production. The potential of these soils to produce such grasses as improved bermudagrass, Kleingrass-75, indiangrass, switchgrass, and weeping lovegrass is high. The potential to produce such grasses as King Ranch bluestem and Kleberg bluestem is medium.

PASTURE AND HAY GROUP 7D

Altoga silty clay, 5 to 10 percent slopes, eroded, is the only soil in this group. This clayey soil is on uplands. Permeability is moderate, and available water capacity is high.

Management is difficult on this soil because it is eroded and has steeper slopes than most soils in other groups. Some areas are so severely eroded that area shaping is required before grass can be planted. Nitrogen and phosphorus are needed to maintain satisfactory forage production.

This soil is suited to cool-season grazing because surface drainage is good. The potential of this soil to produce such grasses as improved bermudagrass, weeping lovegrass, King Ranch bluestem, and Kleberg bluestem is medium.

PASTURE AND HAY GROUP 7H

This group consists of nearly level to gently sloping loamy soils on uplands. Permeability is very slow, and available water capacity is high.

These soils become compacted if they are grazed when wet. Seedbed preparation is difficult because the soils have clayey lower layers and their surface moisture conditions change rapidly. When these soils are dry, cracks form on the surface and water rapidly enters, but after the soil is wet, the cracks close and water enters very slowly. Establishing grass is difficult because a crust forms on the surface after rain and surface moisture rapidly dries out. Nitrogen, phosphorus, and potassium are needed to maintain satisfactory forage production. The potential of these soils to produce such grasses as improved bermudagrass, weeping lovegrass, and Kleingrass-75 is high. The potential to produce such grasses as King Ranch bluestem and Kleberg bluestem is medium.

PASTURE AND HAY GROUP 8A

This group consists of gently sloping gravelly loamy to loamy soils on uplands. Permeability is moderately slow to very slow, and available water capacity is high to low.

These soils are low in fertility, and a complete fertilizer containing nitrogen, phosphorus, and potassium is needed to maintain satisfactory forage production. The potential of these soils to produce such grasses as improved bermudagrass and weeping lovegrass is medium to high.

PASTURE AND HAY GROUP 8C

This group consists of nearly level to gently sloping loamy soils on uplands. Some areas are severely eroded. Permeability is moderate, and available water capacity is high.

A complete fertilizer containing nitrogen, phosphorus, and potassium is needed to maintain satisfactory production. The potential of these soils to produce such grasses as improved bermudagrass and weeping lovegrass is medium to high.

PASTURE AND HAY GROUP 13A

This group consists of gently sloping clayey and loamy to gravelly loamy soils on uplands. These shallow and very shallow soils are moderately slowly permeable or slowly permeable. Available water capacity is low and very low.

Nitrogen and phosphorus are needed to maintain

satisfactory forage production. The amount of fertilizer needed varies according to the depth of the soil. The potential of these soils to produce such grasses as improved bermudagrass, King Ranch bluestem, and Kleberg bluestem is medium or low.

PASTURE AND HAY GROUP 14A

This group consists of nearly level to gently sloping clayey to gravelly and loamy soils on uplands. These shallow to very shallow soils are moderately slowly permeable. Available water capacity is very low.

A complete fertilizer containing nitrogen, phosphorus, and potassium is needed to maintain satisfactory forage production. The amount of fertilizer needed varies with the depth of the soil. The potential of these soils to produce such grasses as improved bermudagrass, King Ranch bluestem, and Kleberg bluestem is medium to low.

## Predicted Yields

Table 2 lists predicted yields of the principal crops grown in the county. The predictions are based on

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

[Absence of a figure indicates that the crop is not commonly grown on the specified soil]

| Soil | Cotton (lint) | Grain sorghum | Oats | Wheat | Pasture |
|---|---|---|---|---|---|
| | *Lb* | *Lb* | *Bu* | *Bu* | *AUM*[1] |
| Altoga silty clay, 2 to 5 percent slopes | 250 | 2,500 | 40 | 25 | 4.5 |
| Austin silty clay, 1 to 3 percent slopes | 300 | 3,000 | 55 | 30 | 5.5 |
| Austin silty clay, 3 to 5 percent slopes | 300 | 2,500 | 40 | 20 | 4.0 |
| Axtell fine sandy loam, 1 to 3 percent slopes | 250 | 2,000 | | | 5.0 |
| Bastrop fine sandy loam, 0 to 2 percent slopes | 350 | 3,000 | 40 | | 5.0 |
| Bosque clay loam | 450 | 4,000 | 60 | 40 | 6.5 |
| Brackett clay loam, 1 to 3 percent slopes | | | 20 | 10 | 2.0 |
| Branyon clay, 0 to 1 percent slopes | 475 | 5,000 | 70 | 35 | 7.0 |
| Branyon clay, 1 to 3 percent slopes | 400 | 4,500 | 70 | 30 | 7.0 |
| Burleson clay, 0 to 1 percent slopes | 450 | 4,500 | 60 | 30 | 7.0 |
| Burleson clay, 1 to 3 percent slopes | 400 | 4,000 | 60 | 30 | 6.5 |
| Chigley gravelly fine sandy loam, 1 to 3 percent slopes | 300 | 2,000 | | | 4.0 |
| Crawford clay, 0 to 1 percent slopes | 400 | 5,000 | 60 | 35 | 7.0 |
| Crawford clay, 1 to 3 percent slopes | 350 | 4,000 | 60 | 35 | 6.0 |
| Denton silty clay, 0 to 1 percent slopes | 375 | 4,000 | 60 | 35 | 6.0 |
| Denton silty clay, 1 to 3 percent slopes | 350 | 3,500 | 60 | 35 | 6.0 |
| Denton association, undulating | | | 40 | 20 | 4.5 |
| Eddy-Stephen complex, 0 to 3 percent slopes | | | 30 | 15 | 2.5 |
| Frio silty clay | 450 | 4,000 | 60 | 40 | 6.5 |
| Heiden clay, 1 to 3 percent slopes | 400 | 4,000 | 65 | 30 | 7.5 |
| Heiden clay, 3 to 5 percent slopes | 350 | 3,000 | 40 | 25 | 6.0 |
| Heiden-Ferris complex, 3 to 8 percent slopes, eroded | | 2,000 | 35 | 20 | 4.0 |
| Houston Black clay, 0 to 1 percent slopes | 475 | 5,000 | 70 | 30 | 8.0 |
| Houston Black clay, 1 to 3 percent slopes | 450 | 4,500 | 70 | 30 | 7.5 |
| Houston Black clay, 3 to 5 percent slopes | 350 | 3,000 | 40 | 25 | 6.0 |
| Krum silty clay, 0 to 1 percent slopes | 400 | 4,000 | 70 | 35 | 7.0 |
| Krum silty clay, 1 to 3 percent slopes | 350 | 4,000 | 65 | 30 | 7.0 |
| Krum-Lewisville association, undulating | 250 | 3,000 | 45 | 20 | 5.5 |
| Lewisville silty clay, 1 to 3 percent slopes | 300 | 3,000 | 60 | 30 | 7.0 |
| Lewisville silty clay, 3 to 5 percent slopes | 225 | 2,500 | 45 | 20 | 5.0 |
| Lewisville-Altoga complex, 2 to 5 percent slopes | 225 | 2,500 | 40 | | 5.5 |
| Lindy clay loam, dark subsoil variant, 0 to 2 percent slopes | 250 | 4,000 | 55 | 30 | 6.0 |
| Menard soils, 5 to 8 percent slopes, eroded | | 1,300 | 35 | | 4.5 |
| Patrick soils, 1 to 8 percent slopes | | 2,000 | 40 | 15 | 3.5 |
| Payne loam, 0 to 1 percent slopes | 350 | 3,500 | 40 | 25 | 6.0 |
| Payne loam, 1 to 3 percent slopes | 300 | 3,000 | 40 | 25 | 6.0 |
| Pedernales fine sandy loam, 1 to 3 percent slopes | 300 | | 55 | 25 | 4.0 |
| Purves silty clay, 1 to 4 percent slopes | | 2,500 | 40 | 20 | 3.5 |
| San Saba clay, 0 to 1 percent slopes | 400 | 5,000 | 60 | 30 | 6.0 |
| San Saba clay, 1 to 3 percent slopes | 325 | 4,000 | 60 | 30 | 6.0 |
| Speck soils, 1 to 3 percent slopes | | 3,000 | 40 | 20 | 3.5 |
| Stephen silty clay, 1 to 3 percent slopes | 150 | 3,000 | 45 | 20 | 3.5 |
| Stephen silty clay, 3 to 5 percent slopes | 150 | 2,500 | 40 | 20 | 3.5 |
| Trinity clay | 450 | 5,000 | 70 | | 8.0 |
| Venus clay loam, 0 to 1 percent slopes | 375 | 4,000 | 65 | 30 | 7.0 |
| Venus clay loam, 1 to 3 percent slopes | 300 | 4,000 | 60 | 30 | 7.0 |
| Venus clay loam, 3 to 5 percent slopes | 250 | 3,000 | 50 | 20 | 5.0 |
| Wilson clay loam, 0 to 1 percent slopes | 350 | 3,000 | 50 | 20 | 5.5 |
| Wilson clay loam, 1 to 3 percent slopes | 300 | 2,500 | 45 | 20 | 5.5 |
| Wilson clay loam, 3 to 5 percent slopes | 250 | 2,250 | 30 | 15 | 5.0 |

[1] AUM stands for Animal-unit-month, a term used to express the amount of forage or feed required to maintain one animal unit, 1,000 pounds live weight, for a period of 30 days.

estimates made by farmers, soil scientists, and others who have knowledge of yields in the county and on information taken from research data. The predicted yields are average yields per acre that can be expected at the level of management that tends to produce the highest economic returns.

The yields are given for dryland farming. Soils that are used only as range or for recreation are not included in this table.

Crops other than those shown in table 2 are grown in the county, but their predicted yields are not included in the table, because their acreage is small or because reliable data on yields are not available.

The predicted yields given in table 2 can be expected if:

1. Rainfall is effectively used and conserved.
2. Surface or subsurface drainage systems, or both, are installed.
3. Crop residue is managed to maintain tilth.
4. Minimum but timely tillage is used.
5. Insect, disease, and weed control measures are consistently used.
6. Fertilizer is applied according to soil test and crop needs.
7. Suited crop varieties are used at optimum seeding rates.

## Irrigation

A limited supply of surface water available for irrigation is stored in the Belton and Stillhouse Hollow Reservoirs. Prior to the construction of these lakes, the rate of flow of the Leon and Lampasas Rivers was at its lowest during the summer, when the maximum amount of irrigation water was needed. The potential for surface water storage in most parts of the county can be developed to furnish considerably more irrigation water. Runoff water in the county is good for irrigation because the amount of undesirable minerals is very small.

Small quantities of underground water are under most soils on stream terraces in the county. The depth to this water ranges from about 12 to 40 feet. This water is adequate for household use in most places. In some places there is enough water for small gardens, lawns, and fruit trees.

Ground water from the Trinity Sand Formation[2] can generally be obtained everywhere in the county. However, the depth to this water ranges from 520 feet in the western part of the county to more than 1,800 feet in the eastern part. This water has a salt content that makes it unsuitable for irrigation of some crops in some places. Ground water to be used for irrigation should be chemically analyzed before irrigation operations are planned.

In most places the same crops can be grown under both irrigated and dryland farming. Through the use of irrigation a more intensive use of high-residue crops, legumes, fertilizers, and residue management is possible. Technicians of the Soil Conservation Service, who assist the Central Texas and the Little River-San Gabriel Soil and Water Conservation Districts, are available to help to design suitable irrigation systems, to help to plan cropping systems, and to help solve irrigation problems.

[2]Sellards, E. H., Adkins, W. S., and Plummer, F. B. The geology of Texas. Univ. of Tex. Bul. 3232, v. 1, Stratigraphy, 1,007 pp., illus. 1932.

## Range[3]

Range is land on which the native vegetation is mainly grasses, grasslike plants, forbs, and shrubs that are suitable for grazing and that are available in sufficient quantity to justify grazing use. Areas of range are natural grasslands, savannas, many wetlands, and certain forb and shrub communities. The 1967 Conservation Needs Inventory indicates that 13 percent of Bell County is in range and 16 percent is in noncommercial forest. The noncommercial forest is actually savanna grassland, but because the area has not been used properly, oak, juniper, and associated hardwoods and underbrush have increased in number and encroached on the other plants until the area resembles a scrub forest. The woody plants in this forest have commercial value only for cedar posts, and the area is used primarily to grow forage for livestock and wildlife. Thus, almost 30 percent of the land area of Bell County, 154,000 acres, is made up of native vegetation and is used for the production of livestock forage and as wildlife habitat.

Early settlers were mainly stockmen who grazed cattle on open range. Extensive cattle ranching began about 1850. As a result of the coming of the railroad and the introduction of barbed wire about 1880, the plowing and cultivation of areas progressed from sandy uplands to bottom lands and finally to the Blackland Prairie. The shallower soils of the Grand Prairie were used principally for ranching and stock farming. Most range is on the Grand Prairie in the western half of the county, and only small areas of native grassland are on the Blackland Prairie in the eastern half.

### *Range sites and condition classes*

Soils differ in their capacity to produce grass and other plants for grazing. Soils that produce about the same kind and amount of forage, if the range is in similar condition, make up a range site.

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

Plants that cannot compete with the plants in the climax plant community for moisture, nutrients, and light are called invaders. Invaders come in after the climax vegetation has been reduced by grazing. Many are annual weeds and some are shrubs that

[3]By DON T. PENDLETON, range conservationist, Soil Conservation Service.

have some grazing value, but others have little or no value for grazing.

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

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

The potential forage production depends on the range site. The current forage production depends on the range condition and the moisture available to plants during their growing season.

The main objective of good range management is to keep the range in excellent or good condition. If this is done, water is conserved, yields are improved or maintained, and the soils are protected. The major concern in range management is recognition of important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Plant growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods, under the supervision of a careful manager, may have a deteriorated appearance that temporarily conceals its quality and its capacity to recover.

### *Descriptions of the range sites*

In this section the 16 range sites of Bell County are described, and the climax plants and principal invaders on the sites are named. An estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition is also given. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

#### ADOBE RANGE SITE

This range site is made up of shallow, gently sloping and rolling soils on the tops of small hills. These soils are underlain by soft limestone. Runoff is rapid even where the grass cover is good. The hazard of erosion is moderate to severe. Available water capacity is very low.

If this site is in climax condition, it is a savanna. The climax plants are mainly grasses. Motts of live oak, Texas oak, and Bigelow oak are scattered throughout the site. Little bluestem makes up about 50 percent, by weight, of the annual production, and tall grama and side-oats grama make up 20 percent. Other grasses in various combinations that make up about 20 percent of the production are pinhole bluestem, silver bluestem, tall dropseed, green sprangletop, slim tridens, hairy grama, three-awns, panicums, seep muhly, and fall witchgrass. Woody plants and forbs make up 10 percent of the production. These include redbud, black dalea, kidneywood, and ash. Juniper, Texas persimmon, Mexicanbuckeye, agrito, Texas sophora, western soapberry, and sumac originally grew in areas of rocky outcrops on the steep slopes.

Where this site is in deteriorated condition, the main plant is juniper. Other invaders are sumac, Mexicanbuckeye, Texas persimmon, queen's-delight, evax, cedar sedge, Texas grama, hairy tridens, three-awns, and poverty dropseed.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 3,500 pounds in wet years to 1,800 pounds in dry years.

#### BLACKLAND RANGE SITE

This range site is made up of nearly level to sloping soils that are moderately deep to deep. Sloping areas commonly have microridges and valleys extending up and down the slopes. Nearly level areas have a microrelief of knolls and depressions. Runoff is slow to rapid, and available water capacity is medium or high. The hazard of erosion is slight to severe.

The climax plants are mainly grasses. Motts of large live oak are scattered throughout the site, and hackberry and elm are along the draws. Woody plants contribute little to the total annual production. Little bluestem makes up about 50 percent, by weight, of the annual production, and indiangrass and big bluestem in localized areas make up 30 percent. A small amount of eastern gamagrass grows on this site. Other grasses in various combinations that make up about 10 percent of the production are switchgrass, wildrye, Florida paspalum, side-oats grama, silver bluestem, meadow dropseed, Texas wintergrass, Texas cupgrass, buffalograss, low-growing panicums, and sedges. Forbs such as Maximilian sunflower, Engelmanndaisy, bundleflower, prairie-clover, yellow neptunia, blacksamson, gayfeather, and western ragweed make up about 10 percent of the production.

Where this site is in deteriorated condition, buffalograss, Texas wintergrass, broomweed, western ragweed, mesquite, osage-orange, and honeylocust increase or invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 7,500 pounds in wet years to 4,000 pounds in dry years.

#### CHALKY RIDGE RANGE SITE

This range site is made up of nearly level to sloping, very shallow to moderately deep soils on uplands. This is the highest site in the Blackland Prairie landscape. Runoff is medium or rapid, and available water capacity is low or very low. The hazard of erosion is slight to severe.

The climax plants are mainly grasses. Large live oak trees are widely scattered on the site but contribute little to the total annual production. Little bluestem makes up 50 percent, by weight, of the annual production; indiangrass, big bluestem, Florida paspalum, and Canada wildrye make up 20 percent; side-oats grama, meadow dropseed, and silver

bluestem make up 10 percent; and Texas wintergrass, tridens, buffalograss, low-growing panicums, three-awns, and fall witchgrass make up 10 percent. Forbs such as Engelmanndaisy, Maximilian sunflower, gayfeather, blacksamson, penstemons, bundleflower, and prairie-clover make up about 10 percent of the annual production. The scattered trees, topography, and many flowering forbs make this an attractive site.

Where this site is in deteriorated condition, buffalograss, Texas grama, hairy tridens, three-awns, broomweed, and western ragweed increase or invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 4,000 pounds in wet years to 2,000 pounds in dry years.

### CLAYEY BOTTOMLAND RANGE SITE

This range site consists of deep, nearly level soils on flood plains of major rivers and their tributaries. Runoff is very slow, and available water capacity is high. The hazard of erosion is slight.

If this site is in climax condition, it is a savanna. Elm, hackberry, and ash are the dominant trees. Oak, pecan, cottonwood, Texas sophora, and willow also grow on this site. Woody plants shade about 30 percent of the site and make up about 20 percent, by weight, of the total annual production; Virginia wildrye, the dominant herbaceous plant, makes up 40 percent; and sedges, switchgrass, eastern gamagrass, beaked panicum, and rustyseed paspalum in different combinations make up 40 percent.

Because this site is close to water, has large shade trees, and produces quality forage, it was one of the first sites in the county to be overgrazed. Few areas are in native vegetation, and those that are have degenerated considerably from the climax condition. Most areas are now dominated by a dense canopy of elm and hackberry trees. Where the site is in such a deteriorated condition, shade-tolerant cool-season grasses such as Virginia wildrye increase or invade. Sedges, greenbriar, coralberry, grape, berryvines, and sumac also increase or invade. Heavily grazed open areas are almost entirely buffalograss or bermudagrass and such weedy forbs as ironweed, blood ragweed, and white crownbeard.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 7,500 pounds in wet years to 5,000 pounds in dry years. In areas where the tree canopy is 30 percent, as much as 1,500 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

### CLAY LOAM RANGE SITE

This range site is made up of nearly level to strongly sloping and undulating soils on uplands. These soils are deep and moderately deep. Runoff is slow to rapid, and available water capacity is high. The hazard of erosion is slight to severe.

If this site is in climax condition, it is a tall grass prairie. Elm and hackberry trees grow along the water courses, and a few motts of large live oak trees are scattered throughout the site. Woody plants contribute little to the total annual production. Little bluestem makes up about 40 percent of the total production, and indiangrass and big bluestem make up about 30 percent. Other grasses in various combinations that make up about 25 percent of the production are switchgrass, side-oats grama, silver bluestem, tall dropseed, Texas wintergrass, vine-mesquite, and Texas cupgrass. Such forbs as Maximilian sunflower, Engelmanndaisy, gayfeather, prairie-clover, bundleflower, western ragweed, and snow-on-the-mountain make up about 5 percent of production.

Because this site is accessible and produces quality forage, it is a preferred grazing area and is likely to be one of the first sites to be overgrazed. Where this site is in deteriorated condition, buffalograss and Texas wintergrass increase or invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 6,500 pounds in wet years to 3,500 pounds in dry years.

### CLAYPAN PRAIRIE RANGE SITE

This range site is made up of deep, nearly level to gently sloping soils on uplands. Runoff is very slow to medium, and available water capacity is high. The hazard of erosion is slight or moderate.

If this site is in climax condition, it is a prairie. A few live oak, elm, and hackberry trees grow along the water courses and in scattered motts. Large old post oak trees are widely scattered throughout the site, but the site is a marginal post oak habitat. The post oak trees do not increase aggressively, and once they have been cut or otherwise removed from the site, they generally do not become reestablished. Woody plants contribute little to the total annual production. Little bluestem makes up 60 percent, by weight, of the annual production, and indiangrass contributes about 15 percent. Other grasses in various combinations that make up about 15 percent of the production are switchgrass, big bluestem, Canada wildrye, Florida paspalum, silver bluestem, meadow dropseed, side-oats grama, and Texas wintergrass. Such forbs as Engelmanndaisy, bundleflower, sensitivebrier, yellow neptunia, scurf-pea, prairieparsley, and western ragweed make up about 10 percent of the production.

Where this site is in deteriorated condition, mesquite trees are aggressive invaders. Meadow dropseed, silver bluestem, and Texas wintergrass also increase or invade. Many formerly cultivated fields and numerous areas of climax stands have deteriorated to stands of increaser and invader plants. Texas wintergrass produces especially well in association with the mesquite.

Where this site is in excellent condition, potential annual production of air-dry herbage ranges from 6,000 pounds in wet years to 3,000 pounds in dry years.

### CLAYPAN SAVANNA RANGE SITE

This range site is made up of deep, gently sloping soils on uplands. Runoff is medium, and available

water capacity is medium. The hazard of erosion is slight.

If this site is in climax condition, it is a savanna. Little bluestem makes up almost 50 percent, by weight, of the total annual production, purpletop makes up as much as 10 percent, and tall grasses such as indiangrass, big bluestem, switchgrass, and Florida paspalum make up about 5 percent. Side-oats grama, tall dropseed, silver bluestem, and Texas wintergrass make up about 15 percent of the production. Small amounts of low-growing paspalums, low-growing panicums, three-awns, Carolina jointtail, splitbeard bluestem, hairy grama, and sedges also grow on this site. Woody plants such as post oak, elm, blackjack oak, hackberry, elbowbush, skunkbush, greenbriar, and grape make up about 15 percent of the annual production. Such native legumes as lespedeza, tickclover, snoutbean, milkpea, yellow neptunia, sensitivebrier, and western indigo make up about 5 percent of the production.

Where this site is in deteriorated condition, elm, oak, eastern redcedar, mesquite, elbowbush, skunkbush, and bumelia increase or invade. Red lovegrass, sand dropseed, horsenettle, hairy grama, tumble lovegrass, three-awns, low-growing paspalums, wildindigo, bitter sneezeweed, silverleaf nightshade, and curlycup gumweed invade or increase in open areas.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 5,000 pounds in wet years to 2,500 pounds in dry years. In areas where the tree canopy is 20 percent, as much as 800 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

### DEEP REDLAND RANGE SITE

This range site is made up of deep to moderately deep, nearly level to gently sloping soils on the tops of low ridges and on the intervening slopes. Runoff is slow to medium, and available water capacity is medium or high. The hazard of erosion is slight.

If this site is in climax condition, it is an open grassland and scattered motts of trees. Woody plants, mainly live oak and post oak, shade 10 percent or less of the site. Bigelow oak, Texas oak, elm, and hackberry also grow on the site. Indiangrass, big bluestem, and little bluestem make up as much as 60 percent of the total annual production; side-oats grama, silver bluestem, tall dropseeds, vine-mesquite, and Texas cupgrass make up 20 percent; Texas wintergrass and Canada wildrye make up 10 percent; and buffalograss, curlymesquite, fall witchgrass, and Scribner panicum make up 5 percent. Woody plants and forbs such as Maximilian sunflower, bushsunflower, Engelmanndaisy, bundleflower, pitcher sage, Mexican sagewort, ruellia, knotweed leafflower, and western ragweed make up about 5 percent of the production. Because this site is accessible and produces quality forage, it is one of the most heavily grazed sites in the county.

Where this site is in deteriorated condition, curlymesquite, buffalograss, live oak, mesquite, ash, juniper, Texas persimmon, broomweed, western ragweed, Texas grama, and hairy tridens increase or invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 6,000 pounds in wet years to 3,000 pounds in dry years.

### ERODED BLACKLAND RANGE SITE

Only Ferris-Heiden complex, 5 to 12 percent slopes, eroded, is in this range site. These deep, sloping to strongly sloping soils were cultivated at one time. They are damaged by erosion, and many gullies cannot be crossed by machinery. Runoff is rapid, and the hazard of erosion is severe. Available water capacity is high, and permeability is very slow.

If this site is in climax condition, it is a tall grass prairie. Little bluestem makes up as much as 50 percent, by weight, of the total annual production, and indiangrass and big bluestem make up 20 percent or more. These two kinds of grass dominate some localized areas. Other grasses in various combinations that make up about 20 percent of the annual production are Canada wildrye, switchgrass, Florida paspalum, side-oats grama, meadow dropseed, silver bluestem, Texas wintergrass, low-growing panicums, and sedges. Forbs such as Maximilian sunflower, Engelmanndaisy, bundleflower, prairieclover, yellow neptunia, blacksamson, gayfeather, and halfshrub sundrops make up as much as 10 percent of the production. They add color to the site and variety to the diet of animals feeding on this site. Live oak, elm, hackberry, and bumelia grow on this site, but woody plant production is insignificant.

Where this site is in deteriorated condition, mesquite, pricklypear, osage-orange, buffalograss, bermudagrass, western ragweed, broomweed, and annual forbs increase or invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 6,000 pounds in wet years to 4,000 pounds in dry years.

### GRAVELLY RANGE SITE

Only Riesel gravelly soils, 1 to 3 percent slopes, are in this range site. These gently sloping soils are deep. Runoff is medium, and available water capacity is low. The hazard of erosion is slight.

If this site is in climax condition, it is a savanna. Little bluestem makes up 50 percent of the total annual production; indiangrass, switchgrass, purpletop panicum, and beaked panicum in various combinations make up about 15 percent; and side-oats grama, purple lovegrass, low-growing panicums, tall dropseed, and three-awns make up about 15 percent. Woody plants such as post oak, blackjack oak, elm, hawthorn, greenbriar, yaupon, grape, and berryvines make up 15 percent of the production. Lespedeza, tickclover, snoutbean, and sensitivebrier make up about 5 percent of the production.

Where this site is in deteriorated condition, woody plants increase and invade to form dense thickets. Red lovegrass, splitbeard bluestem, broomsedge

bluestem, wildindigo, goldenrod, bitter sneezeweed, croton, and bullnettle also increase or invade.

Where this site is in excellent condition, potential annual acre yield of air-dry herbage ranges from 3,500 pounds in wet years to 2,000 pounds in dry years. In areas where the tree canopy is 20 percent, as much as 700 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

#### LOAMY BOTTOMLAND RANGE SITE

This range site is made up of deep, nearly level soils on flood plains. This site receives extra water from occasional to frequent stream flooding and runoff from adjacent higher sites. Runoff is slow to medium, and available water capacity is high. The hazard of erosion is slight.

If this site is in climax condition, it is a savanna. Pecan, elm, hackberry, live oak, ash, western soapberry, cottonwood, and Texas sophora grow on this site. Woody plants contribute as much as 20 percent to the total annual production. Tall grasses such as switchgrass and indiangrass make up more than 35 percent, by weight, of the annual production; big bluestem and little bluestem make up about 25 percent; and cool-season plants such as Virginia wildrye, Texas wintergrass, and sedges make up about 10 percent. Other climax grasses that make up about 10 percent of the production are eastern gamagrass, Lindheimer muhly, vine-mesquite, meadow dropseed, side-oats grama, silver bluestem, and buffalograss. Because this site produces quality forage, has large shade trees, and is close to water, it is a preferred grazing area. It was one of the first sites to be overgrazed.

Where this site is in deteriorated condition, the tall grasses decrease, and the tree canopy thickens. Shade-tolerant plants such as wildrye, sedges, and low-growing panicums increase or invade. Open areas are dominated by buffalograss or bermudagrass and weedy forbs, such as blood ragweed, white crownbeard, ironweed, parthenium, sumpweed, sunflower, cocklebur, and broomweed.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 6,500 pounds in wet years to 4,000 pounds in dry years. In areas that have a tree canopy of 20 percent, as much as 1,300 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

#### LOW STONY HILL RANGE SITE

This range site is made up of undulating to rolling, very shallow to shallow soils on large flats between drainageways or on tops of hills or plateaus. Runoff is slow to medium, and available water capacity is low. The hazard of erosion is slight.

If this site is in climax condition, it is a savanna. Motts of live oak, hackberry, and elm grow in abundance along the water courses. Bigelow oak, bumelia, elbowbush, sumacs, and black dalea also grow on this site. Woody plants contribute about 10 percent to the total annual production. Little bluestem makes up 40 percent, by weight, of the annual production; indiangrass and big bluestem make up 15 percent; and side-oats grama, tall dropseed, silver bluestem, and vine-mesquite make up 15 percent. Texas wintergrass and Canada wildrye make up 10 percent to the annual production, and green sprangletop, buffalograss, fall witchgrass, and hairy grama make up 5 percent. Forbs such as bundleflower, knotweed leafflower, dalea, prairie-clover, scurf-pea, gayfeather, and halfshrub sundrops make up 5 percent of the production.

Where this site is in deteriorated condition, ash, juniper, sumac, mesquite, Texas persimmon, pricklypear, broomweed, croton, hairy tridens, Texas grama, and three-awns increase and invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 3,000 pounds in wet years to 1,000 pounds in dry years. In areas that have a tree canopy of 20 percent, as much as 600 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

#### REDLAND RANGE SITE

This range site is made of shallow, gently sloping and undulating soils on uplands. Runoff is medium to rapid, and available water capacity is low. The hazard of erosion is slight.

If this site is in climax condition, it is a savanna. Live oak, shin oak, and motts of post oak are scattered throughout the site. Woody plants contribute about 10 percent to the total production. Little bluestem makes up 50 percent of the total annual production; indiangrass and big bluestem make up as much as 20 percent; and side-oats grama, silver bluestem, tall dropseed, vine-mesquite, Texas wintergrass, and buffalograss make up about 15 percent. Such forbs as Maximilian sunflower, bushsunflower, Engelmanndaisy, Mexican sagewort, knotweed leafflower, and western ragweed make up 5 percent of the production.

Where this site is in deteriorated condition, Texas wintergrass, buffalograss, live oak, ash, juniper, mesquite, Texas persimmon, western ragweed, broomweed, and hairy tridens increase or invade.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 5,000 pounds in wet years to 3,000 pounds in dry years. In an area that has a tree canopy of 15 percent, as much as 600 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

#### SANDY LOAM RANGE SITE

This range site is made up of deep, nearly level to sloping soils on uplands. Runoff is medium, and available water capacity is high. The hazard of erosion is slight to severe.

If this site is in climax condition, it is a savanna. Little bluestem makes up about 50 percent, by weight, of the total annual production; tall grasses such as indiangrass, big bluestem, and sand love-

grass make up 15 percent; and purpletop, tall dropseed, side-oats grama, silver bluestem, Texas wintergrass, low-growing paspalums, and low-growing panicums make up 15 percent. Woody plants such as post oak, blackjack oak, elm, hackberry, elbowbush, skunkbush, bumelia, greenbriar, grape, wildplum, and Carolina snailseed make up about 15 percent of the annual production. Such forbs as Engelmanndaisy, gayfeather, lespedeza, tickclover, sensitivebrier, bundleflower, yellow neptunia, snoutbean, vetch, milkpea, western indigo, partridgepea, and western ragweed make up about 5 percent of the production.

Where this site is in deteriorated condition, uncultivated areas have a dense stand of trees, shrubs, and woody vines. Red lovegrass, splitbeard bluestem, low-growing paspalums, low-growing panicums, tumble lovegrass, hairy grama, sand dropseed, sandbur, silverleaf nightshade, croton, partridgepea, mesquite, juniper, and persimmon increase or invade in formerly cultivated areas as well as in deteriorated climax areas.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 4,500 pounds in wet years to 2,000 pounds in dry years. In areas that have a tree canopy of 20 percent, as much as 900 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

#### SHALLOW RANGE SITE

This range site is made up of gently sloping and undulating, shallow to very shallow soils on uplands. Runoff is slow or medium, and available water capacity is low. The hazard of erosion is slight.

The climax plants are mainly mid grasses. A few motts of live oak are scattered throughout the site. Little bluestem makes up 50 percent of the total annual production; indiangrass and big bluestem make up 15 percent; tall dropseed, side-oats grama, and silver bluestem make up 20 percent; and Texas wintergrass, slim tridens, fall witchgrass, tall grama, and Wright three-awn make up 10 percent. Elbowbush and bumelia also grow on the site. Woody plants and forbs make up about 5 percent of the total annual production. Among the forbs are Maximilian sunflower, Engelmanndaisy, gayfeather, golden dalea, halfshrub sundrops, and knotweed leafflower.

Where this site is in deteriorated condition, Texas grama, hairy tridens, poverty dropseed, broomweed, evax, queen's-delight, and three-awn increase or invade.

Where this site is in excellent condition, potential annual acre yield of air-dry herbage ranges from 4,500 pounds in wet years to 2,500 pounds in dry years.

#### STEEP ROCKY RANGE SITE

Only Real association, hilly, is in this range site. These shallow to very shallow soils are in rough, broken, hilly areas on uplands. Runoff is rapid, and available water capacity is very low. The hazard of erosion is severe.

If this site is in climax condition, it is a savanna. Live oak, Texas oak, and Bigelow oak are the dominant woody plants. Ash, redbud, hackberry, elm, escarpment blackcherry, kidneywood, bumelia, elbowbush, and black dalea also grow on this site. Sumac, Texas persimmon, Mexican buckeye, Texas sophora, agrito, and juniper grow in small amounts on the rocky, craggy outcrop. Woody plants contribute about 15 percent, by weight, to the total annual production. Little bluestem makes up about 35 percent of the production, and side-oats grama produces about 15 percent. Tall grasses such as indiangrass and big bluestem grow in areas of deeper soils and make up about 5 percent of the production. Other grasses in various combinations that make up 20 percent of the production are tall dropseed, silver bluestem, cane bluestem, green sprangletop, slim tridens, rough tridens, Wright three-awn, purple three-awn, Reverchon panicum, Texas wintergrass, and fall witchgrass. Such forbs as bushsunflower, Engelmanndaisy, gayfeather, halfshrub sundrops, bundleflower, daleas, prairie-clover, and knotweed leafflower make up as much as 10 percent of the production.

Where this site is in deteriorated condition, juniper, oak, Texas persimmon, Mexicanbuckeye, agrito, and sumac generally become dominant. The understory is a sparse cover of cedar sedge, hairy tridens, three-awns, evax, and queen's-delight. This site is not used regularly by cattle and sheep. Goats, however, make extensive use of the site, and it is a preferred habitat for deer.

Where this site is in excellent condition, potential annual acre production of air-dry herbage ranges from 3,000 pounds in wet years to 1,500 pounds in dry years. In areas that have a 20 percent tree canopy, as much as 600 pounds of the annual production is woody plants, and some or all of this production will likely be unpalatable to or out of reach of grazing animals.

## Wildlife

Soils directly influence the kind and amount of vegetation and the amount of water in an area. In this way they indirectly influence the kind of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are (1) thickness of soil useful to crops, (2) texture of the surface layer, (3) available water capacity to a depth of 40 inches, (4) wetness, (5) surface stoniness or rockiness, (6) flooding hazard, (7) slope, and (8) permeability of the soil to air and water.

In table 3, the soils of Bell County are rated for the production of six elements of wildlife habitat and for three groups, or kinds, of wildlife. The ratings indicate relative suitability for various elements. A rating of *good* indicates that habitat is easily improved, maintained, or created. The soil has few or no limitations that affect management, and satisfactory results can be expected. A rating of *fair* indicates that habitat can be improved, maintained, or created, but the soil has moderate limitations that affect management or development. A moderate intensity of management and fairly fre-

TABLE 3.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife*

| Soil series and map symbols | Elements of wildlife habitat | | | | | | Kinds of wildlife | | |
|---|---|---|---|---|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous upland plants | Hardwood trees, shrubs, and vines | Wetland food and cover plants | Ponds | Open-land | Range-land | Wetland |
| Altoga: AlC, AlE2 | Fair | Fair | Fair | Fair | Very poor | Poor | Fair | Fair | Very poor. |
| Austin: AsB, AsC, AuC. For Urban land part of AuC, see Urban land. | Fair | Fair | Fair | Good | Very poor | Very poor | Fair | Fair | Very poor. |
| Axtell: AxB | Good | Good | Good | Good | Very poor | Very poor | Good | Good | Very poor. |
| Bastrop: BaA | Good | Good | Good | Good | Very poor | Very poor | Good | Good | Very poor. |
| Bosque: Be, Bf | Fair | Good | Good | Fair | Poor | Very poor | Good | Good | Very poor. |
| Brackett: BkB, BnE. For Urban land part of BnE, see Urban land. | Poor | Poor | Fair | Fair | Very poor | Very poor | Poor | Fair | Very poor. |
| BRE | Very poor | Poor | Fair | Fair | Very poor | Very poor | Poor | Fair | Very poor. |
| Branyon: ByA, ByB | Good | Good | Good | Fair | Very poor | Fair | Good | Fair | Very poor. |
| Burleson: BzA, BzB | Fair | Fair | Fair | Fair | Very poor | Fair | Fair | Fair | Very poor. |
| Chigley: ChB | Good | Good | Good | Good | Poor | Very poor | Good | Good | Very poor. |
| Crawford: CrA, CrB | Fair | Fair | Fair | Good | Very poor | Very poor | Fair | Fair | Very poor. |
| Denton: DeA, DeB, DnB, DPB. For Urban land part of DnB, see Urban land. | Fair | Fair | Fair | Good | Very poor | Very poor | Fair | Fair | Very poor. |
| Eddy: EsB, EsD. For Stephen part of EsB and EsD, see Stephen series. | Poor | Poor | Poor | Fair | Very poor | Very poor | Poor | Poor | Very poor. |
| Ferris: FeE2. For Heiden part of FeE2, see Heiden series. | Poor | Fair | Fair | Fair | Very poor | Fair | Fair | Fair | Very poor. |
| Frio: Fr, Fs | Good | Good | Good | Good | Very poor | Very poor | Good | Fair | Poor. |
| Heiden: HeB, HeC, HfD, HgD2. For Ferris part of HgD2, see Ferris series. | Good | Fair | Good | Fair | Very poor | Good | Good | Fair | Very poor. |
| Houston Black: HoA, HoB, Hoc, HuC. For Urban land part of HuC, see Urban land. | Good | Fair | Good | Fair | Very poor | Good | Good | Fair | Very poor. |
| Krum: KrA, KrB, KuB, KVB. For Urban land part of KuB, see Urban land. For Lewisville part of KVB, see Lewisville series. | Fair | Fair | Fair | Fair | Very poor | Poor | Fair | Fair | Very poor. |
| Lewisville: LeB, LeC, LgC, LuC. For Altoga part of LgC, see Altoga series. For Urban land part of LuC, see Urban land. | Fair | Fair | Fair | Good | Very poor | Very poor | Fair | Fair | Very poor. |

TABLE 3.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife*—Continued

| Soil series and map symbols | Elements of wildlife habitat | | | | | | Kinds of wildlife | | |
|---|---|---|---|---|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous upland plants | Hardwood trees, shrubs, and vines | Wetland food and cover plants | Ponds | Open-land | Range-land | Wetland |
| Lindy variant: LyB | Fair | Good | Good | Good | Very poor | Very poor | Good | Good | Very poor. |
| Menard: MeD2 | Good | Good | Good | Fair | Very poor | Very poor | Good | Good | Very poor. |
| Patrick: PaD | Good | Good | Good | Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Payne: PcA, PcB | Good | Good | Good | Good | Very poor | Poor | Good | Good | Very poor. |
| Pedernales: PdB | Good | Good | Good | Fair | Very poor | Very poor | Good | Good | Very poor. |
| Purves: PrB, PuD. For Urban land part of PuD, see Urban land. | Poor | Poor | Fair | Fair | Very poor | Very poor | Poor | Fair | Very poor. |
| PVD | Very poor | Poor | Fair | Fair | Very poor | Very poor | Poor | Fair | Very poor. |
| Real: REF | Very poor | Poor | Fair | Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Riesel: RgB | Poor | Fair | Fair | Good | Very poor | Very poor | Fair | Fair | Very poor. |
| San Saba: SaA, SaB, SnB. For Urban land part of SnB, see Urban land. | Fair | Fair | Fair | Fair | Very poor | Poor | Fair | Fair | Very poor. |
| Speck: SPD | Very poor | Fair | Fair | Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| SsB | Fair | Fair | Good | Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Stephen: StB, StC, SuC. For Urban land part of SuC, see Urban land. | Poor | Poor | Fair | Fair | Very poor | Very poor | Poor | Fair | Very poor. |
| Tarrant: TAD, TPF. For Purves part of TPF, see Purves series. | Very poor | Poor | Fair | Fair | Very poor | Very poor | Poor | Fair | Very poor. |
| Trinity: Tr, Ty | Fair | Fair | Good | Fair | Poor | Poor | Fair | Fair | Fair. |
| Urban land: Ub. Properties too variable to rate. | | | | | | | | | |
| Venus: VeA, VeB, VeC | Good | Good | Good | Good | Very poor | Very poor | Good | Good | Very poor. |
| Wilson: WcA, WcB, WcC | Fair | Good | Good | Good | Very poor | Poor | Good | Good | Very poor. |

quent attention may be required for satisfactory results. A rating of *poor* indicates that habitat can be improved, maintained, or created, but the soil has severe limitations. Management may be difficult, expensive, and require intensive effort. Results are questionable. A rating of *very poor* indicates that under the prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitat. Unsatisfactory results are probable.

The ratings of wildlife habitat in table 3 mainly take into account the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason selection of a site for development as a habitat for wildlife requires inspection at the site.

The six habitat elements rated in table 3 are briefly defined in the following paragraphs.

*Grain and seed crops* are crops that produce annual grain, such as corn, sorghum, millet, and soybeans.

*Grasses and legumes* are domestic grasses and legumes that are established by planting. They provide food and cover for wildlife (fig. 9). Grasses include bahiagrass, ryegrass, and panicgrass; leg-

*Figure 9.*—A nest of quail eggs in a native grass meadow on Denton silty clay, 1 to 3 percent slopes.

umes include annual lespedeza, shrub lespedeza, and other clovers.

*Wild herbaceous upland plants* are native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Ragweed, wild bean, pokeweed, and cheatgrass are examples of these plants. On range typical plants are bluestem, grama, perennial forbs, and legumes.

*Hardwood trees, shrubs, and vines* are nonconiferous trees, shrubs, and woody vines that produce wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be planted and developed through wildlife management programs. Typical species in this category are oak, dogwood, maple, viburnum, grape, honeysuckle, greenbriar, and silverberry.

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

*Ponds* are dugout ponds or a combination of dugout ponds and low dikes or dams. They hold enough water of suitable quality and depth to support fish production.

The three major kinds of wildlife rated in table 3 are briefly defined as follows.

*Open-land wildlife* are birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, dove, meadowlark, field sparrow, cottontail rabbit, and fox are examples of open-land wildlife.

*Rangeland wildlife* are birds and mammals that normally live in natural rangelands. White-tailed deer, fox, bobcat, raccoon, wild turkey, dove, and woodpecker are examples of rangeland wildlife.

*Wetland wildlife* are birds and mammals that normally live in wet areas. Duck, geese, rail, shore birds, beaver, heron, and muskrat are examples of wetland wildlife.

## Recreation

Knowledge of soils is necessary for planning, developing, and maintaining areas used for recreation. In table 4 the soils of Bell County are rated according to the limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

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

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

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

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have

TABLE 4.—*Degree of limitation and soil features affecting recreational development*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

| Soil series and map symbols | Camp areas | Playgrounds | Picnic areas | Paths and trails |
|---|---|---|---|---|
| Altoga: AlC, AlE2 | Severe: silty clay surface layer. | Severe: silty clay surface layer; slope. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| *Austin: AsB, AsC, AuC<br>For Urban land part of AuC, see Urban land. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| Axtell: AxB | Severe: very slow permeability. | Severe: very slow permeability. | Slight | Slight. |
| Bastrop: BaA | Slight | Slight | Slight | Slight. |
| Bosque:<br>Be | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. | Slight. |
| Bf | Severe: frequently flooded. | Severe: frequently flooded. | Moderate: flooding hazard. | Slight. |
| *Brackett:<br>BkB, BnE<br>For Urban land part of BnE, see Urban land. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. |
| BRE | Moderate: slope | Severe: slope | Moderate: slope | Slight. |
| Branyon: ByA, ByB | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| Burleson: BzA, BzB | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| Chigley: ChB | Moderate: moderately slow permeability. | Moderate: moderately slow permeability. | Slight | Slight. |
| Crawford: CrA, CrB | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| *Denton:<br>DeA, DeB, DnB<br>For Urban land part of DnB, see Urban land. | Severe: clay surface layer. | Severe: clay surface layer. | Severe: clay surface layer. | Severe: clay surface layer. |
| DPB | Severe: clay surface layer. | Severe: clay surface layer. | Severe: clay surface layer. | Severe: clay surface layer. |
| *Eddy: EsB, EsD<br>For Stephen part of EsB and EsD, see Stephen series. | Moderate: 35 to 50 percent coarse fragments. | Severe: bedrock at a depth of 5 to 12 inches; 35 to 50 percent coarse fragments. | Moderate: 35 to 50 percent coarse fragments. | Moderate: 35 to 50 percent coarse fragments. |
| *Ferris: FeE2<br>For Heiden part of FeE2, see Heiden series. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| Frio: Fr, Fs | Severe: silty clay surface layer; flooding hazard. | Severe: silty clay surface layer; flooding hazard. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| *Heiden: HeB, HeC, HfD, HgD2.<br>For Ferris part of HgD2, see Ferris series. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| *Houston Black: HoA, HoB, HoC, HuC.<br>For Urban land part of HuC, see Urban land. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |

TABLE 4.—*Degree of limitation and soil features affecting recreational development*—Continued

| Soil series and map symbols | Camp areas | Playgrounds | Picnic areas | Paths and trails |
|---|---|---|---|---|
| *Krum: KrA, KrB, KuB, KVB. For Urban land part of KuB, see Urban land. For Lewisville part of KVB, see Lewisville series. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| *Lewisville: LeB, LeC, LgC, LuC. For Altoga part of LgC, see Altoga series. For Urban land part of LuC, see Urban land. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| Lindy variant: LyB | Moderate: clay loam surface layer; slow permeability. | Moderate: clay loam surface layer; slow permeability. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. |
| Menard: MeD2 | Slight | Severe: slope | Slight | Slight. |
| Patrick: PaD | Severe: silty clay surface layer. | Severe: silty clay surface layer; slope. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| Payne: PcA, PcB | Severe: very slow permeability. | Severe: very slow permeability. | Slight | Slight. |
| Pedernales: PdB | Moderate: moderately slow permeability. | Moderate: moderately slow permeability. | Slight | Slight. |
| *Purves: PrB, PuD For Urban land part of PuD, see Urban land. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| PVD | Severe: stony | Severe: silty clay surface layer; bedrock at a depth of 8 to 20 inches; 20 to 35 percent coarse fragments. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| Real: REF | Severe: slope; coarse fragments. | Severe: slope; coarse fragments. | Severe: slope; coarse fragments. | Moderate: slope; coarse fragments. |
| Riesel: RgB | Moderate: slow permeability. | Moderate: slow permeability. | Slight | Slight. |
| *San Saba: SaA, SaB, SnB For Urban land part of SnB, see Urban land. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| Speck: SPD, SsB | Moderate: clay loam surface layer; slow permeability. | Severe: bedrock at a depth of 14 to 20 inches. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. |
| *Stephen: StB, StC, SuC For Urban land part of SuC, see Urban land. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| *Tarrant: TAD, TPF For Purves part of TPF, see Purves series. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. | Severe: silty clay surface layer. |
| Trinity: Tr, Ty | Severe: clay surface layer; flooding hazard; very slow permeability. | Severe: clay surface layer; flooding hazard; very slow permeability. | Severe: clay surface layer. | Severe: clay surface layer. |
| Urban land: Ub. Properties too variable to rate. | | | | |
| Venus: VeA, VeB, VeC | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. | Moderate: clay loam surface layer. |
| Wilson: WcA, WcB, WcC | Severe: very slow permeability; somewhat poorly drained. | Severe: very slow permeability; somewhat poorly drained. | Moderate: clay loam surface layer; somewhat poorly drained. | Moderate: clay loam surface layer. |

*Figure 10.*—Picnic area on Tarrant-Purves association, rolling, along Belton Lake.

slopes or stoniness that greatly increase cost of leveling sites or of building access roads (fig. 10).

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

## Engineering Uses of the Soils[4]

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

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

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-

[4]By HUGH A. SMITH, civil engineer, Soil Conservation Service.

country movement of vehicles and construction equipment.

7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5 and 6 which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in tables 5 and 6, and it also can be used to make other useful maps.

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

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

### *Engineering classification systems*

The two systems most commonly used in classifying samples of soils for engineering are the Unified soil classification system,[5] used by SCS engineers, the Department of Defense, and others, and the AASHO system,[6] adopted by the American Association of State Highway Officials.

In the Unified soil classification system, soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, GW-GM. The letters used in class designation mean: G, gravel; S, sand; M, silt; and C, clay. Clean sands are identified by SW or SP; sands that have fines of silt and clay by SM or SC; silt and clay that have a low liquid limit by ML and CL; and silt and clay that have a high liquid limit by MH and CH.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet, the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A-6 or A-7. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest.

### *Estimated properties*

Estimates of several soil properties important in engineering are given in table 5. These estimates are made for typical soil profiles by layers that are sufficiently different to behave in a different way when used for engineering purposes. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. In the following paragraphs the columns in table 5 are explained.

The depth to seasonal high water table is not given, because a high water table is not a problem in Bell County.

In the column headed "Hydrologic group," the runoff potential from rainfall is given. Four major soil groups are used, and the soils are classified on the basis of intake of water at the end of long-duration storms that occur after prior wetting and opportunity for swelling and without the protective effects of vegetation.

The major soil groups are described in the following paragraphs:

Group A consists of soils that have a high infiltration rate even when thoroughly wetted. These are chiefly deep, well-drained to excessively drained sand, gravel, or both. These soils have a high rate of water transmission and a low runoff potential.

Group B consists of soils that have a moderate infiltration rate when thoroughly wetted. These are chiefly moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission and a moderate runoff potential.

Group C consists of soils that have a slow infiltration rate when thoroughly wetted. These are chiefly soils that have a layer that impedes downward movement of water or soils that have moderately fine texture to fine texture. These soils have a slow rate of water transmission and a high runoff potential.

Group D consists of soils that have a very slow infiltration rate when thoroughly wetted. These are chiefly clay soils that have a high swelling potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious

[5]United States Department of Defense. Unified soil classification system for roads, airfields, embankments, and foundations. MIL-STD-619B, 30 pp., illus. 1968.

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

TABLE 5.—*Estimates of soil properties*

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

| Soil series and map symbols | Hydrologic group | Depth to bedrock | Depth from surface | USDA texture | Classification | | Percentage passing sieve— | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Unified | AASHO | Coarse fraction greater than 3 inches | No. 4 (4.7 mm) |
| | | *In* | *In* | | | | | |
| Altoga: AlC, AlE2 | C | >72 | 0–6 | Silty clay | CL or CH | A-6 or A-7 | | 100 |
| | | | 6–58 | Silty clay | CL | A-6 or A-7 | | 100 |
| | | | 58–62 | Chalky marl. | | | | |
| *Austin: AsB, AsC, AuC | C | 22–40 | 0–16 | Silty clay | CH or CL | A-7-6 | 0–5 | 95–100 |
| | | | 16–35 | Silty clay | CH or CL | A-7-6 | 0–5 | 95–100 |
| For Urban land part of AuC, see Urban land. | | | 35–48 | Marly clay and soft chalky marl. | | | | |
| Axtell: AxB | D | >72 | 0–8 | Fine sandy loam | SM or ML | A-2-4, A-4 | | 90–100 |
| | | | 8–78 | Clay | CH or CL | A-7-6 | | 95–100 |
| Bastrop: BaA | B | >72 | 0–16 | Fine sandy loam | ML, SM, ML-CL | A-4 | | 95–100 |
| | | | 16–72 | Sandy clay loam | CL, SC | A-6 | | 95–100 |
| Bosque: Be, Bf | B | >72 | 0–80 | Clay loam and silty clay. | CL or ML | A-6 or A-7 | | 100 |
| *Brackett: BkB, BnE, BRE | C | 10–20 | 0–16 | Loam | CL or SC | A-6 | 0–20 | 70–100 |
| For Urban land part of BnE, see Urban land. | | | 16–50 | Thinly interbedded, weakly and strongly cemented, platy limestone and calcareous clay loam. | | | | |
| Branyon: ByA, ByB | D | >72 | 0–70 | Clay | CH | A-7 | | 95–100 |
| Burleson: BzA, BzB | D | >72 | 0–38 | Clay | CH | A-7-6 | 0–2 | 99–100 |
| | | | 38–93 | Clay | CH | A-7-6 | 0–1 | 95–100 |
| Chigley: ChB | C | 40–70 | 0–15 | Gravelly and very gravelly fine sandy loam. | SM | A-2-4, A-4 | | 90–95 |
| | | | 15–46 | Gravelly clay and clay | CH, CL, SC | A-7, A-6 | | 85–95 |
| | | | 46–50 | Soft chalky marly clay and nodular limestone. | CL, SC | A-6 | 0–5 | 55–90 |
| Crawford: CrA, CrB | D | 20–40 | 0–36 | Clay | CH, CL | A-7 | 0–5 | 85–100 |
| | | | 36–70 | Limestone bedrock. | | | | |
| *Denton: DeA, DeB, DnB, DPB | D | 22–40 | 0–21 | Silty clay | CH | A-7 | 0–10 | 80–100 |
| | | | 21–40 | Silty clay | CH or CL | A-7 | 0–20 | 80–100 |
| For Urban land part of DnB, see Urban land. | | | 40–60 | Hard limestone. | | | | |
| *Eddy: EsB, EsD | C | 5–12 | 0–5 | Gravelly clay loam | GC or GM | A-6, A-2 | 0–20 | 40–50 |
| For Stephen part of EsB and EsD, see Stephen series. | | | 5–8 | Very gravelly clay loam | GC or GM or GP-GC | A-2 | 10–60 | 20–30 |
| | | | 8–60 | Marine chalky limestone. | | | | |
| *Ferris: FeE2 | D | >72 | 0–56 | Clay and marly clay | CH | A-7-6 | | 95–100 |
| For Heiden part of FeE2, see Heiden series. | | | 56–80 | Shaly clay | | | | |
| Frio: Fr, Fs | B | >72 | 0–88 | Silty clay | CL | A-6 or A-7-6 | 0–20 | 65–100 |

*significant in engineering*

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to the symbol < means less than. Absence of data indicates that no estimate was made]

| Percentage passing sieve—Continued | | | Liquid limit | Plasticity index | Permeability | Available water capacity | Reaction | Shrink-swell potential | Corrosivity of uncoated steel |
|---|---|---|---|---|---|---|---|---|---|
| No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | | | | | | | |
| | | | *Pct* | | *In per hr* | *In per in of soil* | *pH* | | |
| 95–100 | 85–95 | 80–95 | 40–51 | 20–31 | 0.6–2.0 | 0.15–0.18 | 7.9–8.4 | High | Moderate. |
| 95–100 | 85–95 | 75–80 | 30–48 | 15–25 | 0.6–2.0 | 0.15–0.18 | 7.9–8.4 | Moderate | Moderate. |
| 95–100 | 80–100 | 75–95 | 45–65 | 25–40 | 0.2–0.6 | 0.15–0.20 | 7.9–8.4 | High | High. |
| 90–100 | 80–100 | 75–95 | 45–60 | 20–35 | 0.2–0.6 | 0.15–0.20 | 7.9–8.4 | High | High. |
| 90–100 | 75–90 | 30–60 | 12–25 | 0–4 | 0.6–2.0 | 0.11–0.15 | 5.6–6.0 | Low | High. |
| 90–100 | 80–100 | 50–75 | 45–55 | 25–35 | <0.06 | 0.13–0.16 | 5.1–7.3 | High | High. |
| 95–100 | 80–100 | 40–70 | 18–22 | 3–6 | 2.0–6.0 | 0.11–0.17 | 6.1–7.3 | Low | Moderate. |
| 95–100 | 80–100 | 40–65 | 24–35 | 11–24 | 0.6–2.0 | 0.15–0.19 | 6.1–7.3 | Low | Moderate. |
| 95–100 | 95–100 | 60–80 | 30–45 | 10–22 | 0.6–2.0 | 0.15–0.18 | 7.9–8.4 | Low | High. |
| 65–100 | 55–95 | 40–85 | 30–40 | 10–20 | 0.2–0.6 | 0.10–0.15 | 7.9–8.4 | Low | High. |
| 95–100 | 80–100 | 75–100 | 60–90 | 35–65 | <0.06 | 0.15–0.18 | 7.9–8.4 | Very high | Very high. |
| 98–100 | 85–100 | 80–95 | 51–75 | 30–55 | <0.06 | 0.15–0.20 | 6.1–6.5 | Very high | High. |
| 90–100 | 75–95 | 70–95 | 55–85 | 40–60 | <0.06 | 0.15–0.20 | 7.4–8.4 | Very high | High. |
| 70–80 | 40–50 | 10–45 | [1] NP | NP | 2.0–6.0 | 0.09–0.13 | 6.1–6.5 | Low | High. |
| 70–95 | 70–90 | 36–80 | 35–55 | 15–30 | 0.2–0.6 | 0.14–0.18 | 5.6–6.5 | Moderate | High. |
| 50–80 | 36–65 | 36–60 | 20–35 | 8–20 | 0.6–2.0 | 0.10–0.14 | 6.1–8.4 | Low | High. |
| 85–100 | 75–100 | 70–100 | 50–80 | 30–50 | <0.06 | 0.14–0.18 | 6.1–8.4 | Very high | High. |
| 80–100 | 80–100 | 75–95 | 50–70 | 30–45 | 0.06–0.2 | 0.15–0.20 | 7.9–8.4 | High | High. |
| 80–100 | 80–100 | 70–95 | 40–60 | 25–45 | 0.06–0.2 | 0.12–0.17 | 7.9–8.4 | High | High. |
| 35–50 | 30–45 | 20–40 | 30–40 | 11–20 | 0.2–0.6 | 0.10–0.13 | 7.9–8.4 | Low | High. |
| 15–25 | 10–20 | 8–15 | 30–40 | 11–20 | 0.2–0.6 | 0.03–0.07 | 7.9–8.4 | Low | High. |
| 95–100 | 80–95 | 75–95 | 51–70 | 35–50 | <0.06 | 0.15–0.18 | 7.9–8.4 | Very high | High. |
| 65–100 | 60–100 | 55–95 | 35–50 | 20–30 | 0.2–0.6 | 0.15–0.22 | 7.9–8.4 | Moderate | High. |

TABLE 5.—*Estimates of soil properties*

| Soil series and map symbols | Hydrologic group | Depth to bedrock | Depth from surface | USDA texture | Classification | | Percentage passing sieve— | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Unified | AASHO | Coarse fraction greater than 3 inches | No. 4 (4.7 mm) |
| | | *In* | *In* | | | | | |
| *Heiden: HeB, HeC, HfD, HgD2. For Ferris part of HgD2, see Ferris series. | D | >72 | 0–70 | Clay and shaly clay | CH | A-7-6 | | 95–100 |
| *Houston Black: HoA, HoB, HoC, HuC. For Urban land part of HuC, see Urban land. | D | >72 | 0–110 | Clay | CH | A-7 | | 95–100 |
| *Krum: KrA, KrB, KuB, KVB. For Urban land part of KuB, see Urban land. For Lewisville part of KVB, see Lewisville series. | C | >72 | 0–36 | Silty clay | CH | A-7-6 | | 95–100 |
| | | | 36–82 | Silty clay | CH | A-7-6 | | 85–100 |
| *Lewisville: LeB, LeC, LgC, LuC. For Altoga part of LgC, see Altoga series. For Urban land part of LuC, see Urban land. | B | >72 | 0–18 | Silty clay | CH, CL | A-7 | | 100 |
| | | | 18–70 | Silty clay | CH, CL | A-7 | | 100 |
| Lindy variant: LyB | C | 25–60 | 0–6 | Clay loam | CL | A-6 | 0–5 | 75–100 |
| | | | 6–43 | Clay and silty clay | CH or CL | A-7 | 0–5 | 80–100 |
| | | | 43–56 | Silty clay loam and chert and limestone fragments. | | | | |
| Menard: MeD2 | B | >72 | 0–10 | Fine sandy loam | SM, ML, CL-ML | A-4, A-2 | | 95–100 |
| | | | 10–50 | Sandy clay loam | CL, SC | A-6 | | 95–100 |
| Patrick: PaD | B | >72 | 0–18 | Silty clay | CL, CH | A-7 | | 85–100 |
| | | | 18–70 | Very gravelly sand | GM, GC, GW-GM | A-2-4 | 0–10 | 25–50 |
| Payne: PcA, PcB | C | >72 | 0–7 | Loam | CL | A-4 | | 95–100 |
| | | | 7–80 | Clay and silty clay | CL or CH | A-7 | 0–5 | 95–100 |
| Pedernales: PdB | C | >72 | 0–14 | Fine sandy loam | SM, ML, CL-ML | A-4 | | 95–100 |
| | | | 14–52 | Sandy clay | CL, CH | A-6 or A-7 | | 90–100 |
| | | | 52–90 | Sand and gravel. | | | | |
| *Purves: PrB, PuD, PVD. For Urban land part of PuD, see Urban land. | D | 8–20 | 0–14 | Silty clay | CH | A-7-6 | 0–20 | 90–100 |
| | | | 14–24 | Hard limestone. | | | | |
| Real: REF | D | 8–20 | 0–15 | Gravelly and very gravelly loam. | GC, GM, SC, or SM | A-2-6 | 0–15 | 40–75 |
| | | | 15–40 | Weakly cemented limestone. | | | | |
| Riesel: RgB | C | >72 | 0–16 | Gravelly and very gravelly fine sandy loam. | GM, SM | A-2-4 | 0–5 | 25–85 |
| | | | 16–56 | Gravelly clay and clay | GC, SC, CL, CH | A-7, A-2 | 0–5 | 25–90 |
| | | | 56–62 | Very gravelly loamy sand. | GP-GM | A-1 | 5–10 | 10–40 |
| *San Saba: SaA, SaB, SnB. For Urban land part of SnB, see Urban land. | D | 24–40 | 0–35 | Clay | CH | A-7-6 | | 100 |
| | | | 35–38 | Indurated limestone. | | | | |

*significant in engineering*—Continued

| Percentage passing sieve—Continued | | | Liquid limit | Plasticity index | Permeability | Available water capacity | Reaction | Shrink-swell potential | Corrosivity of uncoated steel |
|---|---|---|---|---|---|---|---|---|---|
| No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | | | | | | | |
| | | | *Pct* | | *In per hr* | *In per in of soil* | *pH* | | |
| 95–100 | 80–95 | 75–95 | 55–80 | 40–50 | <0.06 | 0.15–0.20 | 7.9–8.4 | Very high | High. |
| 95–100 | 95–100 | 85–100 | 55–110 | 35–90 | <0.06 | 0.15–0.20 | 7.9–8.4 | Very high | Very high. |
| 95–100 | 95–100 | 85–95 | 50–65 | 30–45 | 0.2–0.6 | 0.15–0.20 | 7.9–8.4 | High | High. |
| 75–100 | 70–95 | 65–90 | 50–60 | 30–40 | 0.2–0.6 | 0.15–0.20 | 7.9–8.4 | High | High. |
| 98–100 | 70–90 | 70–85 | 40–65 | 25–40 | 0.6–2.0 | 0.16–0.20 | 7.9–8.4 | High | High. |
| 95–100 | 65–90 | 65–85 | 35–55 | 20–35 | 0.6–2.0 | 0.16–0.20 | 7.9–8.4 | High | High. |
| 70–100 | 70–100 | 60–85 | 20–40 | 10–20 | 0.6–2.0 | 0.12–0.20 | 5.1–8.4 | Low | High. |
| 75–100 | 75–100 | 65–90 | 38–55 | 20–30 | 0.06–0.2 | 0.10–0.20 | 5.1–8.4 | Moderate | High. |
| 95–100 | 75–90 | 30–60 | 15–20 | 2–7 | 2.0–6.0 | 0.11–0.17 | 6.1–7.3 | Low | High. |
| 95–100 | 80–100 | 36–60 | 30–40 | 12–22 | 0.6–2.0 | 0.15–0.19 | 6.1–7.8 | Low | High. |
| 75–95 | 60–90 | 51–79 | 45–60 | 23–35 | 0.6–2.0 | 0.13–0.15 | 7.9–8.4 | Moderate | High. |
| 25–45 | 10–25 | 8–20 | 15–25 | 1–8 | >20 | 0.02–0.03 | 7.9–8.4 | Very low | High. |
| 95–100 | 85–100 | 60–80 | 15–30 | 3–10 | 0.2–0.6 | 0.15–0.20 | 6.1–7.3 | Low | High. |
| 95–100 | 90–100 | 70–90 | 35–55 | 20–30 | <0.06 | 0.14–0.18 | 6.1–8.4 | Moderate | High. |
| 90–100 | 75–100 | 36–55 | 15–25 | 2–7 | 0.6–2.0 | 0.12–0.17 | 6.6–7.3 | Low | High. |
| 90–100 | 85–100 | 55–75 | 35–55 | 20–35 | 0.2–0.6 | 0.15–0.20 | 6.1–7.8 | High | High. |
| 80–95 | 80–95 | 70–90 | 50–65 | 30–40 | 0.2–0.6 | 0.12–0.18 | 7.9–8.4 | High | High. |
| 30–65 | 25–50 | 20–35 | 25–35 | 10–20 | 0.6–2.0 | 0.05–0.10 | 7.9–8.4 | Moderate | High. |
| 15–75 | 12–65 | 5–25 | <20 | NP | 2.0–6.0 | 0.04–0.10 | 6.1–7.3 | Low | High. |
| 20–80 | 18–80 | 15–75 | 41–55 | 20–30 | 0.06–0.2 | 0.05–0.12 | 6.6–7.3 | Moderate | High. |
| 10–30 | 10–15 | 6–10 | NP | NP | 6.0–20 | 0.03–0.05 | 7.4–7.8 | Very low | High. |
| 98–100 | 95–100 | 90–100 | 55–70 | 35–45 | <0.06 | 0.15–0.20 | 7.4–8.4 | Very high | High. |

TABLE 5.—*Estimates of soil properties*

| Soil series and map symbols | Hydrologic group | Depth to bedrock | Depth from surface | USDA texture | Classification | | Percentage passing sieve— | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Unified | AASHO | Coarse fraction greater than 3 inches | No. 4 (4.7 mm) |
| | | *In* | *In* | | | | | |
| Speck: SPD, SsB | D | 14–20 | 0–8 | Gravelly clay loam | CL | A-6 or A-7 | 0–5 | 90–100 |
| | | | 8–19 | Clay | CL or CH | A-7-6 | | 75–95 |
| | | | 19–21 | Indurated limestone. | | | | |
| *Stephen: StB, StC, SuC | C | 8–20 | 0–5 | Silty clay | CH or CL | A-7 | 0–5 | 95–100 |
| | | | 5–14 | Silty clay | CL or CH | A-7 | 0–5 | 100 |
| For Urban land part of SuC, see Urban land. | | | 14–36 | Soft and hard chalk. | | | | |
| *Tarrant: TAD, TPF | D | 6–20 | 0–16 | Silty clay | CH | A-7-5 | 25–65 | 80–100 |
| | | | 16–20 | Hard limestone. | | | | |
| For Purves part of TPF, see Purves series. | | | | | | | | |
| Trinity: Tr, Ty | D | >72 | 0–72 | Clay | CH | A-7-6 | | 100 |
| Urban land: Ub. Properties too variable to estimate. | | | | | | | | |
| Venus: VeA, VeB, VeC | B | >72 | 0–12 | Clay loam | CL, CL-ML | A-6 | | 100 |
| | | | 12–46 | Clay loam | CL, CL-ML | A-6 | | 95–100 |
| | | | 46–72 | Clay loam | CL, CL-ML, SC-SM, SC | A-6 | | 80–100 |
| Wilson: WcA, WcB, WcC | D | >72 | 0–7 | Clay loam | CL | A-6 | | 95–100 |
| | | | 7–42 | Clay | CH, CL | A-7-6 | | 90–100 |
| | | | 42–72 | Clay | CL, CH | A-7-6 | | 95–100 |

[1] NP = Nonplastic.

material. These soils have a very slow rate of water transmission and a very high runoff potential.

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

In the column headed "Depth from surface," the depth is given in inches for the major distinctive layers of the soil profile.

Soil texture is described in table 5 in the standard terms used by the U.S. Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and other terms used in USDA textural classification are defined in the Glossary.

The percentage passing sieve estimates are given for a range in percentage of soil material passing sieves of four sizes. This information is useful in helping to determine suitability of the soil as a material for construction purposes.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state, and the liquid limit from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5.

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

*significant in engineering*—Continued

| Percentage passing sieve—Continued | | | Liquid limit | Plasticity index | Permeability | Available water capacity | Reaction | Shrink-swell potential | Corrosivity of uncoated steel |
|---|---|---|---|---|---|---|---|---|---|
| No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | | | | | | | |
| | | | *Pct* | | *In per hr* | *In per in of soil* | *pH* | | |
| 80–100 | 80–95 | 75–90 | 30–45 | 15–25 | 0.2–0.6 | 0.15–0.20 | 6.1–6.5 | Low | High. |
| 75–95 | 75–95 | 60–95 | 45–55 | 25–35 | 0.06–0.2 | 0.15–0.20 | 6.6–7.3 | Moderate | High. |
| 90–100 | 85–100 | 80–90 | 45–60 | 20–32 | 0.2–0.6 | 0.10–0.15 | 7.9–8.4 | Moderate | High. |
| 90–95 | 85–95 | 80–90 | 45–60 | 20–32 | 0.2–0.6 | 0.10–0.15 | 7.9–8.4 | Moderate | High. |
| 80–100 | 70–90 | 70–95 | 55–70 | 30–40 | 0.2–0.6 | 0.15–0.17 | 6.6–8.4 | High | High. |
| 98–100 | 85–100 | 80–95 | 51–60 | 30–40 | <0.06 | 0.15–0.20 | 7.9–8.4 | Very high | Very high. |
| 95–100 | 85–100 | 50–75 | 20–40 | 5–18 | 0.6–2.0 | 0.15–0.20 | 7.9–8.4 | Low | High. |
| 95–100 | 85–100 | 50–75 | 20–40 | 5–18 | 0.6–2.0 | 0.15–0.20 | 7.9–8.4 | Low | High. |
| 70–100 | 65–100 | 40–75 | 20–40 | 5–18 | 0.6–2.0 | 0.15–0.18 | 7.9–8.4 | Low | High. |
| 95–100 | 95–100 | 60–85 | 25–35 | 7–20 | 0.2–0.6 | 0.15–0.20 | 6.1–6.5 | Low | High. |
| 80–100 | 80–100 | 65–90 | 41–55 | 25–35 | <0.06 | 0.14–0.20 | 6.1–7.8 | High | High. |
| 95–100 | 90–100 | 70–90 | 41–55 | 25–35 | <0.06 | 0.12–0.15 | 7.4–7.8 | High | High. |

such transient soil features as plowpans and surface crusts. These ratings should not be confused with the coefficient of permeability, or k-value, used by engineers.

Available water capacity is the ability of a soil to hold water for use by most plants. It commonly is defined as the numerical difference between the amount of water in the soil at field capacity and the amount of water at the time most crop plants wilt. The rate is expressed as inches of water per inch of soil depth.

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

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

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate as well as by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that the probability of soil-induced corrosion damage is low. A rating of *high* means that the probability of damage is high, so that protective measures for steel and a more resistant type of concrete should be used to avoid or minimize damage. All the soils of Bell County are

TABLE 6.—*Engineering*

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

| Soil series and map symbols | Degree and kind of limitation for— | | | | |
|---|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Shallow excavations | Dwellings without basements | Sanitary landfill[1] |
| Altoga: AlC, AlE2 | Moderate: moderate permeability. | Moderate: seepage. | Moderate: silty clay. | Severe: high shrink-swell potential. | Severe: silty clay. |
| *Austin: AsB, AsC, AuC<br>For Urban land part of AuC, see Urban land. | Severe: bedrock at a depth of 22 to 40 inches; moderately slow permeability. | Severe: bedrock at a depth of 22 to 40 inches. | Severe: silty clay; bedrock at a depth of 22 to 40 inches. | Severe: high shrink-swell potential. | Severe: silty clay; bedrock at a depth of 22 to 40 inches. |
| Axtell: AxB | Severe: very slow permeability. | Moderate: slope. | Severe: clay | Severe: high shrink-swell potential. | Severe: clay |
| Bastrop: BaA | Moderate: moderate permeability. | Moderate: seepage. | Slight | Slight | Slight |
| Bosque: Be, Bf | Severe: hazard of flooding. | Severe: hazard of flooding. | Severe: hazard of flooding. | Severe: hazard of flooding. | Severe: hazard of flooding. |
| *Brackett: BkB, BnE, BRE<br>For Urban land part of BnE, see Urban land. | Severe: bedrock at a depth of 10 to 20 inches. | Severe: bedrock at a depth of 10 to 20 inches. | Moderate: rippable bedrock at a depth of 10 to 20 inches. | Moderate: rippable bedrock at a depth of 10 to 20 inches. | Severe: bedrock at a depth of 10 to 20 inches. |
| Branyon: ByA, ByB | Severe: very slow permeability. | Slight | Severe: clay | Severe: very high shrink-swell potential. | Severe: clay |
| Burleson: BzA, BzB | Severe: very slow permeability. | Slight | Severe: clay | Severe: very high shrink-swell potential. | Severe: clay |
| Chigley: ChB | Severe: moderately slow permeability. | Moderate: coarse fragments. | Severe: gravelly clay. | Severe: low strength. | Severe: clay and gravelly clay. |
| Crawford: CrA, CrB | Severe: bedrock at a depth of 20 to 40 inches; very slow permeability. | Severe: bedrock at a depth of 20 to 40 inches. | Severe: clay; bedrock at a depth of 20 to 40 inches. | Severe: very high shrink-swell potential. | Severe: clay; bedrock at a depth of 20 to 40 inches. |
| *Denton: DeA, DeB, DnB, DPB<br>For Urban land part of DnB, see Urban land. | Severe: bedrock at a depth of 22 to 40 inches; slow permeability. | Severe: bedrock at a depth of 22 to 40 inches. | Severe: clay | Severe: high shrink-swell potential. | Severe: clay; bedrock at a depth of 22 to 40 inches. |
| *Eddy: EsB, EsD<br>For Stephen part of EsB and EsD, see Stephen series. | Severe: bedrock at a depth of 5 to 12 inches. | Severe: bedrock at a depth of 5 to 12 inches. | Moderate: rippable bedrock at a depth of 5 to 12 inches. | Moderate: rippable bedrock at a depth of 5 to 12 inches. | Severe: bedrock at a depth of 5 to 12 inches. |
| *Ferris: FeE2<br>For Heiden part of FeE2, see Heiden series. | Severe: very slow permeability. | Severe: slope of 5 to 12 percent. | Severe: clay | Severe: very high shrink-swell potential. | Severe: clay |

*interpretations*

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

| Degree and kind of limitation for—Continued | | | Suitability as a source of— | | Soil features affecting— | |
|---|---|---|---|---|---|---|
| Local roads and streets | Pond reservoir areas | Pond embankments | Road fill | Topsoil | Terraces and diversions | Grassed waterways |
| Severe: low strength. | Moderate: seepage. | Moderate: medium compressibility. | Poor: high shrink-swell potential. | Poor: silty clay. | Slope | Slope. |
| Severe: high shrink-swell potential. | Severe: bedrock at a depth of 22 to 40 inches. | Moderate: fair slope stability. | Poor: high shrink-swell potential. | Poor: silty clay. | All features favorable. | All features favorable. |
| Severe: high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: high shrink-swell potential. | Fair: thickness of material. | High erosion potential. | All features favorable. |
| Moderate: low strength. | Moderate: seepage. | Moderate: poor resistance to piping and erosion. | Fair: low strength. | Fair: thickness of material. | All features favorable. | All features favorable. |
| Severe: hazard of flooding. | Moderate: seepage. | Moderate: fair slope stability; medium compressibility. | Fair: low strength. | Fair: clay loam. | Hazard of flooding. | Hazard of flooding. |
| Moderate: low strength; rippable bedrock at a depth of 10 to 20 inches. | Severe: bedrock at a depth of 10 to 20 inches. | Severe: only 10 to 20 inches of borrow material. | Fair: low strength. | Poor: coarse fragments. | Shallow depth | Shallow depth. |
| Severe: very high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: very high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |
| Severe: very high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: very high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |
| Severe: low strength. | Moderate: seepage. | Moderate: fair slope stability. | Poor: low strength. | Poor: coarse fragments. | High erosion potential. | All features favorable. |
| Severe: bedrock at a depth of 20 to 40 inches; very high shrink-swell potential. | Severe: bedrock at a depth of 20 to 40 inches. | Moderate: 20 to 40 inches of borrow material. | Poor: very high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |
| Severe: bedrock at a depth of 22 to 40 inches; high shrink-swell potential. | Severe: bedrock at a depth of 22 to 40 inches. | Moderate: fair slope stability; 22 to 40 inches of borrow material. | Poor: high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |
| Moderate: bedrock at a depth of 5 to 12 inches. | Severe: bedrock at a depth of 5 to 12 inches. | Severe: only 5 to 12 inches of borrow material. | Poor: bedrock at a depth of 5 to 12 inches. | Poor: thickness of material; coarse fragments. | Shallow depth | Shallow depth. |
| Severe: low strength; very high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: very high shrink-swell potential. | Poor: clay | Steep and eroded slopes. | Steep and eroded slopes. |

TABLE 6.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | | |
|---|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Shallow excavations | Dwellings without basements | Sanitary landfill[1] |
| Frio: Fr, Fs | Severe: moderately slow permeability; hazard of flooding. | Severe: hazard of flooding. | Severe: hazard of flooding. | Severe: hazard of flooding. | Severe: hazard of flooding. |
| *Heiden: HeB, HeC, HfD, HgD2<br>For Ferris part of HgD2, see Ferris series. | Severe: very slow permeability. | Moderate: slope. | Severe: clay | Severe: very high shrink-swell potential. | Severe: clay |
| *Houston Black: HoA, HoB | Severe: very slow permeability. | Slight | Severe: clay | Severe: very high shrink-swell potential. | Severe: clay |
| HoC, HuC<br>For Urban land part of HuC, see Urban land. | Severe: very slow permeability. | Moderate: slope. | Severe: clay | Severe: very high shrink-swell potential. | Severe: clay |
| *Krum: KrA, KrB, KuB<br>For Urban land part of KuB, see Urban land. | Severe: moderately slow permeability. | Slight | Severe: clay | Severe: high shrink-swell potential. | Severe: clay |
| KVB<br>For Lewisville part of KVB, see Lewisville series. | Severe: moderately slow permeability. | Moderate: slope. | Severe: clay | Severe: high shrink-swell potential. | Severe: clay |
| *Lewisville: LeB, LeC, LgC, LuC<br>For Altoga part of LgC, see Altoga series. For Urban land part of LuC, see Urban land. | Moderate: moderate permeability. | Moderate: seepage. | Moderate: silty clay. | Severe: high shrink-swell potential. | Severe: silty clay. |
| Lindy variant: LyB | Severe: slow permeability. | Moderate: bedrock at a depth of 25 to 60 inches. | Severe: clay | Moderate: moderate shrink-swell potential. | Severe: clay; bedrock at a depth of 25 to 60 inches. |
| Menard: MeD2 | Moderate: moderate permeability. | Moderate: seepage. | Slight | Slight | Slight |
| Patrick: PaD | Severe: very rapid permeability; possible pollution of ground water. | Severe: seepage | Moderate: clay | Moderate: low strength. | Severe: seepage |
| Payne: PcA, PcB | Severe: very slow permeability. | Slight | Severe: clay | Severe: low strength. | Severe: clay |
| Pedernales: PdB | Severe: moderately slow permeability. | Slight | Moderate: sandy clay. | Severe: high shrink-swell potential; low strength. | Moderate: sandy clay. |
| *Purves: PrB, PuD, PVD<br>For Urban land part of PuD, see Urban land. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: silty clay; bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches; high shrink-swell potential. | Severe: silty clay; bedrock at a depth of 8 to 20 inches. |

*interpretations*—Continued

| Degree and kind of limitation for—Continued | | | Suitability as a source of— | | Soil features affecting— | |
|---|---|---|---|---|---|---|
| Local roads and streets | Pond reservoir areas | Pond embankments | Road fill | Topsoil | Terraces and diversions | Grassed waterways |
| Severe: low strength. | Moderate: seepage. | Moderate: medium compressibility. | Poor: low strength. | Poor: silty clay. | Hazard of flooding. | All features favorable. |
| Severe: low strength; very high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: very high shrink-swell potential; low strength. | Poor: clay | Slope | Slope. |
| Severe: low strength; very high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: very high shrink-swell potential; low strength. | Poor: clay | Clay | Clay. |
| Severe: low strength; very high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: very high shrink-swell potential; low strength. | Poor: clay | Slope | Slope. |
| Severe: low strength; high shrink-swell potential. | Moderate: seepage. | Moderate: fair slope stability. | Poor: high shrink-swell potential; low strength. | Poor: clay | All features favorable. | All features favorable. |
| Severe: low strength; high shrink-swell potential. | Moderate: seepage. | Moderate: fair slope stability. | Poor: high shrink-swell potential; low strength. | Poor: clay | Slope | Slope. |
| Severe: low strength; high shrink-swell potential. | Moderate: seepage. | Moderate: fair slope stability. | Poor: high shrink-swell potential; low strength. | Poor: silty clay. | Slope | Slope. |
| Severe: low strength. | Moderate: bedrock at a depth of 25 to 60 inches. | Moderate: fair slope stability. | Poor: low strength. | Fair: clay loam. | All features favorable. | All features favorable. |
| Moderate: low strength. | Moderate: seepage. | Moderate: poor resistance to piping and erosion. | Fair: low strength. | Fair: thickness of material. | Slope | Slope. |
| Severe: low strength. | Severe: seepage. | Moderate: 18 to 30 inches of borrow material. | Fair: low strength. | Poor: silty clay. | Slope | Slope. |
| Severe: low strength. | Slight | Moderate: fair slope stability. | Poor: low strength. | Fair: thickness of material. | All features favorable. | All features favorable. |
| Severe: high shrink-swell potential; low strength. | Moderate: gravel and sand at a depth of 35 to 60 inches. | Moderate: fair slope stability; medium compressibility. | Poor: low strength. | Fair: thickness of material. | All features favorable. | All features favorable. |
| Severe: bedrock at a depth of 8 to 20 inches; high shrink-swell potential. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: only 8 to 20 inches of borrow material. | Poor: bedrock at a depth of 8 to 20 inches; high shrink-swell potential. | Poor: silty clay; coarse fragments. | Shallow depth | Shallow depth. |

TABLE 6.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | | |
|---|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Shallow excavations | Dwellings without basements | Sanitary landfill[1] |
| Real: REF | Severe: bedrock at a depth of 8 to 20 inches; slope. | Severe: bedrock at a depth of 8 to 20 inches; slope. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. |
| Riesel: RgB | Severe: slow permeability. | Severe: coarse fragments. | Severe: clay and gravelly clay. | Severe: low strength. | Severe: clay and gravelly clay. |
| *San Saba: SaA, SaB, SnB. For Urban land part of SnB, see Urban land. | Severe: bedrock at a depth of 24 to 40 inches; very slow permeability. | Severe: bedrock at a depth of 24 to 40 inches. | Severe: bedrock at a depth of 24 to 40 inches. | Severe: low strength; very high shrink-swell potential. | Severe: bedrock at a depth of 24 to 40 inches. |
| Speck: SPD, SsB | Severe: bedrock at a depth of 14 to 20 inches; slow permeability. | Severe: bedrock at a depth of 14 to 20 inches. | Severe: bedrock at a depth of 14 to 20 inches. | Severe: bedrock at a depth of 14 to 20 inches. | Severe: bedrock at a depth of 14 to 20 inches. |
| *Stephen: StB, StC, SuC. For Urban land part of SuC, see Urban land. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: silty clay. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. |
| *Tarrant: TAD, TPF. For Purves part of TPF, see Purves series. | Severe: bedrock at a depth of 6 to 20 inches. | Severe: bedrock at a depth of 6 to 20 inches. | Severe: silty clay. | Severe: bedrock at a depth of 6 to 20 inches; high shrink-swell potential. | Severe: silty clay; bedrock at a depth of 6 to 20 inches. |
| Trinity: Tr, Ty | Severe: hazard of flooding; very slow permeability. | Severe: hazard of flooding. | Severe: clay; hazard of flooding. | Severe: hazard of flooding. | Severe: clay; hazard of flooding. |
| Urban land: Ub. Properties too variable to rate. | | | | | |
| Venus: VeA, VeB, VeC | Slight | Severe: seepage. | Moderate: clay loam. | Slight | Moderate: clay loam. |
| Wilson: WcA, WcB | Severe: very slow permeability. | Slight | Severe: clay | Severe: high shrink-swell potential. | Severe: clay |
| WcC | Severe: very slow permeability. | Moderate: slope. | Severe: clay | Severe: high shrink-swell potential. | Severe: clay |

[1] Onsite studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water need to be made for

rated low for corrosivity to concrete except the Axtell series, which rates moderate. Therefore, the column for corrosivity to concrete was not included in the table.

### *Engineering interpretations*

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in nearby areas, and on the experience of engineers and soil scientists with the soils of Bell County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for terraces, diversions, and waterways. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installing, and maintaining structures.

Soil limitations are indicated by the ratings slight,

*interpretations*—Continued

| Degree and kind of limitation for—Continued | | | Suitability as a source of— | | Soil features affecting— | |
|---|---|---|---|---|---|---|
| Local roads and streets | Pond reservoir areas | Pond embankments | Road fill | Topsoil | Terraces and diversions | Grassed waterways |
| Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: only 8 to 20 inches of borrow material. | Poor: bedrock at a depth of 8 to 20 inches. | Poor: coarse fragments. | Slope; shallow depth. | Slope; shallow depth. |
| Severe: low strength. | Severe: seepage. | Moderate: 40 to 65 inches of borrow material. | Poor: low strength. | Poor: coarse fragments. | Gravelly fine sandy loam. | Gravelly fine sandy loam. |
| Severe: low strength; very high shrink-swell potential. | Severe: bedrock at a depth of 24 to 40 inches. | Moderate: fair slope stability; cracks when dry. | Poor: low strength; very high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |
| Severe: bedrock at a depth of 14 to 20 inches; low strength. | Severe: bedrock at a depth of 14 to 20 inches. | Severe: 14 to 20 inches of borrow material. | Poor: bedrock at a depth of 14 to 20 inches; low strength. | Fair: clay loam. | Shallow depth | Shallow depth. |
| Severe: low strength. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: 8 to 20 inches of borrow material. | Poor: bedrock at a depth of 8 to 20 inches; low strength. | Poor: silty clay. | Shallow depth | Shallow depth. |
| Severe: bedrock at a depth of 6 to 20 inches; low strength. | Severe: bedrock at a depth of 6 to 20 inches. | Severe: 6 to 20 inches of borrow material. | Poor: bedrock at a depth of 6 to 20 inches; high shrink-swell potential. | Poor: silty clay. | Shallow depth; slope. | Shallow depth; slope. |
| Severe: very high shrink-swell potential. | Slight | Moderate: fair slope stability; high compressibility. | Poor: low strength; very high shrink-swell potential. | Poor: clay | Hazard of flooding. | Hazard of flooding. |
| Moderate: low strength. | Severe: seepage. | Moderate: fair resistance to piping and erosion. | Fair: low strength. | Fair: clay loam. | All features favorable. | All features favorable. |
| Severe: high shrink-swell potential. | Slight | Moderate: fair slope stability; high compressibility. | Poor: high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |
| Severe: high shrink-swell potential. | Slight | Moderate: fair slope stability. | Poor: high shrink-swell potential. | Poor: clay | All features favorable. | All features favorable. |

landfill deeper than 5 or 6 feet.

moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations that are minor and easily overcome or modified by special planning and design. *Moderate* means that the soils have properties favorable for the rated use. Limitations can be overcome or modified with planning, design, or special maintenance. Some of these limitations can be tolerated. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

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

In the following paragraphs the columns in table 6 are explained.

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

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumptions are made that the embankment is compacted to medium density and that the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope; if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification, and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

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

Dwellings without basements, as rated in table 6, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

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

Local roads and streets, as rated in table 6, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly of asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep. Soil properties that most affect design and construction of roads and streets are load-supporting capacity, stability of the subgrade, and workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material as well as the shrink-swell potential indicate load-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect the ease of excavation and the amount of cut and fill needed to reach and even grade.

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

Pond embankments are raised structures of soil material constructed across drainageways in order to impound water. These embankments are generally less than 20 feet high, are constructed of homogeneous soil material, and are compacted to medium density. Embankments having core and shell-type construction are not rated in this table. Embankment foundation, reservoir area, and slope are assumed to be suitable for pond construction. Soil properties are considered that affect the embankment and the availability of borrow material. The soils suitable for pond embankments have good slope stability, low permeability, slight compressibility under load, and good resistance to piping and erosion. The best borrow material is free of stones or rocks and thick enough for easy excavation.

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

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants grown on the soil when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and content of stone fragments affect suitability. Damage to the area from which topsoil is taken is also considered in the rating.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept.

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

Grassed waterways are either natural or shaped channels seeded with grass to carry runoff water without causing erosion. The suitability of a soil for grassed waterways is determined by the hazard of erosion; the amount of shaping that can be done, which in turn depends on slope, stoniness, and depth to bedrock; and the difficulty in establishing vegetation.

# *Formation and Classification of the Soils*

In this section the five major factors of soil formation are discussed in terms of their effect on the soils of Bell County, the processes of soil horizon differentiation are described, the comprehensive system of soil classification is discussed, and the soils in the county are placed in some of the categories of that system.

## Factors of Soil Formation

Soil is the product of the interaction of five major factors of soil formation. These factors are climate, living organisms, parent material, relief, and time. The kind of soil that develops is determined by the interaction of these factors.

Climate and living organisms are the active forces in soil formation. These forces act on the parent material, which has accumulated through the weathering of rock and unconsolidated deposits, and slowly change that material into a natural body that has genetically related horizons. The parent material itself affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. The effects of climate and living organisms are conditioned by relief. Finally, time is needed to change the parent material into a soil. The amount of time may be long or short. Generally, a long time is required for distinct horizons to develop in a soil.

The interrelationship of the five factors of soil formation is complex, and it is difficult to isolate the effect of any one factor. Each factor is discussed separately in the paragraphs that follow, but the interaction of all the factors, rather than the separate reaction of any one of them, determines the nature of the soil.

### *Climate*

Bell County has a humid, subtropical climate characterized by hot summers. This climate contributes to the formation of soil in several ways. Expansion at high temperatures and contraction at low temperatures fracture parent rock and soil material and hasten weathering. The pattern of rainfall causes the soils to be alternately wet and dry. When such clay soils as Branyon, Crawford, Heiden, and Houston Black dry, they crack. The cracks fill with water when it rains, and the water washes topsoil to the bottom of the crack. In many places these cracks are more than 40 inches deep. After these clay soils become wet, they swell and the cracks close completely. Alternate shrinking and swelling of these soils and the downward movement of the topsoil cause the soil to churn and prevent formation of distinct horizons. Other soils, such as Axtell and Pedernales soils, have clayey lower layers. Water moving through the soil carries clay particles downward into the soil from the surface layer. As the movement of water slows, these clay particles are deposited. As clay accumulates, the water moves more slowly, and the deposition of clay accelerates. Thus, the process tends to speed up, and eventually the lower layers become clayey.

### *Living organisms*

Plants, animals, insects, worms, bacteria, fungi, and man contribute to the formation of soil. Gain of organic matter and of nitrogen in the soil, gain or loss of plant nutrients, and a change in structure and porosity are among the effects of living organisms on soil. In that part of the county on the prairie, grasses have had more influence than other plants on the formation of the soils. The grasses provided litter that protected the surface and added organic matter to dark-colored soils, such as Houston Black and San Saba soils. The grass roots reached deep into the soil and fed on minerals at lower depths. Lime, minerals, and organic matter were distributed throughout the profile as these plants died and decomposed. The decomposed plant roots left channels that increased the intake of water and the aeration of the soil. Earthworms and other organisms fed on the decomposed roots. The borings of earthworms also helped to channel water and air through the soil.

The soils that formed in the wooded part of the county have been affected mainly by oak-savanna vegetation. These soils formed under hardwoods. They are medium to low in organic matter and have a light-colored surface layer.

Man has only been in the survey area a relatively short time. During this time he has concentrated cattle for grazing and has plowed the land. The results of his activities are that soil erosion has taken place at an accelerated rate and, in many places, organic matter has been rapidly depleted.

### *Parent material*

Parent material is the unconsolidated mass from which a soil forms. It determines the chemical and mineralogical composition of the soil. The soils of Bell County formed in parent material of two geologic ages. Material from the Cretaceous Period is throughout the county, and material from the Pleistocene Epoch is deposited along streams and, in some places, over Cretaceous material.

Material from the Cretaceous Period is mainly interbedded limestone and calcareous marl. The western half of the county is underlain by material

of the Comanchean Series, and the eastern half by material of the Gulf Series. The Comanchean Series consists of the Fredericksburg, Trinity, and Washita Groups, and the Gulf Series consists of the Austin, Eagle Ford, and Taylor Groups.

Brackett, Purves, Real, Speck, and Tarrant soils are in areas where limestone is near the surface. Crawford, Denton, Lindy, and San Saba soils are in areas that are deeper over limestone. Austin, Eddy, and Stephen soils are examples of soils that formed in weathered material from the Gulf Series.

Soils such as Bosque, Frio, and Trinity are on the flood plains of rivers and drainageways and formed in alluvium.

### *Relief*

Bell County is a moderately dissected plain that slopes southeastward toward the coast at a rate of about 10 feet per mile. Generally, the relief of the area is smooth, and there are only a few prominent hills in the west-central part of the county. Several westward-facing escarpments mark the rock outcrops.

Relief, or slope, affects soil formation through its influence on runoff, drainage, and erosion. Payne soils, for instance, have slow to medium runoff. Water has moved through the soil and has contributed to the development of soil horizons. Tarrant and Brackett soils, however, formed in the steep areas. Less water has moved through these steeper soils, and they have less distinct horizons. Soil material is removed by water erosion almost as fast as soil formation takes place.

### *Time*

A long time is required for soils to form distinct horizons. The differences in the length of time that parent materials have been in place reflect the degree of soil development.

The soils in Bell County range from young to old. The young soils, such as Bosque, have little horizon development. The horizons of Bosque soils still show the evidence of differentiation, and there has been little change from the original stream-deposited alluvium. The older soils, such as Wilson, have well-expressed horizons.

## Processes of Horizon Differentiation

Most soils have three major horizons. They are designated A, B, and C. In some young soils, as well as in soils that have montmorillonitic clay, which shrinks and swells, a B horizon has not developed. In other soils an R, or rock, layer is present.

Several processes are involved in the formation of A, B, and C horizons. In Bell County, the main processes are the accumulation of organic matter, the leaching of calcium carbonates and bases, and the formation and translocation of silicate clay minerals. In most soils more than one of these processes have been active in the development of horizons. The horizons in a soil differ in one or more properties such as color, thickness, texture, structure, consistence, porosity, or reaction.

The A horizon is the surface layer. It can be either the horizon of maximum organic matter, called the A1, or the horizon of maximum leaching of dissolved or suspended materials, called the A2. The organic-matter content of the soils in Bell County ranges from high to low. Branyon soils have a thick, dark A1 horizon that has a high organic-matter content. Axtell soils have a very thin A1 horizon over an A2 horizon that is thicker and has low organic-matter content.

The B horizon lies immediately beneath the A horizon. It is either the horizon where the maximum amount of dissolved or suspended materials, such as iron or clay, has accumulated or an altered horizon that has distinct structure but little evidence of clay translocation and accumulation. The B horizon that has a significant accumulation of clay is given the designation Bt. The Bt horizon is firmer than the horizons immediately above or below it and may have blocky structure. A horizon that has distinct structure and little evidence of clay accumulation may only be given the B designation. Axtell and Wilson soils have a distinct Bt horizon, and Lewisville and Venus soils have a B horizon.

The C horizon is little affected by the soil-forming process, but it can be material that is modified by weathering.

An R layer is underlying consolidated bedrock, such as limestone.

## Classification of Soils

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

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

The system of soil classification used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the system should search the latest literature available.[7,8]

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this sytem the criteria used as a basis for classification are soil properties that are

[7]Simonson, Roy W. Soil classification in the United States. Science, v. 137, No. 3535, pp. 1027–1034, 1962.

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

TABLE 7.—*Classification of soil series*

| Series | Family | Subgroup | Order |
|---|---|---|---|
| Altoga | Fine-silty, carbonatic, thermic | Typic Ustochrepts | Inceptisols. |
| Austin | Fine-silty, carbonatic, thermic | Typic Haplustolls (Calciustolls). | Mollisols. |
| Axtell | Fine, montmorillonitic, thermic | Udertic Paleustalfs | Alfisols. |
| Bastrop | Fine-loamy, mixed, thermic | Udic Paleustalfs | Alfisols. |
| Bosque | Fine-loamy, mixed, thermic | Cumulic Haplustolls | Mollisols. |
| Brackett | Loamy, carbonatic, thermic, shallow | Typic Ustochrepts | Inceptisols. |
| Branyon | Fine, montmorillonitic, thermic | Udic Pellusterts | Vertisols. |
| Burleson | Fine, montmorillonitic, thermic | Udic Pellusterts | Vertisols. |
| Chigley | Fine, mixed, thermic | Udic Paleustalfs | Alfisols. |
| Crawford | Fine, montmorillonitic, thermic | Udic Chromusterts | Vertisols. |
| Denton | Fine, montmorillonitic, thermic | Vertic Calciustolls | Mollisols. |
| Eddy | Loamy-skeletal, carbonatic, thermic, shallow | Typic Ustorthents | Entisols. |
| Ferris | Fine, montmorillonitic, thermic | Udorthentic Chromusterts | Vertisols. |
| Frio | Fine, mixed, thermic | Cumulic Haplustolls | Mollisols. |
| Heiden | Fine, montmorillonitic, thermic | Udic Chromusterts | Vertisols. |
| Houston Black | Fine, montmorillonitic, thermic | Udic Pellusterts | Vertisols. |
| Krum | Fine, mixed, thermic | Vertic Haplustolls | Mollisols. |
| Lewisville | Fine-silty, mixed, thermic | Typic Calciustolls | Mollisols. |
| Lindy variant | Fine, mixed, thermic | Udic Haplustalfs | Alfisols. |
| Menard | Fine-loamy, mixed, thermic | Typic Haplustalfs | Alfisols. |
| Patrick | Clayey over sandy or sandy-skeletal, carbonatic, thermic | Typic Calciustolls | Mollisols. |
| Payne | Fine, montmorillonitic, thermic | Udic Paleustalfs | Alfisols. |
| Pedernales | Fine, mixed, thermic | Udic Paleustalfs | Alfisols. |
| Purves | Clayey, montmorillonitic, thermic | Lithic Calciustolls | Mollisols. |
| Real | Loamy-skeletal, carbonatic, thermic, shallow | Typic Calciustolls | Mollisols. |
| Riesel | Clayey-skeletal, montmorillonitic, thermic | Udic Paleustalfs | Alfisols. |
| San Saba | Fine, montmorillonitic, thermic | Udic Pellusterts | Vertisols. |
| Speck | Clayey, mixed, thermic | Lithic Argiustolls | Mollisols. |
| Stephen | Clayey, mixed, thermic, shallow | Typic Haplustolls (Calciustolls). | Mollisols. |
| Tarrant | Clayey-skeletal, montmorillonitic, thermic | Lithic Calciustolls | Mollisols. |
| Trinity | Fine, montmorillonitic (calcareous), thermic | Vertic Haplaquolls | Mollisols. |
| Venus | Fine-loamy, mixed, thermic | Typic Calciustolls | Mollisols. |
| Wilson | Fine, montmorillonitic, thermic | Vertic Ochraqualfs | Alfisols. |

observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 7, the soil series of Bell County are placed in some categories of the classification system. Classes of the system are briefly defined in the following paragraphs.

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

SUBORDER: Each order is divided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect the presence or the absence of waterlogging or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order.

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

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

FAMILY: Soil families are separated 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. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are

TABLE 8.—*Temperature*

[Data recorded at Temple, elevation

| Month | Temperature[1] | | | | Precipitation | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Probability, in percent, of receiving— | | | |
| | Average daily maximum | Average monthly maximum | Average daily minimum | Average monthly minimum | Average total | 0 or trace | 0.50 inch or more | 1 inch or more | 2 inches or more |
| | °F | °F | °F | °F | In | Pct | Pct | Pct | Pct |
| January | 58.3 | 78.4 | 36.2 | 18.8 | 2.35 | (3) | 90 | 74 | 48 |
| February | 62.1 | 80.7 | 39.4 | 23.5 | 2.62 | (3) | 95 | 83 | 55 |
| March | 70.4 | 85.7 | 45.7 | 29.6 | 2.01 | (3) | 92 | 76 | 48 |
| April | 78.5 | 90.8 | 55.2 | 39.6 | 3.67 | (3) | 96 | 89 | 70 |
| May | 84.9 | 93.8 | 63.5 | 50.9 | 4.65 | (3) | 98 | 94 | 79 |
| June | 92.2 | 98.3 | 70.3 | 62.1 | 3.17 | 1 | 90 | 74 | 55 |
| July | 96.1 | 102.3 | 73.0 | 68.0 | 1.96 | (3) | 86 | 70 | 40 |
| August | 97.5 | 104.3 | 72.7 | 66.4 | 1.97 | 5 | 80 | 62 | 38 |
| September | 91.6 | 100.3 | 67.2 | 54.6 | 3.15 | (3) | 88 | 75 | 55 |
| October | 82.2 | 92.7 | 57.2 | 42.2 | 2.73 | 3 | 82 | 82 | 45 |
| November | 69.3 | 85.3 | 45.8 | 30.3 | 2.93 | (3) | 85 | 70 | 40 |
| December | 61.5 | 78.9 | 39.9 | 23.8 | 2.66 | 1 | 90 | 80 | 50 |
| Year | 78.7 | | 55.4 | | 33.87 | | | | |

[1] Average length of record, 35 years.
[2] Average length of record, 12 years.
[3] Less than 1 percent.

the class names for texture, mineralogy, and so on, that are used as family differentiae.

SERIES: The series consists of 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.

## Climate[9]

The climate of Bell County is humid subtropical and is characterized by hot summers. The range between the annual extremes of temperature is wide, a characteristic of continental climates. Tropical maritime air controls the climate during spring, summer, and fall. In winter and early in spring, frequent surges of Polar Canadian air cause sudden drops in temperature and add considerable variety to the daily weather.

Precipitation is fairly evenly distributed throughout the year and averages 33.87 inches annually (table 8). The driest months are July and August. The wettest year since 1891, the first year climatological data were recorded in the county, was 1902. A total of 58.33 inches fell that year. Only 13.89 inches fell in 1954, the driest year of record.

The prevailing winds are southerly. The strongest persistent winds are in March and April. The strongest winds are the peak gusts and squalls associated with thunderstorms. These winds accompany both intense low-pressure centers—extratropical cyclones—that move eastward from the Texas Panhandle and vigorous, fast-moving cold fronts.

The relative humidity is fairly uniform throughout the year, but it varies considerably during the day. The average annual relative humidity is 83 percent at 6:00 a.m., 55 percent at noon, and 52 percent at 6:00 p.m. The average amount of sunshine received annually is about 62 percent of the total amount possible. The evaporation of lake water is estimated at 56 inches annually.

Winter temperatures are generally mild, and cold spells are brief. The minimum temperature drops to 32° F or below only on about half of the nights in January, the coldest month. Considerable cloudiness occurs in the morning. The overcast breaks up about noon and is followed by sunshine and warmer temperatures during the afternoon. Prolonged periods of overcast skies and persistent, light precipitation are likely to occur about once or twice a month. The amount of sunshine received in winter averages about 50 percent of the total amount possible. Snowfalls are generally light. Measurable amounts of snow are rare because the snow melts as rapidly as it falls and leaves no accumulation. The lowest temperature on record at Temple is −4°, which occurred February 11, 1899.

Spring is a season of rapid and often abrupt weather changes. This is especially true in March, when warm and cool spells of short duration follow each other in rapid succession. The drizzle and light rain of winter decrease and shower or thundershower activity increases to an average of about 6

[9] By ROBERT B. ORTON, climatologist for Texas, U.S. Weather Service, U.S. Department of Commerce.

*and precipitation*

700 feet; period of record 1933-67]

| Precipitation—Continued | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Probability, in percent, of receiving—Continued | | | | Average number of days when rainfall is—[1] | | | Snow and sleet | | |
| 3 inches or more | 4 inches or more | 5 inches or more | 6 inches or more | 0.10 inch or more | 0.50 inch or more | 1 inch or more | Average total[1] | Maximum[1] | Greatest depth[2] |
| *Pct* | *Pct* | *Pct* | *Pct* | | | | *In* | *In* | *In* |
| 30 | 18 | 10 | 4 | 4 | 1 | 1 | 0.8 | 8.0 | 5 |
| 34 | 18 | 9 | 4 | 5 | 2 | 1 | .6 | 9.0 | 5 |
| 30 | 18 | 10 | 2 | 3 | 1 | ([4]) | .1 | 3.5 | 0 |
| 50 | 34 | 23 | 15 | 6 | 2 | 2 | 0 | 0 | 0 |
| 59 | 45 | 31 | 21 | 5 | 2 | 2 | 0 | 0 | 0 |
| 40 | 28 | 20 | 15 | 4 | 2 | 1 | 0 | 0 | 0 |
| 20 | 10 | 5 | 4 | 2 | 1 | 1 | 0 | 0 | 0 |
| 20 | 10 | 5 | 4 | 3 | 1 | 1 | 0 | 0 | 0 |
| 38 | 28 | 20 | 15 | 5 | 2 | 1 | 0 | 0 | 0 |
| 30 | 20 | 18 | 10 | 4 | 2 | 1 | 0 | 0 | 0 |
| 25 | 15 | 10 | 5 | 5 | 2 | 1 | .2 | 6.0 | ([5]) |
| 30 | 20 | 10 | 5 | 5 | 1 | 1 | ([5]) | ([5]) | 0 |
| | | | | 51 | 19 | 13 | 1.7 | 9.0 | 5 |

[4] Less than one-half day.
[5] Trace.

days per month in April and 7 days in May, the peak month for thunderstorms.

In summer, daytime temperatures are high and the day-to-day weather seldom changes. Thundershowers occur less frequently in summer than in spring, but they help to break the uniformity of the hot weather. Early morning and evening temperatures are normally pleasant, and midday temperatures are hot. The highest temperature on record is 112°, which occurred August 11, 1947.

In fall, temperatures continue to be high into September. The daily maximum is 90° or above about 57 percent of the time. The amount of precipitation increases in September. After mid-October, more cold fronts move through the area and the weather becomes more varied. Thundershowers become less frequent, temperatures more moderate, and windspeeds relatively low.

The average length of the freeze-free period in Bell County is 260 days. The average date of the last occurrence of 32° in spring is March 9, and the first occurrence of 32° in fall is November 24.

A summary of the temperature and precipitation data for the county is given in table 8.

## 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, that has been deposited on land by streams.

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

**Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

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

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

**Claypan.** A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

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

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

**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, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

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

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

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

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

**Diversion, or diversion terrace.** A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

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

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

**Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

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

**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.

**Gravel.** As a soil separate, the rounded or angular fragments of rock that range in size from 2 millimeters to 3 inches in diameter. As a soil textural class, soil material that consists of 15 to 50 percent gravel, by volume. In engineering, gravel is a coarse-grained soil of which more than 50 percent is retained on a No. 4 screen.

**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, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

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

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

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

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

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

**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.

**Munsell notation.** A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

**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.*

**pH value.** A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

**Plowpan.** A compacted layer formed in the soil immediately below the plowed layer.

**Poorly graded.** A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

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

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

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

**Relief.** The elevations of inequalities of a land surface, considered collectively.

**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 surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

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

**Soil separates.** Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science

are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

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

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

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

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

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

**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.

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

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

## GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a pasture and hay group, or a range site read the introduction to the section it is in for general information about its management. Dashes in a column mean that the mapping unit was not placed in that particular grouping. Other information is given in tables as follows:


Acreage and extent, table 1, page 5.
Predicted yields, table 2, page 42.
Suitability of the soils for wildlife, table 3, page 49.
Recreational development, table 4, page 52.
Engineering uses of soils, tables 5 and 6, pages 56 through 67.


| Map symbol | Mapping unit | Page | Capability unit | | Pasture and hay group | | Range site | |
|---|---|---|---|---|---|---|---|---|
| | | | Symbol | Page | Symbol | Page | Name | Page |
| AlC | Altoga silty clay, 2 to 5 percent slopes | 6 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| AlE2 | Altoga silty clay, 5 to 10 percent slopes, eroded | 6 | VIe-2 | 39 | 7D | 41 | Clay Loam | 45 |
| AsB | Austin silty clay, 1 to 3 percent slopes | 7 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| AsC | Austin silty clay, 3 to 5 percent slopes | 7 | IVe-2 | 38 | 7C | 41 | Clay Loam | 45 |
| AuC | Austin-Urban land complex, 1 to 5 percent slopes | 7 | -------- | -- | --- | -- | ---------- | -- |
| AxB | Axtell fine sandy loam, 1 to 3 percent slopes | 8 | IIIe-1 | 36 | 8A | 41 | Claypan Savanna | 45 |
| BaA | Bastrop fine sandy loam, 0 to 2 percent slopes | 8 | IIe-3 | 35 | 8C | 41 | Sandy Loam | 47 |
| Be | Bosque clay loam | 9 | I-1 | 35 | 1C | 41 | Loamy Bottomland | 47 |
| Bf | Bosque clay loam, frequently flooded | 9 | Vw-1 | 39 | 1C | 41 | Loamy Bottomland | 47 |
| BkB | Brackett clay loam, 1 to 3 percent slopes | 9 | IVs-1 | 39 | 13A | 41 | Adobe | 44 |
| BnE | Brackett-Urban land complex, 3 to 12 percent slopes | 10 | -------- | -- | --- | -- | ---------- | -- |
| BRE | Brackett association, rolling | 10 | VIIs-2 | 40 | --- | -- | Adobe | 44 |
| ByA | Branyon clay, 0 to 1 percent slopes | 11 | IIw-1 | 36 | 7A | 41 | Blackland | 44 |
| ByB | Branyon clay, 1 to 3 percent slopes | 11 | IIe-1 | 35 | 7A | 41 | Blackland | 44 |
| BzA | Burleson clay, 0 to 1 percent slopes | 12 | IIw-1 | 36 | 7A | 41 | Blackland | 44 |
| BzB | Burleson clay, 1 to 3 percent slopes | 12 | IIe-1 | 35 | 7A | 41 | Blackland | 44 |
| ChB | Chigley gravelly fine sandy loam, 1 to 3 percent slopes | 12 | IIIe-1 | 36 | 8A | 41 | Claypan Savanna | 45 |
| CrA | Crawford clay, 0 to 1 percent slopes | 13 | IIIs-1 | 38 | 7A | 41 | Deep Redland | 46 |
| CrB | Crawford clay, 1 to 3 percent slopes | 13 | IIIe-5 | 38 | 7A | 41 | Deep Redland | 46 |
| DeA | Denton silty clay, 0 to 1 percent slopes | 14 | IIs-1 | 35 | 7C | 41 | Clay Loam | 45 |
| DeB | Denton silty clay, 1 to 3 percent slopes | 14 | IIe-2 | 35 | 7C | 41 | Clay Loam | 45 |
| DnB | Denton-Urban land complex, 1 to 3 percent slopes | 14 | -------- | -- | --- | -- | ---------- | -- |
| DPB | Denton association, undulating | 14 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| EsB | Eddy-Stephen complex, 0 to 3 percent slopes | 15 | IVs-1 | 39 | 14A | 42 | Chalky Ridge | 44 |
| EsD | Eddy-Stephen complex, 3 to 8 percent slopes | 15 | VIe-3 | 39 | 14A | 42 | Chalky Ridge | 44 |
| FeE2 | Ferris-Heiden complex, 5 to 12 percent slopes, eroded | 16 | VIe-2 | 39 | 7B | 41 | Eroded Blackland | 46 |
| Fr | Frio silty clay | 16 | I-1 | 35 | 1C | 41 | Loamy Bottomland | 47 |
| Fs | Frio silty clay, frequently flooded | 17 | Vw-1 | 39 | 1C | 41 | Loamy Bottomland | 47 |
| HeB | Heiden clay, 1 to 3 percent slopes | 18 | IIe-1 | 35 | 7A | 41 | Blackland | 44 |
| HeC | Heiden clay, 3 to 5 percent slopes | 18 | IIIe-2 | 36 | 7A | 41 | Blackland | 44 |
| HfD | Heiden stony clay, 3 to 8 percent slopes | 18 | VIe-2 | 39 | --- | -- | Blackland | 44 |

| Map symbol | Mapping unit | Page | Capability unit | | Pasture and hay group | | Range site | |
|---|---|---|---|---|---|---|---|---|
| | | | Symbol | Page | Symbol | Page | Name | Page |
| HgD2 | Heiden-Ferris complex, 3 to 8 percent slopes, eroded | 18 | IVe-1 | 38 | 7B | 41 | Blackland | 44 |
| HoA | Houston Black clay, 0 to 1 percent slopes | 20 | IIw-1 | 36 | 7A | 41 | Blackland | 44 |
| HoB | Houston Black clay, 1 to 3 percent slopes | 20 | IIe-1 | 35 | 7A | 41 | Blackland | 44 |
| HoC | Houston Black clay, 3 to 5 percent slopes | 20 | IIIe-2 | 36 | 7A | 41 | Blackland | 44 |
| HuC | Houston Black-Urban land complex, 1 to 5 percent slopes | 20 | -------- | -- | --- | -- | ---------- | -- |
| KrA | Krum silty clay, 0 to 1 percent slopes | 21 | IIs-1 | 35 | 7C | 41 | Clay Loam | 45 |
| KrB | Krum silty clay, 1 to 3 percent slopes | 21 | IIe-2 | 35 | 7C | 41 | Clay Loam | 45 |
| KuB | Krum-Urban land complex, 0 to 3 percent slopes | 21 | -------- | -- | --- | -- | ---------- | -- |
| KVB | Krum-Lewisville association, undulating | 21 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| LeB | Lewisville silty clay, 1 to 3 percent slopes | 22 | IIe-2 | 35 | 7C | 41 | Clay Loam | 45 |
| LeC | Lewisville silty clay, 3 to 5 percent slopes | 22 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| LgC | Lewisville-Altoga complex, 2 to 5 percent slopes | 22 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| LuC | Lewisville-Urban land complex, 1 to 5 percent slopes | 22 | -------- | -- | --- | -- | ---------- | -- |
| LyB | Lindy clay loam, dark subsoil variant, 0 to 2 percent slopes | 23 | IIe-2 | 35 | 7C | 41 | Deep Redland | 46 |
| MeD2 | Menard soils, 5 to 8 percent slopes, eroded | 24 | IVe-5 | 39 | 8C | 41 | Sandy Loam | 47 |
| PaD | Patrick soils, 1 to 8 percent slopes | 24 | IVe-3 | 38 | 7C | 41 | Chalky Ridge | 44 |
| PcA | Payne loam, 0 to 1 percent slopes | 25 | IIIs-2 | 38 | 7H | 41 | Claypan Prairie | 45 |
| PcB | Payne loam, 1 to 3 percent slopes | 25 | IIIe-4 | 37 | 7H | 41 | Claypan Prairie | 45 |
| PdB | Pedernales fine sandy loam, 1 to 3 percent slopes | 26 | IIe-3 | 35 | 8A | 41 | Sandy Loam | 47 |
| PrB | Purves silty clay, 1 to 4 percent slopes | 26 | IVe-3 | 38 | 13A | 41 | Shallow | 48 |
| PuD | Purves-Urban land complex, 1 to 8 percent slopes | 26 | -------- | -- | --- | -- | ---------- | -- |
| PVD | Purves association, undulating | 26 | VIs-1 | 39 | --- | -- | Shallow | 48 |
| REF | Real association, hilly | 27 | VIIs-1 | 39 | --- | -- | Steep Rocky | 48 |
| RgB | Riesel gravelly soils, 1 to 3 percent slopes | 28 | VIe-1 | 39 | 8A | 41 | Gravelly | 46 |
| SaA | San Saba clay, 0 to 1 percent slopes | 28 | IIIs-1 | 38 | 7A | 41 | Blackland | 44 |
| SaB | San Saba clay, 1 to 3 percent slopes | 28 | IIIe-5 | 38 | 7A | 41 | Blackland | 44 |
| SnB | San Saba-Urban land complex, 0 to 3 percent slopes | 28 | -------- | -- | --- | -- | ---------- | -- |
| SPD | Speck association, undulating | 29 | VIs-1 | 39 | --- | -- | Redland | 47 |
| SsB | Speck soils, 1 to 3 percent slopes | 29 | IIIe-6 | 38 | 13A | 41 | Redland | 47 |
| StB | Stephen silty clay, 1 to 3 percent slopes | 30 | IIIe-6 | 38 | 13A | 41 | Chalky Ridge | 44 |
| StC | Stephen silty clay, 3 to 5 percent slopes | 30 | IVe-3 | 38 | 13A | 41 | Chalky Ridge | 44 |

| Map symbol | Mapping unit | Page | Capability unit | | Pasture and hay group | | Range site | |
|---|---|---|---|---|---|---|---|---|
| | | | Symbol | Page | Symbol | Page | Name | Page |
| SuC | Stephen-Urban land complex, 1 to 6 percent slopes | 30 | -------- | -- | --- | -- | ---------- | -- |
| TAD | Tarrant association, undulating | 31 | VIIs-3 | 40 | --- | -- | Low Stony Hill | 47 |
| TPF | Tarrant-Purves association, rolling | 31 | VIIs-1 | 39 | --- | -- | Low Stony Hill | 47 |
| Tr | Trinity clay | 32 | IIw-1 | 36 | 1A | 40 | Clayey Bottomland | 45 |
| Ty | Trinity clay, frequently flooded | 32 | Vw-1 | 39 | 1A | 40 | Clayey Bottomland | 45 |
| Ub | Urban land | 32 | -------- | -- | --- | -- | ---------- | -- |
| VeA | Venus clay loam, 0 to 1 percent slopes | 33 | I-1 | 35 | 7C | 41 | Clay Loam | 45 |
| VeB | Venus clay loam, 1 to 3 percent slopes | 33 | IIe-2 | 35 | 7C | 41 | Clay Loam | 45 |
| VeC | Venus clay loam, 3 to 5 percent slopes | 33 | IIIe-3 | 37 | 7C | 41 | Clay Loam | 45 |
| WcA | Wilson clay loam, 0 to 1 percent slopes | 34 | IIIw-1 | 38 | 7H | 41 | Claypan Prairie | 45 |
| WcB | Wilson clay loam, 1 to 3 percent slopes | 34 | IIIe-4 | 37 | 7H | 41 | Claypan Prairie | 45 |
| WcC | Wilson clay loam, 3 to 5 percent slopes | 34 | IVe-4 | 39 | 7H | 41 | Claypan Prairie | 45 |

☆ U. S. GOVERNMENT PRINTING OFFICE : 1977--226-645/33

# NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.